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INDEX TO "THE ELECTRICIAN."
VOL. LXXXI.

SPECIAL INDEXES.

	PAGE
*Municipal, Foreign and General Notes	vi.
Companies' Meetings, Reports, Dividends, Statutory Returns, &c.	v i.
Companies (New Electrical, &c.) Registered	viii.

* *Entries in these Indexes are not included in the* GENERAL INDEX.

SUB-HEADINGS IN GENERAL INDEX.

	PAGE		PAGE		
Accounts	ii.	Obituary	iv.	Telegraphy	
Educational	iii.	Parliamentary Intelligence ..	iv.	Telephony	
Institution of Electrical Engineers	iii.	Personal	iv.	Wireless Telegraphy and Telephony	
Legal Intelligence	iv.	Railways, Electric	v.		
		Reviews of Books	v.		

Names of Authors of Articles and Papers are indexed alphabetically in the GENERAL INDEX, *and not under the sub-heading*

General Alphabetical Index.

Heavy figures **denote that the subject matter is a "Leading Article" or in the "Editorial Notes." When the letter (C) is placed after a title it signifies that the article in question appeared in the Correspondence columns.**

A

Abaci Construction [Eason], 339
Accidents, Industrial, 625
Accidents, Industrial, Causes of, **118**
Accidents in Quarries and Metal Mines in the U.S. in 1916, 307

ACCOUNTS—
Aberdeen, 446, 485
Barking, 260
Bath, 426
Belfast, 367
Birkenhead, 466
Birmingham, 217
Blackburn, 238
Blackpool, 137, 456
Bolton, 324
Brighton, 283, 408
Bristol, 303
Burnley, 233
Carlisle, 260, 324
Chester, 408
Colchester, 283
Coventry, 446
Croydon, 426
Fareham, 325
Glasgow, 217, 324, 367, 485
Greenock, 446
Halifax, 52, 238
Hampstead (London), 367
Haslingden, 52
Hastings, 466
Huddersfield, 283
Hull, 325
Islington, 506
Kettering, 426
King's Lynn, 426, 506
Leeds, 217, 367
Liverpool, 53
Manchester, 137, 233
Norwich, 485
Nottingham, 260
Poplar, 367
Preston, 426
Rochdale, 283, 408
Salford, 75, 446
Sheffield, 260, 446
Southport, 426
South Shields, 137
Sunderland, 260, 283
Tynemouth, 238
W. Bromwich, 466
W. Ham, 426
Willesden, 426
Wimbledon, 283
Winchester, 426
Wolverhampton, 485
Worcester, 466

Accumulators, Maintenance in War Time, 549
Accumulators, Separators for, 251
Administrative Ability, **892**
Advertising in Technical Journals, 342
ADLER, L.: Armature Heating in Traction Motors, **308**, 311
Advisory Council, Provisional, 522
A.E.G. Organisation, 348
Aeronautical Engineering Training, 548
Aeroplane Röntgen Outfit, 645
Afforestation in Great Britain, 428
After-War Difficulties, 280
Agricultural Machinery, 34
Air Raid Signals, 264
Aircraft Materials and Parts, Standardisation of, 399
Air-Gap having Slots in Both Opposing Surfaces, Reluctance of, (Carter) 400, [Smith] (C) 421
Alcohol for Motor Fuel, 522
Alkali Industry, 631
Alien Enemy Companies, 71
ALLCOTT, C. T.: New Standard of Current and Potential, 684
Alloys, Acid-Resisting Ferro-Silicon, 328
Alloys of Lead and Tin, New, 706
Alternators, Synchronising [Styff], 290
Alternators, Determination of Internal Phase Angle, 328
Alternating Currents and Electric Oscillations, New Method of Measuring [Williams], 253
Aluminium Production in the United States, 509
American Engineers and War Service, **328**
America's Energy Supply, **568**
APPLETON, E. V. L.:
Note on the Production of Continuous Electrical Oscillations by the Three-Electrode Valve, 743
(C): Approximate Integration, 402
Arbitration, Compulsory, 156
Arc, Flaming, Chemistry of, 201
Arc in Gases, Experimental Examination under Pressure [Mathieson], 451
Arc Lamp Globes, Renovating Discoloured, 707
Armature Winding, Continuous Current, Elementary Principles [Denton] (concluded from p. 897, Vol. LXXX.) 8, [Maccall] (C) 14, 68 [Denton] (C) 29, 91, 361, [Nims] (C) 255
ARNHOLD BROS. & Co. (C), Commercial Development of Engineering in China, 29
Artillery Developments during the War, 307
Arora Electric Fires, 442
Asbestos for Boiler Settings, 586
Asbestos, Modern Uses, 328, 410
Association of Consulting Engineers, 126
Association of Mining Electrical Engineers, 220, **242**
Australian Imports, 215
Australian Industries, Organisation of, 385
Australian Trade in 1917, 600
Australian Zinc, 16
ATKINSON, L. B.: Dynamical Theory of Electric Engines, **608**, 616
Atmospherics, Device for Elimination, 680
Australian Post Office Engineers' Salaries, 690

B

Bad Debts, Foreign, Insuring Against, 195
Balloon Fabrics, Permeability, 549
Bank Amalgamation, 71
Banking Facilities and After-war Problems, **442**
BARCLAY, S. F.: Mechanical Design and Specification of the Turbo-Alternator Rotor (*Discussion*), 228, [Behrend] (C) 110, [Barclay] (C) 214
BASTIAN, C. O. (C): Coal Economy and National Health, 131
Batti-Wallahs and Mr. Havelock Wilson, 429
Batti-Wallah's Society, 508, 541, 568, 623
Battery, Primary; New Form, 56
Batteries, Vehicle, Lead for, 92
Battery Charging, Resistances, 410
BEARCE, W. D.: Operation of Railway Sub-Stations without Attendants, 229
Bearings, Armature Ball, Advantages on Electric Cars, 732
Bearings, Ball, for Electric Motors, 3
Belfast Association of Engineers, 508
Belgian Reconstruction and Trade, 635
Belgian Industry, Reconstruction, 17
Belgium, Re-construction of Elec. Supply, 494
BEHN-ESCHENBURG, H.: Regenerative Braking with Single-Phase Commutator Motors, **705**, 708
BEHREND, H.: Charging Currents and Earthing Devices in Transmission Lines, **219**, 222
BEHREND, B. A. (C): Improvement of the Turbo-Alternator, 110
Belts, Driving, Paper, 593
BENN, E. J. P.: Trade Parliaments and Their Work, 11, 25, 45, 65, 87, 103, 132, 148, 165, 213
BIERMANN, F.: Electrical Apparatus for Boiling Water, 740
Birthday Honours, 99, 119, 141
Bismuthinite and Various other Substances, Photo-electric Sensitivity, 286
Birmingham Industries, Electricity, 673
Bituminous Coals, Firing, in Large House Heating Boilers, 98
Blast Furnace Practice, 35
Blind, Electrical Work for [Ravenshaw] (C) 277
Board of Trade Electric Power Supply Committee, **4**, 78, 100, **108**
Boilers, Increasing Evaporation, 312
Boiler Operations, Useful Record, 489
Boiler House and Engine Room Efficiency, 501
Boilers Revocation Order, 727
Boilers, Second-Hand Dealing in, 522, 602
Bonus System in America, 134
BOWER, W. R.: Tercentenary of Common Logarithms 231, [Russell] (C) 255, [Bower] (C) 278
Boy Welfare Work, **55**, **656**
Brass, Electric Melting, 620
Brass, Expansion, 264
Brazil, Engineering Investigation, 482
BRIGHT, C. (C): Telegraphy, Aeronautics and War, 580
Brisbane Tramways Purchase, 235
British Aluminium Co.'s Bill, **1**
British Dyes, Ltd., Progress, **98**, 109
British Electrical Engineers' Association, 111, **117**, [Atkinson Simpson, Spurr, Furness, Morgan, Chayter] (C), 153, 154
BRITISH ENGINEER (C): Empire Water-Power Development, 560
British East Africa, Electrical Legislation, 442, 458
British Engineering in China [Veritas] (C), 46
British Engineering Standards Association, 98
British Engineers' Association, 727
British Empire Trade Mark, 195
British Electrical and Allied Manufacturers' Association, 278
British Science Guild, 98, 99, 185, 306
British Scientific Products Exhibition, 3, **285**, 341, **327**, 359, **380**, 382, 398, **410**, 657
British Industry, Oldest, 548
British Industrial Art, **547**
British Trade with the Dominions, 563
BROUGHTON, H. H.: Electric Winding Engines and Mine Hoists, **199**, 206, 226, 332, 354, 433, 453, 473, 495, 534, 553, 574
Building Materials, Heat Transmission, 221
British Westinghouse Contactor Control Gear, 633
Bureaucracy, Protest Against, 650
BURROWS, C. W., and R. L. SANFORD: Experimental Study of the Fahy Permeameter, 202
'Bus Bars, Copper, Carrying Capacity, 201

C

Cable Facilities for Imperial News Service, 280
Cables, Electric, in Australia, 195
Cables, Three-Conductor High-Tension, Measurement of Power Loss in Di-electrics [Farmer], 288
Cadmium, Effect on Alloys of Copper and Zinc, 78
California Railroad Commission's Rules on Inductive Interference, 573
Callender's Co., New Capital, 502
Canadian Trade in 1917, 563
Capital, Foreign, in British Trade, 363
Capital Charges and Coal Costs, **77**
Capital Issue Restrictions, 625
Capital and Labour, **308**, 318
Capital and Labour and the Government, **140**, 149
Carbon Resistivity, Influence of Hydrogen, 220
Carborundum, Grading for Optical Purposes, 118
Carnegie Institution and Terrestrial Magnetism, 264
CARTER, F. W.: Reluctance of an Air-Gap Having Slots in Both Opposing Surfaces, [Smith] (C), 421
CARTER, T.: Size and Working Cost of Motor for Continuous-Current Transformation, 514
Cathode Tube, 370
Cell, Experimental, New Form, 192
Cell, Photo-Electric, Yielding Alternating Current, 265
Cell, Standard, Thermo-Electric [Hoxie], 3
Charges, Minimum, for Electricity, 577
Charges for Electric Supply, Temporary Increase, [Cole] (C) 402
Chemical Obstruction, **22**
Chemistry, Pure and Applied, Future, 292
CHENEVEAU, C., CH. GENEAU, and SIR R. HADFIELD: Contribution to the Study of the Magnetic Properties of Manganese Alloys, Some Special Manganese Steels, 179
CHILDS, A. T., and V. M. MONTSINGER: Temperature Indicator for Transformer Winding, 450
China, British Engineering in [Veritas] (C)
China, Commercial Development of Engineering [Arnhold Bros. & Co.] (C), 29
China, Electrical Manufacture, 423
China, Opportunities for Electrical Development, 390
Chinese Wood-Oil Industry, 34
Cinema as an Advertising Medium, 582
Cinematograph Outfits, Portable, for Sale, 390
Cinematograph Theatres and Coal Supply, 220
CLEWELL, C. E.: Study of Group and Individual Motor Drives, 102
Close of War Matters [Cole] (C), 646
CLOTHIER, H. W.: Some Considerations Relating to Large Power Station Switching, 175
Coal Conservation, 625
Coal Conservation Committee's Report, 404
Coal Conservation Sub-Committee, 121
Coal Consumption on the Hungarian Railways, 707
Coal Costs and Capital Charges, **77**
Coal Crisis [Cole] (C), 541, 671
Coal Economy Campaign, 561
Coal Economy, Industrial [Wilson], 540, 559
Coal Economy and the I.M.E.A., **369**, 384
Coal Economy and National Health [Bastian] (C), 131
Coal, Gas and Electricity, Rationing, 264
Coal Handling Problems [Woodhouse], 16
Coal, High Grade, Use During Periods of Peace, 349
Coal, Price, 194
Coal Saving and Cinematograph Theatres, 3
Coal-Saving and the Electrification of Railways in Switzerland, 449
Coal-Seam Working, Deep, 529
Coal Shortage in Russia, 548
Coal Systems in America, Pulverised, Investigation, 528.
Coal Trade after the War, **199**
Coal, Urgency, **629**
COHEN, L. (C): Resistance and Reactance of Iron Transmission Lines, 480
Coke for Steam Raising, 65
COLE, T. W. (C):
Coal Crisis, 541, 671
Close of War Matters, 646
Temporary Increase of Charges for Electric Supply, 402
The Disabled Soldier, 520
Combination, Industrial, Few Advantages [Smith], 520
Commerce, London Degree, 321
Commercial and Industrial Policy, Post-War, **1**, 16, 34, 49
Commercial Development of Engineering in China [Arnhold Bros. & Co.] (C), 29
Commercial Intelligence Officers, 674

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mmercial Intelligence Service, U.S.A., 747
mmittee of the Privy Council for Scientific nd Industrial Research, **400**, 402, 414
mmutators of Alternating-Current Machines, alculation [Schenkel] 120
mmutators, Smooth, for Electrolytic Plants, 07
ndensers, Dielectric Loss, 540
ndensing Problem in Large Power Stations Rider], 172
nductivity of Sea Water, Value of, for Currents of Frequencies as used in Wireless Telegraphy, [Van der Pol] 432
nductors, Long Electrical, Experiments with Morecroft], 658
nduit Coupling, "Swarren," 745
ntacts, Electric, Improvements, 548
ntract, Breach, Measure of Damages, 321
ntrol Gear, Contactor, in Industrial Work, 33
ntrol Gear, Motor, Hints on Rectifying Faults, 27
nveyor, Jones' Portable Automatic Trimming 436
oker, Electrical, New Form, 410
oking Apparatus, Fuel Economy, 681
operation in Engineering and Allied Trades, 745
pper and Steel Scrap, Utilisation in Canada, 733
pper in U.S.A., 92, 364
pper Scarcity in Sweden, 306
RRESPONDENT": (C) Organisation of Technical Staffs, 697
sts, Scientific Basis [Turnbull] (C), 646
ane Tractor, Electric Vehicle, 441
anes, Electric, Safety Devices [Ritz], 315
EHORE, A. C., Some Applications of Electromagnetic Theory to Matter, 350, 372, 392, 412 [Sayers] (C), 447, 461 [Wedmore] (C), 671
URSEY, P. R.: (C) Wave Velocity and Capacity of Horizontal Helices, 212
umberland Electrolytic System for the Prevention of Scale and Corrosion, 419
urrency and Foreign Exchanges, 563
urrent and Potential, New Standard of, [Allcutt] 684
urrent Measurement, Use of Tikker and Telephone, 118
urrent Rushes on Meters, Methods of Testing Registration [Mollinger and Krukowski], **56**, 67
urrents, Undamped, in "Super-Conductors," **585**, 593
utting Lubricants and Cooling Liquids, 529
ylindrical Grinding, 57

D

amascene Steel, 370
anube, New Electric Power Works, 706
ARLING, C. R., and GRACE, A. W.: Thermo-Electric Properties of Fused Metals, 69
aylight Saving and Electric Fans, 586
aylight Saving in the United States, 26, **827**
ecimal Coinage, 235
ecimal Coinage, Royal Commission, 405
egree of Doctor of Philosophy, 427
emobilisation Advisory Committee, 701
emobilisation and Resettlement in the City, 701
emobilisation Instructions, **655**, 674
emobilisation of Munition Workers, 602
emobilisation Problems, 601, **605**
ENTON, F. M.: Elementary Principles of Continuous-Current Armature Winding (concluded from p. 897, Vol. LXXX.), 8 [Maccall] (C), 14-68 (Denton) (C), 29-91, 361 [Nims] (C), 255
epreciation and Obsolescence, **327**, 342
epreciation of Plant, Income Tax Allowances, 112
esigner, British, of To-morrow, **538**
esigner, British, of Yesterday, **518**
evelopments, Electrical, After the War, 421
iamond, Experiments on Production of, 22
ICK, J. R.:
Calculation of Single-Phase and Three-Phase Lines, 439, 459
Economics of Works Costs, 643, 694, 712, 736
ictograph, Motor Car, 725
iesel Engine Users' Association, 79, 329
IGBY, W. P.: Contract Prices during Demobilisation, 308, **316**, 336
istribution and Production Costs in U.S.A., 43
ORBY, E. W.: Power Factor and Its Improvement, **55**, 61, 81
over Corporation Tramways, **558**, 577
OW, A.: Production of Electricity by Steam Power, 555, **558**
rills, Magnetic, Tests, 307
ynamos, Wind-Driven, 657

E

ASON, A. B.: Construction of Abaci, 339
ERALL, A. C. (C): Improvement of the Turbo-Alternator, 131
conomic History and its Lesson to the Manufacturer of To-day [Smith] (C), 131
conomy, Maintenance, in the Boiler House [Wilson], 169

EDUCATIONAL—
Adult Education, **420**
Apprenticeship Scheme, G.E.C., 259
Battersea Polytechnic, 445, 465
Birmingham University, 51, 387
Bradford, City, Technical College, 465
Bristol University, 366
Business Training for Engineers, **241**
Cardiff Technical Instruction Committee, 652
Carlisle Science School, 51

Educational—*continued.*
Critic, Unorthodox of Education, **28**, [Taylor] (C) 91
Durham University, 282, 303, 345, 366, 387
Edinburgh University, 345, 366, 387, 407
Education and Leadership, **160**
Education Bill, **33** [Whitehouse] (C) 111, 114, 136, 345
Financial Requirements of Universities, 652
Finsbury Technical College, 366
Heriott-Watt College, Edinburgh, 366
King's College, 407, 445
King's College Engineering Society, 703
Languages, Modern, in our Education, **34**
London University, 259, 407, 485
London University Commerce Degree, **263**, 280
Loughborough Technical College, 729, 749
Manchester College of Technology, 233, 259, 282, 345, 407, 445, 525.
Manchester University, 345, 652
Northampton Polytechnic Institute, 345, 387, 465, 703
Pensions for Teachers, **547**, 565
Physics, Teaching in Schools, **133**, 147
Polytechnic School of Engineering, 155
Poplar School of Engineering and Navigation, 508
P.O. Technical Training Classes for Boys, 303
Post-War Developments, 565
Priestley, Lady, Memorial Lecture 729
Riga Polytechnic, Re-opening, 732
Royal Technical College, Glasgow, 366, 407, 445, 544
Salaries, Departmental Committee Report, 525
School-Teachers' Superannuation Bill, 565
Scholarships, Technical Education, 485
Sheffield University, 749
Teacher, What is he Worth ?, **347**
Teachers for Junior Technical Schools, [Technical Teacher] (C) 68
Technical Education, Demand, **679**
Technical Student and the War, **427**
University College Engineering Society (London), 606

Election and the Electric Supply Industry, 700
Electric Drive, Rolling Mills and the [Rothera] 58
Electric Power Development, 30
Electric Power Supply, **585**, **680**, 698
Electric Power Supply, Future, 188
Electric Power Supply, Notes and Considerations on the Post-War Position [Hatton], 470
Electricity Supply, National, 3
Electricity *v.* Gas Supply, 725
Electrical Engineering as Taught in American Colleges [Gray], 591, **596**, 610
Electrical Power Engineers' Association, 299, 349, 422, 488, 631, **680**
Electrical Trades Union and the E.P.E.A. [Jones] (C), **488**, 499
Electricity, Production by Steam Power [Dow], 555, **558**
Electricity Supply Connections, 602
Electricity Supply Undertakings and the War, **338**
Electricity Undertakings, Deficits due to War Restrictions, 92
Electro-Chemical Products, Yield, 203
Electrodes, Magnetite, Improvements, 78
Electroculture, Notes on [Jorgensen], 122, **128**
Electrolytic Copper Refining in Belgian Congo, 461
Electrolytic Metering Can, 38
Electromagnet, Alternating-Current, Stroke [Thomalen], 267
Electromagnetic Theory, Some Applications to Matter [Crehore] 350, 372, 392, 412, [Sayers] (C) 447, 461, [Wedmore] (C) 671
Electromagnetic Machines, Notes on the Design of [Smith] (C), 132
Electrons in Cadmium Vapour, Resonance and Ionising Velocities, 221
"Embargo" Strike, 318, 462
Employers and Employed, Relations, 542
"End of the War," Meaning, 364
Engineer, What is He ? 706
Engineering Profession, Organising, **77**
Engineering Service, Fees, 79
Engineers and Appropriate Military Service, **140**
Engineers' Ballot on 47-Hour Week, 733
Engineers' Club for the Midlands, 56, 92, **77**
Engineers, Graduating Student, Address to [Rice], **306**, 310
Engineers' Protective Associations, **263**, 273
ERNST, W.: Automatic Three-phase Switch, 491
ETCHELLS, H.: Application of the Electric Furnace to the Metallurgy of Iron and its Alloys, 734
Evaporation in Boilers, Increasing, 312
EVES, WM.: Electrical Properties of Vulcanised Fibre, 266
Excess Profits Decision, 602
Excess Profits Duty, 321
Exports, Hardware, 623
Exhibition, "Key Industries," 469, **487**, 500, 502, 508, 528
Exhibition, Suggested Manchester, **427**
Exports, Electrical, from the United States, 286, 542
Exports, Prohibited and Restricted, 71
Exports, Restriction, **21**
Eyesight, Council on, 22
Eyesight, Glasses for Protection, 64
Eyesight, Glasses for Protecting from Injurious Radiation, 141

F

"Faraday House Journal," 141, 508
Faraday Society, 22
Fahy Permeameter, 528
Fahy Permeameter, Experimental Study [Burrows and Sanford], 202
Factories and Workshops, 242, **274**
Factories, National, Future of, 49, 423
Factory Lighting, American Legislation, 11
Fans, Electric, and Daylight Saving, 586
FARMER, F. M.: Measurement of Power Loss in Dielectrics of Three-Conductor High-Tension Cables, 288
Fault Localisation, Notes on Loop Tests for [Stubbings], 40
Federation of British Industries, 581, 606
Federation of British Industries and Peace Terms, 723
Ferrous Alloys, Occluded Gases, 119
Fires, Arora Electric, 442
Fires, Electrical, in New York in 1917, 78
Fires in Transformer Chambers, Automatic Extinction, 57
FLEISCHMANN, Dr. L.: New Graphic Method for Winding Schemes, 689
Flickering of Lamps, Voltage Stabiliser to Diminish, 221
FLIGHT, W. S.: Transformer Oil, 636, 664, 686
France, Industrial Reconstruction, 638
FRITH, J.: (C) Technical Library, 745
Fuel and Lighting Order, Household, 220
Fuel Economy in Canada, 363
Fuel Economy in Cooking Apparatus, 681
Fuel, Effect of Dust in, **370**
Fuel, Efficient Use in the Future, **448**
Fuel, Peat and Wood, 201
Fuel Saving, Industrial, **252**
Fuel Saving in Private Houses, 242
Furnace Electric, Application to the Metallurgy of Iron and its Alloys, [Etchells] 734
Furnace, Elec. Brass, 329
Furnace, Elec., Developments in America in 1917, 428
Furnace, Elec., for Forging and Annealing of Steel [Scott], **263**, 271
Furnace, Elec., Steel, 594
Furnaces, Air Screen, 329
Furnaces, Elec., for Non-Ferrous Metals, 99
Furnaces, Elec., in Metallurgy, 588, 608
Furnaces, Electric, Temperature Uniformity, 632
Fuses for 2,500-volt Circuits, 680

G

Gas Fuel, Natural, in America, 667
Gases, Electrical Purification, 391
GENEAU, Ch. C., CHENEVEAU, and Sir R. HADFIELD: Magnetic Properties of Manganese and of Some Special Manganese Steels, 179
General Electric Co., **286**
Generating Plant, Allocation by the Ministry of Munitions, **605**, 622, 648, **680**
Generating Stations in the United States, 457
Generator, 12,000 k.v.a., Tests on a Joint in Stator Windings, 691
Generators, Checking Working Temperature, 5
Generators, Electrolytic, in Norway, 59
German Iron Deterioration, 560
German Scientific Men and the War, 489
Germany, Trade and Reconstruction, **389**
Germany's Industrial Syndicates, [Smith] (C) 153
Germany's Mineral Developments, 201
Germany, Search for Metals, 390
Germany's State Control of Elec. Power, 79
Glasgow Corporation Electricity Dept. Engineering Society, 488
Glass a "Key" Industry, 46
Glass Control, 30
Glass Industry, British, 78
Glasses for Protecting the Eyes from Injurious Radiation, 141
Glasses for the Protection of Eyesight, 64
Glassware, Scientific, Testing, 243
Government as Trader, **578**
Government Control and Reconstruction, **746**
Government Control of Trade, 279, 722, 746
Government Control Orders, Suspension, 747
Government Work, Relaxation of Priority, 727
GRACE, A. W., and C. R. DARLING: On the Thermo-Electric Properties of Fused Metals, 69
GRAY, A.: Electrical Engineering as Taught in American Colleges, 591, **596**, 610
Greek Commercial Mission, 563
Ground Connections for Electrical Systems, 586

H

HADFIELD, SIR ROBERT, C. CHENEVEAU, and CH. GENEAU: Magnetic Properties of Manganese and some Special Manganese Steels, 179
HATTON, E.: Some Notes and Considerations on the Post-War Position of Electric Power Supply, 470
Headlights, Automobile, Regulations, 469
Headlights, Elec., on Swiss Locomotives, 468
Heat Insulator, New, 200
Heat, Transmission through Heavy Building Materials, 733
Heat-Treatment of Large Masses, **97**
Heating, Industrial Electric, **230**
Heaviside, Oliver, A Tribute to, **33**
HEDLEY, J.: Leeds Automatic Exchange, 84
HILPERT, G.: Method of Determining the Value of Slip, 437, [Perkins] (C) 745
H.M. Forces, Release of Men, 650
Hoist, Boat, Electrically Operated, 370
HOLMBOE, C. F.: Modern Development of Large Hydro-Electric Power Schemes, 142
Houses of Ligno-Concrete, 517
Housing and Welfare, **438**, 439
HOXIE, C. A.: Thermo-Electric Standard Cell, 519
Hungarian Railways Coal Consumption, 707
HUNTER-BROWN, P.: Carbon Brushes, Considered in Relation to the Design and Operation of Electrical Machinery, 720, 738
Hydro-Electric Plant Improvement, 200
Hydro-Electric Power Schemes, Modern Development [Holmboe], 142
Hydro-Electric Power in Tasmania, 443, 577
Hydro-Electric Projects in Australia, 306
Hydrogen, Influence on Resistivity of Carbon, 220

I

Ice, Hauling Electrically 348
Illuminating Engineering in Peace and War 411
Illumination, Effect of Clean Surfaces, 243
I.M.E.A. and Coal Economy, **369**, 384
I.M.E.A. and the Ministry of Munitions, 568 681
I.M.E.A., Convention, **159**, 186; Report of Council, 191
I.M.E.A. Report on Electric Power Supply, 698, 732
Income Tax Allowances for Depreciation, 112, 462
Income Tax Allowance for Obsolescence, 134
India, Demand for Small Motors, 34
India, Elec. Engineering Developments, 348
India Industrial Development, 684, 701
Indian Heavy Steel Industry, 34
Indian Resources Development, 582
Inductance, Formulæ for Calculating, 428
Induction Coil, Capacity-Potential Curves, [Jones] 376, 396, 416
Inductive Capacity, Specific, Changes, 657
Inductive Interference, California Railroad Commission's Rules, 573
Industrial Combinations: Their Uses and Abuses [Smith], (C) 560
Industrial Council for the Elec. Supply Industry, 300
Industrial Councils, 462, 733
Industrial Councils and Local Authorities, 112
Industrial Councils and Trade Boards, 156
Industrial Development of S. Africa, 57
Industrial Efficiency and Fatigue, 342
Industrial Fatigue Research Board, 747
Industrial Health and Efficiency, **220**
Industrial League, 568
Industrial League Journal, 449
Industrial Lighting, White Paint as an Aid, 724
Industrial Progress and Human Inertia, **630**
Industrial Reconstruction Council, 16, 161, 362, 390, 429, 449, 508, 548, 569, 586, 680
Industrial Reconstruction Council Lectures, 257, 349, 488, 528, 607, 632, 656
Industrial Research and Trained Workers, **679**
Industrial Safety, **140**
Industrial Syndication, 215
Industries, Essential, Development, **21**, 30
Industry, British Glass, 78
Industry, Control After the War, **305**
Industry, Organisation, 287
Industry, Social Obligations, 641
Industry, Some Developments During the War, **656**, 669
Industry, State Control, 49, 667
Institute of Chemistry, 2, 286, 733
Institute of Metals, 3, 160, 242, 328, 410, 657
Institution of Civil Engineers, 22

INSTITUTION OF ELECTRICAL ENGINEERS—
Annual General Meeting, **97**, 104
Association, Formation of an, 35
Batteries, Large, for Power Purposes, [McKinnon] (Concluded from p. 893, Vol. LXXX.) 6, (*Discussion*) 27
British Electrical Engineers' Association, 111, **117**, [Atkinson, Simpson, Spurr, Furness, Morgan, Chaytor] (C) 153, 154
British Electrical Proving House, [Turnbull] 24, (*Discussion*) 41, **44**
Carbon Brushes: Considered in Relation to the Design and Operation of Electrical Machinery, [Hunter-Brown] 720, 738
Contract, General Conditions, 568
Contract Prices During Demobilisation, [Digby] 308, **316**, 333
Dinners, 733
Dynamical Theory of Electric Engines, **606**, [Atkinson] 616
Election, 2, 78
Electrical Research Committee, 242
Engineering Associations and the I.E.E., [Whitcher] (C) 193
Examination, A.M.I.E.E., 286
Manchester Local Section, Committee, 2
Meeting, First of Session, 586
Meeting, Special, 707
North-Western Centre, Mr. A. P. M. Fleming's Address, 670
Patent Law Amendment, 612, **618**
Power, Large, Amounts, Control, [Wedmore] (*Discussion*) 14, 80
Power, Single-Phase, Supplied from Three-Phase Systems, [Walker] 682, (*Discussion*) 710
President's Remarks, 631
Programme, First Half of Session, 528
Research and the I.E.E., 161
Steam, High-Pressure and High-Temperature, Use in Large Power Stations, [Shaw] 330, (*Discussion*) 640, 672
Students' Section, 78, 410
Transient Phenomena in Electrical Supply Systems, [Marchant] 63, 89, (*Discussion*) 107
Turbo-Alternator Rotor, Mechanical Design and Specification, [Barclay] (*Discussion*) 228
Welding, Arc, Notes on, [Sayers] **705**, 715
Welding, Elec., 657
Western Local Section, 508, **527**, 539, 60

Digitized by Google

Institution of Engineers and Shipbuilders in Scotland, 607
Institution of Gas Engineers, 161
Instruments, Measuring, Variance, 287
Insulating Material, New, 220
Insulating Materials, Composite, 98
Insulating Resistances, Effect of Temperature and Gaseous Atmosphere, 590
Insulator, High-Voltage Oil-Immersed Strain, 161
Integrating Hemisphere, 533
Intermittent Faults to Earth, 632
Internal Combustion Engine, "Record," 576
Invent, What Not to, **347**
Inventions, Naval, 568
Inventive Capacity, Latent, in the Workshop, **389**
Iron, Cast, Coating with Aluminium, 706
Iron Industry, Australian, 727
Iron Resources of Canada, 220
Iron and Steel Institute, 23, 348
Iron and Steel Prices, 674, 701
Iron and Steel Trades, Engineering, 152

J

JAKEMAN, R. G.: Effect of Power-Factor on Output of Rotary Converters with Reactance Control, 614
Japan as an Electric Lamp Exporter, 363
Japan's Electrical Industry, 494
Japan's Industrial Progress, 522
JOHNSON, J. F.: New Commonwealth Edison Turbine, 475
JOLY, Prof. J.: Scientific Signalling and Safety at Sea, 415
JONES, E. TAYLOR: Capacity-Potential Curves of an Induction Coil, 376, 396, 416
Jones Portable Automatic Trimming Conveyor, 436
JONES, W. A. (C): Electrical Trades Union and the E.P.E.A., **488**, 499
JORGENSEN, I.: Notes on Electroculture, 122, **128**
Journalists, British and American Trade, **731**
Journalists, Technical, and Trade, **2**
Journalists, University Course, **732**, 749

K

KARAPETOFF, V.: Higher Harmonics in Polyphase Electric Systems, 250
Keadby Bridge, Electrical Equipment, 516, 536
KEITH, J. (C): Patent Law Reform, **487**, 499, 520, 528
"Key" Industries Exhibition, 469, **487**, 500, 502, 508, 528
King and Our Industries, **220**
Kitchen, Elec., Modern Central Station, 357
Kitchen, National, in New Bridge-street, London, 192
Kitchens, National, Electricity in, 411
Kitchens and Restaurants, National, Handbook, 428
KLOEFFLER, R. G.: A Study of Electric Range Efficiency, **241**, 244

L

Labour and Industrial Development, 648
Labour After the War, **498**
Labour Disputes, Common Sense, **56**
Labour Notes, 384
Labour Outlook, 362, 399, 422, 441, 457, 477, 500, 516, 541, 557, **547**, 579
Labourer and His Hire, **347**
Lamp, Electric, Industry in France, 449
Lamp, Incandescent, Application of Crystalline Wire to, [Schroter] 337
Lamp Works, French, Metal Filament, 548
Lamps, Electric, Flickering of, [Simons] 36
Lamps, Electric, Safety, 49
Lamps, Incandescent, Data, 200
Lamps, Incandescent, Standard Specifications, 306
Lamps, Metal Filament, "Overshooting," 209
Lamps, Miners' Electric Safety, 423
Land for Public Purposes, 735
Lantern, Water-tight, 461
Lead for Vehicle Batteries, 92
Lead Prices, 215
Leeds, Electricity Supply, 509.

LEGAL INTELLIGENCE—

Accident due to Restricted Lighting, Liability, 624, 746
A.E.G. Electric Co., 213, 320, 542
Baldock v. Westminster City Council, 624, 746
Batteries Contract Dispute, 623, 673
Birmingham Corporation v. S. Allsopp & Sons, 562
Compensation, Workmen's, 155
Dewar's Patent Prolongation, 213
Edison Swan Electric, 300
Employers' Liability Act, 727
Engineering Works Assessment, 601
Factory Regulations, Breach, 727
Glasgow Tramcar Accident, Damages, 194
Horrox v. Leeds Corporation, 256
Isaacs v. Hobhouse, 256, 278, 299, 701
Kensington & Knightsbridge and Notting Hill Co.'s Arbitration, 155, 194
Landlord's Fixtures, 134
London Electric Railway Compensation Award, 581

Legal Intelligence—*continued.*

Mining Regulations, Breaches, 673
Patents, Alien Enemy, 15, 601
Patent, Prolongation, 700, 726
Paton v. Enever, 48
Plant, Electrical, Claim, 650
Post Office Tube Railway, 48
Rio Tinto Co. v. A.E.G. Electric Co. and A.E.G. Electric Co. v. Rio Tinto Co., 278, 300
Scoular (J. A.) v. Notable Elec. Co. & F. Warner, 726
Siemens Bros. & Co., 601
Spinning Invention, Mr. Ferranti's, 29
Stoke-on-Trent Corporation v. S. Triner, 320
Trade Name Dispute, 562
Tramway Benefit Society's Rules, 746
Tungsten Filament Patents, 649
Wages of Munition Workers, 194
Walsall Corporation and Motor Omnibuses, 562
Weld-Blundell, C. J., v. Stephens, 213, 233
White and Others v. Mayor and Corporation of Dover, 15

Legislation, Elec., in British East Africa, 442
Libraries, Technical, Co-ordination in, 509
Library, Technical, [Frith] (C) 745
Lifting Blocks, Design of Electrically-driven, [Wintermeyer] 639
Light Production by Insects, 307
Light Projector, New, 233
Light, Transmission by Glasses, 349
Light Transmission through Water, **508**
Light and Vision, P., 10
Lighting Economies, War Time, 548
Lighting, Elec., of Ecclesiastical Buildings, [Wilson] 223
Lighting Fittings, Industrial, 725
Lighting Fittings, Industrial, in the United States, 160
Lighting, Flood, Solution of Problems, 489, [Robertson] (C) 696
Lighting, Heating and Power Order (1918), and the Best Methods of Making Economies in Lighting, **55**, 68, **117**
Lighting, Indirect, in Textile Factories, 221
Lighting, Industrial, White Paint as an Aid, 724
Lighting Installations, Maintenance, **427**
Lighting and Safety, 134
Lighting the Boiler Room, 264
Lighting School Buildings, Code, 201
Lighting, Street, Diminished in London, **348**
Lightning Arrester Spark-Gaps, 168
Ligno-Concrete Houses, 517
Lincoln Electricity Works, 699
LINCOLN, P. M.: Character of Thermal Storage Demand Meter, 430
Line, Artificial, for High Voltages, 25
Local Authorities and Industrial Councils, 112
Logarithms, Common, Tercentenary [Bower], 231, (C) 278 [Russell], (C) 255
London Electricity Undertakings, Industrial Council, 746
London School of Economics, 448
LOW, A. R.: Dimensions of Transformers, 597, [Robertson] (C) 696
Lubricants, New German, 160
Ludwik Hardness Test, 528
Luminescence due to Radio-Activity, 552

M

MACCALL, W. T.: (C) Elementary Principles of Continuous-current Armature Winding, 14, 68
Machine Tools in Switzerland, 432
MCKINNON, E. C.: Large Batteries for Power (continued from p. 893, Vol. LXXX.) 6, (*Discussion*) 27
Magnesium, Industrial Applications, 328
Magnetos, "B.L.I.C." Manufacture, 480
Magnetos, British Made, **139**, 154
Manganese, Magnetic Properties and Some Special Manganese Steels, [Hadfield, Cheneveau and Geneau] 179
Manufacturers' Council, 257
Manufacturers, Electrical, U.S.A. Census, 257
Manchester, Suggested Exhibition, **427**, 657
MARCHANT, Prof. E. W.: Some Transient Phenomena in Electric Supply Systems, 63, 90
Marshes, Elec., Drainage, 631
Marvin Pyrheliometer, 329
Materials for Post-War Industry, 582
MATHIESON, W.: Experimental Examination of the Arc in Gases under Pressure, 451
Medical Supply Association's Static Machine, 47
Metals, Fine Deposition, New Process, 200
Metals, Fused, Thermo-Electric Properties of, [Darling and Grace] 69
Metal Sheets and Strips, Testing by Erichsen Machines, 233
Metal Suspension Orders, 727
Metal Trade, Empire, 542
Meters, Method of Testing Registration of Current Rushes, [Mollinger and Krukowski] **56**, 67
Meters on Tramcars, 733
Metering Can, Electrolytic, 38
Meter-Testing in Germany, 537
Meter, Thermal Storage Demand, Character, [Lincoln] 430
Metric System in Export Trade, **241**
Mexico, Mining Machinery, 723
Mica Insulation Manufacture in Sweden, 732
Mica, Temperature Variation of the Electrical Conductivity, [Poole] 129
Milan Royal Technical Institute, 348
Mill Merchant at the Frodingham Iron and Steel Works, Electrification of Steam-driven Three-high, 297
Mineral Developments in Germany, 201
Mineral Oil, Synthetic, 732
Mineral Resources, British, 625
Mineral Resources Bureau, Imperial, 300
Mining and Metallurgy, Financial Assistance, 385
Mining Machinery for Mexico, 723
Ministry of Munitions Allocation of Plant, **605**, 622, 648, **680**
Ministry of Munitions, Transformation, 650, **731**
Military Service Act, 1918, 370
Mill, Lumber, Supplies Power to a Central Station, 740
MOLLINGER, J. A., and W. VON KRUKOWSKI: Method of Testing the Registration of Current Rushes on Meters, **56**, 67
MONTSINGER, V. M., and A. T. CHILDS: Temperature Indicator for Transformer Winding, 450
Moore Light, Efficiency, 286
MOORHEAD, O. B.: Manufacture of Vacuum Detectors, 741
MORECROFT, J. H.: Some Experiments with Long Electrical Conductors, 658
Motor Control Gear, Hints on Rectifying Faults, 27
Motor Drives, Study of Groups and Individual, [Clewell] 102
Motor, Dick, Kerr, Ventilated Tramway, 403
Motors, Electric, Ball Bearings for, 3
Motors, Electric, for Sheep Shearing, 34
Motors, Induction, Two and Three-Phase 233
Motors, Induction, Working in Conjunction with Flywheels and Slip Regulators, Calculation of Performance, [Vickers] 248, 269, 293, 313
Motors, Light Weight Traction, 631
Motors, Oerlikon, Three-phase, Low-speed, Variable-speed, with Large Flywheel Effect for Direct Coupling to Mine Ram Pumps, 352, 374
Motors, Polyphase, Use of a Transformer between the Stator and Rotor, 528
Motors, Small, in India, 34
Motors, Traction, Armature Heating, [Adler] **306**, 311
MOULE, J. T.: (C) Entertainment of U.S.A. and Overseas Troops at Christmas, 646
Municipal Borrowing, 701
Municipal Electricity Works, Working Capital, **679**, 699
Municipal Tramways Association, 410, 428, Annual General Meeting 470, **467**
Munitions Machinery for Civil Work, 650

N

National Association of Supervising Electricians, 448
National Electrical Code (U.S.A.), 390
National Health Insurance, 215
National Physical Laboratory, 381, 394
National Physical Laboratory, Volumetric Tests of Scientific Glassware, 390
National Research, **66**
National Union of Scientific Workers, **448**
Newcastle Electrical Engineers and the E.P.E.A., 273
New Zealand's Industrial Development, 38, 579
Niagara, Power from, 428
NIELSON, F. J.: Applications of Electricity in Ships and Shipbuilding, **606**, 621
Nightwork, Women's, at Generating Stations, 245
NIMS, A. A.: (C) Winding Armatures, 255
Nitrogen, Fixation, 586
Nobel Prizes, 606
Non-Ferrous Metals, Control, 602
Non-Ferrous Metal Licences, 462
Non-Ferrous Metals, Stocks, 727
North-East Coast Elec. Supply, 561, 647
North-East Coast Institution of Engineers and Shipbuilders, 528
Norway, Large Electrolytic Generators, 59
Nottingham Power Station, **264**

O

OBITUARY—

Bannaux, J., 733
Bennett, J. G., 35
Bennis, Ed., 569
Bottomley, J., 161
Braun, Prof. F., 141
Burt, J. A., 307
Byng, Lieut. L. G., 391
Callender, J. O., 529, 549
Crosland, J. F. L., 549
D'Arrast, D'Abadie, 607
Davies, Thos., 489
Deaths on Active Service, 3, 23, 35, 57, 99, 119, 141, 161, 411, 489, 509, 529, 569, 587, 607
Dence, Thos., 509
Denton, Flight Cadet J. E., 449
Du Bois, Prof. H. E. J. G., 587
Esslemont, A. S., 449
Fowler, Ald. V., 371
Garnett, C. S., 35
Garside, J. W., 23
Gathorne-Hardy, Hon. A. E., 607
Geale, E. C., 161
Henrici, Prof. O., 329
Hopkinson, Prof. B., 371, 428
Houghton, E. J., 733
Howard, C. C., 35
Howarth, Ald. G., 449
Howgrave-Graham, H., 509
Hutchinson, T. C., 569
Insull, S., 429
Kean, Lieut. F. J., 681
Kent, Dr. Wm., 529

Obituary—*continued.*

Larard, F., 391
Lister, Eng. Rear-Admiral F. H., 371
McLachlan, 2nd Lieut. M. P., 23
Mainguy, Major-General F. B., 549
Maycock, W. P., 201
Miller, A. F., 243
Morton, Lieut. E., 429
Moysey, H. L., 349
Murray, Col. F. J. G., 549
O'Connell, M. W., 587
Padley, Mrs. A. H. E., 99
Parker, Lord, 243
Preece, W. L., 587
Ralph, J. M., 3
Rock, J. W., 23
Russell-Clarke, E., 529
Siemens, Arnold von, 23
Taltavall, T. R., 529
Tata, Sir Ratan, 411
Thain, 2nd Lieut. W. S., 469
Walker, H. C., 632
Warren, W., 489

Obsolescence, Income Tax Allowance, 134
Oerlikon Three-Phase, Low-Speed, Variable-Speed Motors with Large Flywheel Effect, for Direct Coupling to Mine Ram Pumps, 352, 374
Oil-Break Switch, Motor-Operated, 481
Oil, Transformer, Flash, 660, 664, 686
Oils, Lubricating, 78
Ores, Electrical Detection, 161
Organisation of Technical Staffs, 661, **668**, [Correspondent] (C) 697
OSNOS, M.: Theory of the Static Frequency-Doubler, 246
Output and Profits, Restriction, **567**
Oxygen Content in Steels and its Effect on Conductivity, 706

P

Painting, Cleaning Surfaces, 265
Pan-American Trade Marks Union, 92

PARLIAMENTARY INTELLIGENCE—

Aldershot Gas, Water & District Lighting Co.'s Bill, 47
Alien Enemy Companies, 542
Bills to be Promoted in 1919 Session, 673
Electricity Supply and Gas Charges, 194, 562
Extension Permits, Electricity Supply, 582
Fuel and Lighting Order, 320
Industrial Councils, 134
London United Tramways Bill, 194, 581
Marconi Wireless Contract, 155
Patents and Designs Bill, 48
Patents, Life, 562
Post Office (No. 2) Bill, 48
Post Office Telegraphs and Telephones, 155
Private Bill Legislation, 48, **630**, 650
Provisional Orders for 1918, 48, 673
Rotherham Corporation Bill, 194
Royal Assent, 320, 650
Sheffield Corporation Bill, 134, 581
Shropshire, Worcestershire and Staffs Elec. Power Bill, 15, 134, 256
Statutory Undertakings Bill, 279
Tramway Undertakings, Statutory Requirements, 15
Water Power in India, 562
Wednesbury Corp. Elec. Lighting Order, 194

Patent Application 4,862, 15, Rivers-Moore's, [Wilson] (C) 278
Patent Law Reform, [Keith] (C) **487**, 499, 520, 528, ["Patentee"] (C) 697
Patent Office Report, **369**
"PATENTEE": (C) Patent Legislation, 697
Patents Bill, 16
Patents, Extension of Life, 321
Patents in 1917, 287
Parliamentary Conference, International, 235
Peace, **585**
Peace, Industrial, **88**
Peace in Sight, **567**
Peat Bogs of Jutland, 631
Peat Industry in the United States, 489
PERKINS, C. A.: (C) Stroboscopic Determination of Slip, 745

PERSONAL—

Adams, J. B., 57
Arrillaga, F. de P., 221
Aspinall, Sir John A. F., 733
Benn, Capt. W., 449, 529
Bennett, E. P., 469
Bernstein, P. L., 57
Berriman, A. E., 469
Bone, Prof. W. A., 544
Bullard, W., 529
Bunting, J. H., 371
Canham, A., 429
Carlton, N., 707
Chambers, C. H., 632
Chiappini, C. du P., 429
Clarke, G. R., 221
Colefax, H. A., 632
Cooper, A. G., 243
Duckham, Sir Arthur, 23
Durtnall, Lieut. W. P., 469
Edge, Ald. K., 733
Forster, Dr. M. O., 607
Garner, John, 587
Glazebrook, Sir R. T., 119
Griffiths, Dr. E. H., 607
Hagen, Prof. Dr. E., 569
Hamilton, J. B., 79
Hammond, L./Bombr. H. W., **429**

Digitized by Google

Personal—*continued.*
Hele-Shaw, Dr. H. S., 429
Higgins, Capt., 3
Hosker, Dr. J. A., 543
Hutchinson, W. H., 549
James, F. S., 607
Kane, L.-Corp. F. G., 529
Larmor, Sir Joseph, 243, 287
Leggett, M., 141
McKinstry, A., 489
Marconi, G., 429
Maxwell, Sir W., 657
Military Honours, 35, 221, 243, 287, 349, 411, 509, 587
Moore, A. Nichols, 119
Mozley, Capt., 429
Paterson, C. C., 707
Pittaluga, E., 221
Renwick, H. B., 587
Richardson, A., 489
Roles, T., 161
Schofield, H. M., 141
Seabrook, A. H., 23
Sinclair, Capt. A. V., 141
Snell, Sir John, 707
Spencer, C. J., 549
Stafford, Pte. J., 529
Thorne, W., 549
Tweedy, R. N., 371
Vail, T. N., 657
Vignoles, Lieut.-Col., 291
Walker, Prof. Miles, 569
War Casualties, 3, 23, 99, 119, 349, 411, 429, 509, 529
Watson, Dr. G. N., 287
Willis, R. W., 141
Wordingham, C. H., 707
Wright, F. L., 607

Petroleum Products, Prices, 727
Phosphorescence, Nature of, 56
Photographic Prints, Permanence, 220
Photographic Records of Printed Matter, 361
Photometer for Measuring Photographic Densities, 391
Photometer, Spherical, Improvements, [Von Voss] 418
Photometers, Direct Reading, 391
Photometry, Progress, with Special Reference to the War Problems, **731**, 744
Physical Society, 78
Physics in Regard to National Life, 22
Physics, Teaching in Schools, **139**, 147
Plants, Effect of Artificial Light on, 221
Platinum in Germany, 118
Platinum, Substitutes in France, 200
Plexsim Electric Still, 724
POL, B. VAN DER: Value of Conductivity of Sea-Water for Currents of Frequencies as Used in Wireless Telegraphy, 432
Polyphase Electric Systems, Higher Harmonics, [Karapetoff] 250
Polyphase Commutator, Motor Device Illustrating the Properties, 287
POOLE, H. H.: On the Temperature Variation of the Electrical Conductivity of Mica, 129
POPE, Prof. W. J.: Future of Pure and Applied Chemistry, 292
Potash Feldspar, British Supplies, 79
Potash, Reported Production in Spain, 630
Potash Recovery, 328
Potteries, Electricity Supply, 599
Power Factor, Effect on Output of Rotary Converters with Reactance Control, [Jakeman] **614**
Power Factor and its Improvement, [Dorey] **55**, 61, 81
Power from the Earth's Heat, 160
Power Station Extensions, 568
Power, Station, Large, **180**
Power Supplied to a Central Station by a Lumber Mill, 740
Power Supply Engineers' Association, 111, **117**, 154
Power Transmission, [Welbourn] 181
Preference, Imperial, 300
PRESS, A.: Wave Velocity and Capacity of Horizontal Helices in Wireless Telegraphy, and Transmission Line Protective Apparatus, 106, (C) 402, [Coursey] (C) 212
Primary Battery, New Form, 56
Production and Distribution Costs in U.S.A., 43
Professional Men, Rare Opportunity, **508**
Profit and Output, 698
Prophecy, 586
Provincial Electric Supply Committee, **47**
Psychology in the Works, **718**
Public Utility Undertakings and the War, **210**
Publications, Scientific, Co-ordination of, 3
Publishers' Notice, 112
Pumping, Electric, and Rice Saving, 630
Pumping Stations, Electrification, 328

R

Radiometry, Instruments and Methods, 307
Radiotherapeutics, Standard, 469
Radium Substitute, 528
Railway Equipment, Standardisation, 606

RAILWAYS, ELECTRIC.
Central Argentine Railway, Electric Traction, **507**, 510, 530, 550, 570
Chicago, Milwaukee & St. Paul Railway, Elec. Passenger Locomotives, **1**, 4
Coal Saving and the Electrification of Railways in Switzerland, 449
Light Railways, 161
Rack-and-Pinion Railway, 242
Regenerative Braking with Single-Phase Commutator Motors, [Behn-Eschenburg] **705**, 708
Railways, Organisation by the State, 221
Range Efficiency, Electric, **241**, [Kloeffler] 244
Ramsay Memorial Fund, 488, 548
RAVENSHAW, H. W.: (C) Electrical Work for the Blind, 277
Raw Materials, Allocation, 300
Raw Materials, Rationing, 321
Raw Materials, Provision, **629**
Reader's Complaint, **447**, 461
Reconstruction and Government Control, 746
Reconstruction Committees, Interim Industrial, **33**
Reconstruction, Financial Facilities, 747
Reconstruction in France and Belgium, 461
Reconstruction Pamphlets, 706
Reconstruction Problems, 390, 502
Reconstruction Problems and Electric Power Supply, 49
"Record" Internal Combustion Engine, 576
Refuse Disposal Works in New York, 391
Research Information Committee, Allied, 160
Research, National, **66**
Research, Scientific and Industrial, Committee of the Privy Council, **400**, 402, 414
Resistance and Reactance of Iron Transmission Lines, 275, [Cohen] (C) 480
Resistance, Variable Electric, New Form, 706
Restrictions, Removal, 701, **706**
Returns, Companies' Annual, 625
Review of the Foreign Technical Press, 160

REVIEWS OF BOOKS—
Alternating Current Electricity and Its Applications to Industry, [Timble and Higbie] 478
Apparatus, Electrical, Theory and Calculations, [Steinmetz] 128
Applied Electricity for Practical Men, [Rowland] 230
Aviation Pocket Book for 1918, [Matthews] 439
Central Stations, [Croft] 380
Decimal Money Tables, [Pooley] 538
Direct-Current Machinery, Theory and Operation, [Jakeman] 578
Electrical Engineering, Essentials, [Wilson] 693
Electrical Engineering, Principles and Practice, [Gray] 274
Electricity, Theory of, [Livens] 338
Electron, The, [Millikan] 253
Ellison's Motor Ampere Calculator, 693
Engineering Mathematics, [Steinmetz] 358, (Russell, Appleton) (C) 402
Engineers, Education, [Taylor] 28
Illumination, Practical Elec., [Croft] 129
Industrial Buildings, Design and Construction (Kahn] 211
Industrial Engineering: Present Position and Post-War Outlook, [Lanchester] 29
Industrial Peace Terms, [Ramsay] 89
Lighting Art: Its Practice and Possibilities, [Luckeish] 88
Lloyd's Diagram for Calculations, [Lloyd] 89
Macara, Sir Charles W.: A Sketch of Modern Lancashire, [Mills] 45
Mathematics, Elementary, and their Application to Wireless Telegraphy, [Willis] 381
Mathematics for Engineers, Part I., [Rose] 498
Measuring Tools, Modern Engineering, [Pull] 618
Meters, Electricity, [Gerhardi] 742
Metric Conversion Tables, Selwyn's, [Dommett] 693
Miniature Elec. Light, [Jones] 129
Motors, Continuous-Current and Control Apparatus, [Maycock] 28
Motors, Elec., and Control Systems, [Dover] 719
Physics, Text Book, for the Use of Students of Science and Engineering, [Duncan and Starling] 316
Power Wiring Diagrams, [Dover] **44**
Practical Costing, [Gledhill] 719
Practical Electricity, [Croft] 210
Psychology, Present Day Applications, with Special Reference to Industry, Education and Nervous Breakdown, [Myers] **718**, 719
Radio Communication: Theory and Methods: with an Appendix of Transmission over Wires, [Mills] 44
Ramsey, Sir William, as a Scientist and a Man, [Chaudhuri] 693
Soldiers of Labour, [Kennedy] 538
Steam Power, [Hirshfield and Ulbricht] 296
Tables of British Decimal Coinage, Metric and British Weights and Measures, [Lawson] 44
Telegraphy, Aeronautics and War, [Bright] 558, [Bright] (C) 580, 586
Telephone Troubles and How to Find Them, [Hyde] 252
Temperature Conversion Table, 89
War to Work, [Turner] 231
Welfare and Housing, [Hutton] **438**, 439
Wireless Telegraphy and Telephony, Year Book for 1918, 439
Workmen's Time and Balance Book, [Chalker] 538

Rhine, Water-power, 435
RICE, E. W.: Address to Graduating Student Engineers, **306**, 310
RIDER, J. H.: Problem of Condensing in Large Power Stations, 172
RITZ, C.: Safety Devices for Electric Cranes, 315
Riveting, Pneumatic, 357
Road Transport, 99
ROBERTSON, D.: (C) Dimensions of Transformers, 696
Rockets and Illuminating Shells Used in War, **285**
Rockfeller Foundation, 140
Rontgen Outfits, Aeroplane, 645
Rontgen Society, 630
Rosin Supply, 235
Rotary Converters with Reactance Control, Effect of Power Factor, [Jakeman] 614
ROTHERA, L.: Rolling Mills and the Electric Drive, 58
Royal Engineers (Volunteers), 508
Royal Institution, 22, 56, 200, 568, 606, 732
Royal Naval Division, 657
Royal Society, 46, 78, 118, 286, 586, 631
Rubber, Regenerated, 200
Rubber Control Committee, 522
Rubber, Synthetic, 371
RUSSELL, A.: (C) Tercentenary of Common Logarithms, 255
RUSSELL, A.: (C) "Approximate Integration," 402
Russia, Value of the Engineer, 390

S

Safety Code, National Electrical, 286
Samples of Foreign-made Goods from S. America, 650
Samples, Export, 625
SAMUELSON, B.: Possible Economies by the Use of High-Pressure Steam, 166
SANFORD, R. L., and C. W. BURROWS: Experimental Study of the Fahy Permeameter, 202
SAYERS, H. M.: Notes on Regulations for Arc Welding, **705**, 715
SAYERS, J.: (C) Electromagnetic Theory, **447**, 461
Scale and Corrosion, Prevention by Cumberland Electrolytic System, 419
SCHENKEL, M.: Calculation of Commutators of Alternating-Current Machines, 120
SCHRÖTER, F.: Crystalline Wire and its Application to the Incandescent Lamp, 337
School, U.S.A., Army Engineering in France, **488**
Science and the Future, **855**, 663
Scientific Education in Infancy, **528**
Scientists, Enemy, Boycotting, **507**
SCOTT, W. S.: Electric Furnace for Forging and Annealing of Steel, 271
Searchlights and Fresnel Lenses, Illuminating Value, 273
Sea Water, Value of Conductivity, for Currents of Frequencies as Used in Wireless Telegraphy, [Van der Pol] 432
Selenium as a Decolourising Agent in Glass, 348
Semi-Diesel Engine, 594
Separators, Magnetic, for Treating Waste Iron, 306
Shade Carrier, "Easifix" Lamlok, 699
Shanghai, Electricity, **242**
Shareholder Councillors, Capacity, 71
SHAW, J. H.: Use of High-Pressure and High-Temperature Steam in Large Power Stations, 330, (*Discussion*) 640, 672
SHAW, P. E.: Experiments on Tribo-Electricity 209
Shells, Electrochemical Methods of Balancing, 631
SHENSTROM, W.: Welded Ships, 575
Ship, Largest Electric in the World, 56
Shipboard, Applications of Electricity, 127
Shipbuilding Yard, Electrical Equipment, **284**
Ships, Concrete versus Steel, 370
Ships, Electrical Equipment, 22
Ships, Electrically-Welded, 319, 348
Ships, Rivetless, 200, 242, 286
Ships and Shipbuilding, Applications of Electricity, [Nielson] **606**, 621
Ships, Welded (Shenstrom] 575
Shipyard, Electrically Equipped, 371
Siemens Companies, 156
Signalling Apparatus, Committees in the United States, 34
Signalling, Scientific, and Safety at Sea, [Joly] 415
Silk Industry, Electricity, 118
SIMONS, K.: Flickering of Electric Lamps, 36
SIMPSON, M. G.: Duplex Balance for Underground Telegraph Circuits, 719
Single-Phase and Three-Phase Lines, Calculation, [Dick] 439, 459
Slip, Method of Determining the Value, [Hilpert] 437, [Perkins] (C) 745
Small Tools Order (1918), 112
SMITH, H. F.: (C)
A Few Advantages of Industrial Combination, 520
Economic History and its Lesson to the Manufacturer of To-day, 131
Germany's Industrial Syndicates, 153
SMITH, S. P.: (C)
Notes on the Design of Electromagnetic Machines, 132
Reluctance of an Air-Gap Having Slots in both Opposing Surfaces, 421
Snook Apparatus for the Generation of High-Tension Uni-Directional Currents, [Wright] 479
Sociedad Co-operative Telefonica, 699
Societies, Engineering, Co-operation between, **642**
Societies, Scientific, and Enemy Scientists, 509
Soldier, The Disabled, **478**, [Cole] (C) 520
South Africa, Progress of Electric Supply, 482
South African Industrial Progress, 455
South American Trade, 582
South Shields Electricity Supply, 595
Standardisation of Electrical Appliances in Ontario, 49
State Control of Industry, 49
State Interference, Loss by, 7 7
Static Frequency-Doubler Theory, [Osnos] 246
Static Machine of the Medical Supply Association, 47
Statutory Undertakings, Welfare, **296**
Statutory Undertakings and Increased Charges, **567**
Steam, High-Pressure, Possible Economies by Use, [Samuelson] 166
Steam Raising, Coke for, 65
Steel and Copper Scrap, Utilisation in Sweden, 733
Steel Exports, 625
Steel, Heavy, Industry in India, 34
"Steel Structures," 428, 468
Steel and Iron Prices, 674
Steel and Iron Restrictions Removed, 625
Steel, Carbon, Normalising, 337
Strike, The "Embargo," 318, 462
Strikes, Ethics and Physcology, **447**
Steel, Plexsim Electric, 724
Stocks, Trading, Risk of Holding After the War, 195
STUBBINGS, G. W.: Some Notes on Loop Tests for Fault Localisation, 40
STYFF, E.: Synchronising of Alternators, 290
Sub-Stations, Railway, Operation without Attendants, [Bearce] 229
Swedish Export Trade, 385
Swiss Locomotives, Elec. Headlights, 468
Switch, Automatic Three-Phase, [Ernst] 491
Switch, B.T.-H. Lever, 481
Switch and Plug, 12-ampere combined, D.P. Ironclad, 649
Switchboard, 15,000-volt Ironclad Cubicle, 15
Switchboards, All Steel Draw-out Truck Types, 232
Switchboards, Ironsafe Power, 70
Switchgear, 6,000 ampere three-phase Alternator, 133
Switchgear, Large Power Station, [Clothier] 175
Switzerland, Machine Tools, 432
Synthetic Mineral Oil, 732

T

Tasmania, Hydro-Electric Power, 443, 577
Taxation, War, and Foreign Companies, 462
TAYLOR, H. G.: (C) Education of Engineers, 91
"TECHNICAL TEACHER": (C) Teachers for Junior Technical Schools, 68

TELEGRAPHY—
Aluminium Sleeves for Connecting Wires, 328
Australian Telegraphs and Telephones, 405
Australian U.S.A. Submarine Cable, 302
Chamier-Turner "Trinity" Morse Set, [Turner] 13
Duplex Balance for Underground Telegraph Circuits, [Simpson] 719
German Telegraph Concession in Rumania, 302
Telegraphy Through the Ground, 200
Transatlantic Cable Service, 606
U.S.A. Telegraphs and Telephones, 216, 259, 281

TELEPHONY—
Audibility Factor of a Shunted Telephone to the Antenna Circuit as Used in the Reception of Wireless Signals, [Van der Pol] 60, 265
Australian Telegraphs and Telephones, 405
Automatic Telephones at Australia House, London, 317
Highest Telephone System in the World, 348
Hull Telephone Charges, 281
Leeds Automatic Telephone Exchange, 50, 72, 84
Montevideo Telephone Service, 386
Swedish States Telephone Extension, 406
Telephony in Denmark, 624

Temperatures, Rapidly Varying, Measurement, 57
Test Sheath Cable and its Potentialities, **199**, 204
Textile Factories, Indirect Lighting, 221
THOMALEN, A.: Stroke of an Alternating-Current Electromagnet, 267
THORROWGOOD, W. J.: Maximum Regulating Resistance and Maximum Shunt Resistance of Track Circuits, 292
Three-Phase and Single-Phase Lines, Calculation, [Dick] 439, 459
Timber, Future Supplies in Great Britain, 127
Tools Order, Small (1918), 112
Tools, Power-Driven, 30
Tools, Second-hand, 625
Tools, Small, Manufacture of, 49
Track Circuits, Maximum Regulating Resistance and Maximum Shunt Resistance, [Thorrowgood] 292
Traction, Elec., Future, 660
Traction, Elec., in the United States, 482, **507**
Tractors, Small, Considerations Governing Design, [Chorlton] 174
Trade After the War, **1**, 16
Trade, Anglo-Egyptian, 674
Trade Boards Bill, 113
Trade, British, Foreign Capital in, 363
Trade, Foreign, Extension, **467**
Trade, Government Control, 279, 722
Trade, Home, Combination for, 12
Trade Marks Union, Pan-American, 92
Trade Parliaments and their Work, [Benn] 11, 26, 46, 65, 87, 103, 132, 148, 165, 213
Trade Unions for Engineers, 661, **668**
Trade Union Rules, Restoration, 482
Trade Union Congress, **409**
Trader Government as, **578**

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Trades, Electrical, After the War, **150**. 151
Trading Community and War Bonds, ..
Train Lighting, Electro-Magnetically Controlled Coupling, 732
Tramp Abroad, **742**
Tramway and Lighting Charges, Increased, 235, 257
Tramway Fares, 49, 219
Tramway System, Australia's Greatest, 680
Tramways and Light Railways Association, 242
Transformation, Continuous-Current, Size and Working Cost of Machines, [Carter] 492, 514
Transformer Chambers, Automatic Extinction of Fires, 57
Transformer Oil, [Flight] 636, 664, 686
Transformer, Repaired in Record Time, 307
Transformer, Use between the Stator and Rotor in Polyphase Motors, 528
Transformer Winding, Temperature Indicator, [Montsinger and Childs] 450
Transformers, Brush Static, 233
Transformers, Dimensions, [Low] 597, [Robertson] (C) 696
Transition, The Great, **731**
Transmission, Elec., Modern Systems, 497
Transmission Lines, Charging Currents and Earthing Devices, [Behrend] 222
Transmission Lines on Steep Grades, Sag-Temperature Calculations, 265
Transmission Lines, Iron, Resistance and Reactance, [Press] 275, [Cohen] (C) 480
Transmission Line, Longest Span, 397
Transmission, Long Distance, in Germany, 410
Transport Committee's Report, **629**, 647
Tribo-Electricity, Experiments, [Shaw] 209
Trolley Wheels, Large, 657
Troops, U.S.A., and Overseas, Entertainment at Christmas, [Mould] (C) 646
Tubes, Iron, Wood-lined, 379
Tubes, Short Thin, Collapse, 118
Tungsten Arc, Ultra-Violet Spectrum, 83
Tungsten, Shortage, 468
Turbine, Commonwealth Edison, [Johnson] 475, 490
Turbo-Alternator, Improvement, [Behrend] (C) 110, [Barclay] (C) 211
Turbo-Alternator, 55,000 kw., 289
TURNBULL, C.:
(C) Scientific Basis for Costs, 646
A British Electrical Proving House, 24, (*Discussion*) 41, **44**
TURNER, S.: Chamier-Turner "Trinity" Morse Set, 13

U

Ultra-Violet Light, Therapeutic Action, 141
Ultra-Violet Spectrum of the Tungsten Arc, 83
University College Engineering Society (London), 606
Undamped Currents in "Super-Conductors," **585**, 593
U.S. Government Division of Engineering, 370
U.S.A. Army Engineering School in France, **488**
U.S.A. Census of Electrical Manufacturers, 257
U.S.A. Commercial Intelligence Service, 747
U.S.A. Copper in 1917, 92
U.S.A. Electrical Exports, 363
U.S.A. Goods, Designation, 625
U.S.A. Power Plants, Government Operation, 423
U.S.A. Production and Distribution Costs, 43

V

VAN DER POL, B.: Note on the Relation of the Audibility of a Shunted Telephone to the Antenna Circuit as Used in the Reception of Wireless Signals, 60, 265
Vehicle, Elec., Crane Tractor, 441
Vehicles, Elec., in the United States, 87
"VERITAS": (C) British Engineering in China, 46
Vibrations due to Road Transport, 453
VICKERS, H.: Calculation of Performance of Induction Motors Working in Conjunction with Flywheels and Slip Regulators, 248, 269, 293, 313
Visibility, Limits, 706
Visual Diffusity, 119
Voltages, High, Artificial Line for, 25
Voltages, Standardisation, **389**
VON KRUKOWSKI, W., and J. A. MOLLINGER: Method of Testing the Registration of Current Rushes on Meters, **58**, 67
VON VOSS, R.: Improvements in the Spherical Photometer, 418
Vulcanised Fibre, Electrical Properties, [Eves] 266

W

Wage Awards, Compulsory, 522
Wages of London Electricians, 622
Wages of Men and Women Workers, **389**, 405
Wages, Regulation, 624
WALKER, Prof. MILES: Supply of Single-Phase Power from Three-Phase Systems, 682, (*Discussion*) 710
Walsall Electricity Works, 711
War Bonds and the Trading Community, 92
"War Period," Meaning, 235
War Products, Collection, 630
War Restrictions Removed, 651
Water, Electrical Apparatus for Boiling, [Biermann] 740
Waterfall, Determining the Mean Power, 548
Water-power Development, 134
Water-power Development, Empire [British Engineer] (C) 560
Water-power Development in Russia, 328
Water-power in Canada, 717
Water-power in India, **140**
Water-power in the British Empire, 343, **358**
Water-power on the Rhine, 435
Water-power Resources, 195
Water Power Resources in Ireland, 701
Water Transport in Germany, Extension, 469
Waterways in the United States, 468
WATSON, S. J.: Presidential Address to I.M.E.A., 186
Wave Velocity and Capacity of Horizontal Helices, [Coursey] (C) 212
WEDMORE, E. B.:
(C) Some Applications of Electromagnetic Theory of Matter, 671
Control of Large Amounts of Power, (*Discussion*) 14, 80
Week, The, 48-Hour, **655**
WELBOURN, B.: Transmission of Power, 181
Welding, Electric, 22
Welding, Elec., Application to Ship Construction and Repair, 379
Welding, Electric Arc, Motor Car Workshop, 724
Welding, Elec., Bibliography, 549
Welding, Elec., of Cast Iron, 448
Welding, Elec., for Shipbuilding, 448, **488**, 619
Welding, Electric, with Various Metals, 291
Welfare and Housing, **438**, 439
Welfare Work, Boy, **55**
Weston Cells, Researches, 410
WHITCHER, J.: (C) Engineering Associations and the I.E.E., 193
WHITEHOUSE, J. H.: (C) Education Bill, 111
Whitley Councils, Progress in Formation, 235
Whitley Report, 78, 455
WILLIAMS, I.: New Method of Measuring Alternating Currents and Electric Oscillations, 253
WILSON, D.:
Industrial Coal Economy, **527**, 540, 559
Maintenance of Economy in the Boiler House, 169
WILSON, W.: Elec. Lighting of Ecclesiastical Buildings, 223
WILSON, W. H.: (C) Rivers-Moore's Patent Application 4,862 15, 278
Winding, Colliery: Power for, 329
Winding Engines, Elec., and Mine Hoists, [Broughton] **199**, 206, 226, 332, 354, 433, 453, 473, 495, 534, 553, 574
Winding Schemes, New Graphic Method, [Fleischmann] 689
WINTERMEYER, H.: Design of Electrically-driven Lifting Blocks, 639
Wire, Stretched, Forming Part of a Closed Electric Circuit, Vibration, 243

WIRELESS TELEGRAPHY AND TELEPHONY—

Air Service, Radio-Telegraphy in, 707
Argentina, Marconi Station, 50
Argentina, Wireless Telegraphy, 281, 302, 365, 386
Audibility Factor of a Shunted Telephone to the Antenna Circuit as Used in the Reception of Wireless Signals, [Van der Pol] 60, 265
Brazilian Telegraphs, 386
Canada, Wireless Telegraphy, 345
China, Wireless Telephony, 406
Empire Radio-Telegraph Schemes, 650
Holland, Radio-Telegraphy, 365
Mexico, Radio-telegraphy in, 50
Oscillations, Continuous Electrical, Note on Production by Three-Electrode Valve, [Appleton] 743
Radio-Telegraph Progress, 196
South American Cables, 50
Vacuum Detectors, Manufacture, [Moorhead] 741
Wave Velocity and Capacity of Horizontal Helices in Wireless Telegraphy and Transmission Line Protective Apparatus, [Press] 105, (C) 402, [Coursey] (C) 212
Wireless as an Aid to the Police, 468
Wireless Telephony on Spanish Ships, 196

Women in Industry, 563, 680
Women of Gt. Britain and Ireland, National Council, 681
WOODHOUSE, W. B.: Problems of Coal Handling, 162
Wood Firing for Locomotives, 410
Wood-Oil Industry in China, 34
Works Committees, 411
Works Costs, Economics, [Dick] 643, 694, 712, 736

WORKS, DESCRIPTION OF—

Benjamin Electric, Ltd., New Works, 456, 488
Fuller Co.'s Electrical Works, 224
Hull, New Turbine Plant, 125
Leeds Automatic Exchange, [Hedley] 84
Union Cable Co., 594

Works Schools, **547**, 557
WRIGHT, R. S.: Snook Apparatus for the Generation of High-tension Uni-Directional Currents, 479

Z

Zinc, Australian, 17
Zincblende, Magnetic Qualities, 307

Municipal, Foreign and General Notes.

ELEC. SUPPLY—

Aberdeen, 215, 424, 443, 543, 582, 602
Aberystwyth, 215
Accrington, 135, 215, 258, 675, 702
Acton, 280
Aldeburgh, 113
Arbroath, 702
Arklow, 195, 443, 625
Armagh, 17, 93
Aylesbury, 113
Ayr, 280, 542
Ballymoney, 280, 702
Bangor (Co. Down), 503
Barnes, 503, 523
Barnsley, 156, 564
Barrow, 702
Bath, 651
Beckenham, 280
Beccles, 582
Bedford, 93, 156, 483, 625
Belfast, 134, 424, 463, 503, 625, 651, 675
Bexhill, 280
Birmingham, 113, 215, 300, 321, 625
Birr (Ireland), 258
Blackburn, 49, 135, 443, 564, 702, 748
Blackpool, 49
Blyth, 543
Bognor, 403
Bolton, 58, 135, 564, 675, 702, 748
Bournemouth, 602
Bradford, 156
Braintree, 322
Brierfield, 523
Brighton, 17, 71, 195, 280, 301, 483, 523, 582
Bristol, 443, 748
Burnley, 17, 135, 424, 675
Burton-on-Trent, 93
Bury (Lancs.), 727
Bury St. Edmunds, 49, 258, 443
Carlisle, 564
Carmarthen, 258
Cavan, 405
Charing Cross, W. End & City Electricity Supply, 602
Chelmsford, 343
Chester, 728
Chesterfield, 385, 651
Chippenham, 564
Chorley, 322, 543
City of London, 483
Clayton, 235
Coal and Lighting Order, 114
Colchester, 134, 385
Coleraine, 626
Colne, 301, 523
Colwyn Bay, 195
Cooking, Elec., 157
Coventry, 235, 364, 702
Darwen, 405, 582
Defence of the Realm Act, 651
Denby and Cumberworth, 543
Derby, 215, 280, 364, 603
Doncaster, 651
Dover, 564
Dublin, 93, 343, 385, 463, 135, 156, 542, 651
East Ham, 235, 602
Edinburgh, 71, 93, 483, 543, 582, 603, 626, 675, 727
Egham, 543
Elland, 195, 235
Electric Power Supply Committee's Report, 157, 463, 543
Electrical Energy, Increased Charges, 71, 113, 281, 322, 364, 386, 463
Electrical Power Engineers' Assoc., 17, 30, 50, 113, 135, 156, 280, 322, 463, 564, 603, 625, 651
Electricity v. Gas Supply, 405
Epsom, 702
Erith, 343
Extension of Time Orders, 322
Ferro-Manganese, Electrolytic Production, 17
Fermanagh, 564
Fleetwood, 543
Fuel and Lighting Order, 483
Fulham, 483, 702, 748
Galway, 17
Gillingham, 49
Glasgow, 135, 405, 195, 385, 582, 625, 675
Grays, 322
Greenock, 236, 386, 564, 602
Greetland, 727
Grimsby, 157, 602
Hackney (London), 93, 236, 503
Halifax, 113, 543, 583
Hamilton, 543
Hammersmith (London), 503
Hampstead, 625, 651
Hanley, 727
Harrogate, 702
Haslingden, 215
Haverfordwest, 50
Hereford, 542
Holsworthy, 651
Hornsey, 195
Huddersfield, 301, 651, 675
Hull, 135, 463
Ilford, 503
Industrial Councils in Government Dockyards, 17
Ipswich, 258, 364, 195
Ireland, Water-power, 483, 503, 583
Irish Water-power Scheme, 364
Iron Works, Electricity, 483
Islington, 321, 523, 702
Kensington, 748
Kilmarnock, 702
King's Lynn, 542, 564
Kingston-on-Thames, 543
Kirkcaldy, 322, 156
Kitchens, National, 236
Leeds, 17, 543
Leek, 157, 503
Leigh (Lancs.), 727
Leiston, 727
Leith, 523, 583
Leighton Buzzard, 281, 483
Letterkenny, 702
Leyton, 523
Lighting, Heating & Power Order, 727
Lighting Restrictions and Prices of Electrical Energy, 157, 424
Limavady, 30, 386, 443
Lincoln, 113, 157, 523
Linking-up Fulham and Hammersmith, 281
Liverpool, 424, 543, 748
Llandudno, 215, 281, 748
London County Council, 30, 49, 301
Loughborough, 523, 702
Lurgan, 602
Luton, 156, 195, 235, 424, 503, 702
Maidenhead, 602
Maidstone, 385, 727
Manchester, 17, 215, 503
Manchester Ship Canal, 405
Mansfield, 281
Marylebone (London), 50, 503, 675
Mersey Power Extensions, 17
Newark, 702
Midlands, Electricity Supply, 280
Middleton, 385
Ministry of Munitions, 702
Morley, 602
Motherwell, 523
Munition Works, Light Economy, 483
Mytholmroyd, 483
National Electricity Supply, 30
Nenagh, 281, 386
Newbridge (Kildare), 564
Newbury, 93
Newcastle Chamber of Commerce and the Electrical Industry, 483
Newcastle Elec. Power Supply 343
Newcastle-under-Lyme, 135, 582
Newport (Mon), 424, 564
Norwich, 50
Nottingham, 17, 258, 385, 602
Notts and Derbyshire Elec. Power Supply, 93
Nuneaton, 93, 156
Oilfields, Elec. Power in, 113
Oldham, 71, 564
Ormskirk, 17
Pembroke, 543
Plymouth, 50
Poplar, 195
Portishead, 135
Provisional Orders, 30, 386
Radcliffe (Lancs), 651
Rathmines, 135
Redcar, 156
Redditch, 195, 301
Rolling Mills, Electricity in, 50, 385
Rotherham, 443, 728
Salaries of Work Inspectors, 424
Salford, 236, 564, 651
Scottish Provisional Orders, 30, 71
Sheffield, 50, 236, 258, 364, 443, 523, 728
Shipyards, Electricity, 463
Shop Lighting, 602, 702
Shrewsbury, 523
Silsden, 301
Skelmanthorpe, 503, 564
Slough, 196
Snowdon, 602
Somerset, 651
South Shields, 424, 748
South Wales Linking-up, 135
South Wales, Wages, 258
Southwark (London), 675
Stafford, 196, 322
Stalybridge, 135
Stepney (London), 71, 301, 582, 603, 675, 702
St. Helens, 523, 626
Stirling, 483, 564
Stockton-on-Tees, 258, 625
Stoke-on-Trent, 236, 281, 321, 583, 675, 727
St. Pancras (London), 93, 543
Stratford, 236
Stratford-on-Avon, 258, 564
Stretford, 424
Stroud, 322
Sunderland, 215, 626
Swansea, 72, 156, 343, 443, 464, 523
Swindon, 523
Teddington, 72
Tewkesbury, 464
Time Extension, 364
Tiverton, 675
Todmorden, 113
Tonbridge, 503
Torquay, 50, 135
Tottenham, 93
Trade Unionists and Elec. Power Supply, 135
Twickenham, 322
Wales, Water-power Development, 343
Wallasey, 301
Wakefield, 49, 281
Walkden (Lancs), 651
Walsall, 135, 235, 301, 543, 443, 602, 651
Walthamstow, 523
Warrington,, 483, 748
Water-power of the Empire, 343
W. Bromwich, 523
Weardale, 93
Wednesbury, 72
Welshpool, 322, 582
West Lynn, 748
Westminster, 281
Weybridge, 503, 675
Whitehaven, 156
Whitstable, 385
Wigan, 625
Willasden, 281, 503, 523, 625, 675
Wimbledon, 728
Woking, 602
Wolverhampton, 49, 135, 236, 523, 543, 564, 582, 702
Woolwich, 728
Worcester, 258, 443, 503
Workhouse Lighting, 93
Wormit, 523
Wrexham, 50

TRACTION.

Accidents, 50, 748
Accrington, 583, 652, 675, 748
Ayr, 196
Barrow, 503
Bath, 114
Belfast, 72, 114, 157, 603, 675 728

Digitized by Google

Birmingham, 196, 728,748
Blackpool, 281, 302, 524, 603, 626, 651, 702, 748
Board of Trade Tramways Committee, 652
Bolton, 114, 748
Bournemouth, 135
Bradford, 30, 157, 483, 543, 583, 675
Breakdown, Tramway Claim, 464
Brighton, 196, 748
Bristol, 405, 483
Burnley, 702
Burton-on-Trent, 564
Bury, 675, 702
Cardiff, 196
Chesterfield, 652
Committee on Production, 652
Coventry, 543
Darlington, 135
Dearne Valley, 675
Derby, 281
Doncaster, 30, 702
Dover, 675
Dublin, 603
Douglas (Isle of Man), 728
Dundee, 50, 322, 364, 4243, 48
Dunfermline, 72
East Ham, 603
Edgware and Hampstead Railway, 17, 728
Edinburgh, 30, 72, 157, 253, 322, 405, 464, 583, 651, 728
Edinburgh-Queensferry Tramway, 93
Gillingham, 564
Glasgow, 114, 157, 236, 302, 322, 387, 483, 543, 583, 626, 702
Grimsby, 424
Halifax, 50, 675
Hampstead (London), 50
Haslingden, 564
Hull, 281, 302, 626, 728
Hurst, 302
Ilford, 524
Keighley, 196, 302, 424
Kilmarnock, 93
King's Norton, 675
Kingston, 564
Kirkcaldy, 215
Kitchens, Tramcar, 236
L.C.C. Tramways, 30, 196, 215, 258, 322, 503, 543, 583, 702, 728, 748
Leeds, 443, 483
Leeds Tramway Committee, 93, 114
Leicester, 365, 524
Leith, 524
Leyton, 702
Light Railways, 72, 464, 583
Lincoln, 524
Liverpool, 72, 93, 236, 302, 543, 651, 675
London United Tramways, 543, 652
Longridge-Hellefield Light Railway, 483
Lowestoft, 50
Maidstone, 728
Manchester, 17, 31, 365, 702, 748
Metropolitan Assoc. of Elec. Tramways Managers, 564
Metropolitan District Railway, 17, 215
Middlesbrough and Stockton Tramways, 464
Middlesex, 748
Musselburgh, 728
Nelson, 50
Newcastle-on-Tyne, 114, 652, 675
Newport (Mon), 344, 603
Norwich, 651
Nottingham, 322
Oldham, 564
Plymouth, 72, 196
Pontypridd-Rdondda Tramways, 344, 702
Potteries, 93
Preston, 322, 675
Railway, Electric, Scottish, 424
Reading, 524
Rochdale, 365
Rotherham, 483
St. Helens, 503, 675, 748
Salford, 17, 31, 93, 524, 748
Scarborough, 236
Scottish Tramways Advisory Committee, 93
Sheffield, 50, 135, 258, 365, 564, 728
Southampton, 728
Southend-on-Sea, 196, 748
Southport, 344, 365
Stockton, 626
Stoke-on-Trent, 50
Strikes, Tramway, 302, 365
Sunday Tramways, 484
Sunderland, 31, 114, 281, 344, 365, 443
Swansea, 157, 626
Time Extensions, 443
Tramway Deficits Placed on the Rates, 72
Tramway Depreciation, 72
Tramway Economies, 17, 386
Tramway Fares, 31, 135
Tramway Parcel and Goods Traffic, 215
Tramway Stopping Places, 196, 215
Vehicle, Elec., Costs, 503
Vehicle, Elec., Progress, 196, 236, 322
Vehicle Lights, 748
Vehicles, Elec., for Coal Delivery, 364
Wallasey, 50, 406, 675
Walsall, 236, 424
West Hartlepool, 50
Willesden, 302, 484, 675
Women Tramcar Drivers, 93, 157, 302
Workers' Wages, Tramway, 93, 114, 258, 405, 424
Worcester, 728
Workmen's Fares in the Metropolitan Area, 302
York, 504, 675, 728
Yorkshire Tramway Fares, 322

IMPERIAL.

Australian Institution of Engineers, 703
Australasia, 51, 72, 93, 196, 216, 236, 322, 344, 406, 424, 464, 504, 524, 543, 583, 626, 652
British Columbia, 603
Cable Service, All-Red, 564
Calcium Carbide Manufacture in Tasmania, 729
Campbellford, 543
Canada, 17, 51, 136, 196, 344, 365, 406, 484, 583, 626, 652, 675
Carbon Electrodes, 703
Electrical Employers' Association of New South Wales, 443
Electric Lamp Mfg. Co. Club, 703
Electrolytic Zinc Co. of Australia, 703
Flinders, 603
George Town (Penang), 504
India, 17, 73, 236, 258, 675, 626
Indian Science Congress, 504
Johannesburg, 73, 443, 484
Jamaica, 236
Launceston, 603
Longreach (Australia), 543
Melbourne 543, 652, 703
Montreal, 364
Mossel Bay, 603
Mysore State, 564
New South Wales, 603, 702
New Zealand, 136, 484, 583, 626, 675
Niagara Water Power, 259, 406
Ontario, 675
Papua, 484
Queensland, 564
Rhodesia, 344
Risden (Tasmania), 603
South Africa, 51, 73, 443, 464
St. Lawrence Power Development, 424
Tasmania, 443, 675, 702
Toombul, 543
Toronto Hydro - Electric Scheme, 365
Victorian Suburban Railways, 729
Wireless Communication Direct with Australia, 484

FOREIGN.

A.E.G. Polish Company, 676
Algeria, 676
American Hydro-Electric Development, 464
American Nitrogen-Products Co., 729
Annapolis, 652
Argentina, 73, 365, 424, 544, 583, 603, 652
Austria, 603, 676
Austrian Hydro - Electric Works, 323
Batavia, Industrial Congress, 236
Brazilian-Argentine Trade, 157
Buenos Ayres, 236, 544, 583, 603
Canal, Projected, 583
Chili, 114, 282, 365
China, 114, 196, 504
Christiania, 544, 676
Consolidation of Western Union and Postal Telegraph Companies, 652
Copenhagen, 603
"Coronel," Chilian Steamer, 583
Danish Hydro-Electric Station, 703
France, Standardisation, 259
Furnace, Elec., Progress, 259, 282
German Elec. Generator, 114
German Elec. Industry, 114
German Electricity Supply League, 196
German Methods in Spain, 282
Germany, Porcelain Trust, 237
Germany, Reconstruction, 406
Greece, 444
Guatemala, 73
Hydro-Electric Schemes, 565
Iceland, 583
Italian Association of Rubber and Cable Manufacturers, 323
Italian Elec. Firms Combine, 366
Italy, 464, 652, 484, 676
Japan, 51, 114, 365, 407
Krupp Works for the Ukraine, 504
Laprida, 543, 583
Latin America, Trade Marks, 323
New York Electric Fires, 236
New York Electric Tractors, 157
Norway, 51, 259, 504
Norwegian Electrode Factory, 344
Portugal, 51
Prussia, State and Municipal Elec. Supply, 344
Pumping Unit, Large Electric, 484
Rome-Castellamare-Adriatico Railway, 565
Salt, Extraction from Sea Water, 444
Santiago de Chile, 583
Sicily Hydro-Electric Power, 323
Spain, 51, 157, 237, 424, 504, 543, 676
Sweden, 544
Swedish Electrical Association, 504
Sweden, Electric Furnace Progress, 524
Sweden, Research, 237
Swedish Electrochemical Industry, 444
Swedish Exports, Prohibition, 157
Swedish Hydro - Electric Schemes, 342
Swedish Railways Administration, 729
Swedish Telephone Firms' Amalgamation, 366
Swiss National Trade Mark, 484
Switzerland, 365, 583
United States, 676, 703
Uruguay, 282
U.S.A. Electrical Exports, 444
U.S.A. Government Control of Telegraphs and Telephones, 729
U.S.A. Metal Filament Lamp Sales, 344
U.S.A. Navy Control of Wireless Communications, 652
U.S.A. Nitrate Plant, 425, 444
U.S.A. Rubber Industry, 729
Wireless Royalty Litigation in America, 425
Wireless Service between London and America Resumed., 652

MISCELLANEOUS.

Alien Enemy Property, 344
Aluminium Prices, 484
Aluminium Production, 626
Anchor Works Hospital and Distress Fund, 425
Apprentices, Called-up, Position, 282
Association of Engineering Shipbuilding Draughtsmen, 603
Australian Imports, 525
Bank Amalgamation, 114
Batu-Wallah's Society, 676
Birmingham Brass Trade, 676
Blast Furnace Gases, Utilisation, 197
Blind, Electrical Work for, 237
Books, Forthcoming, 73
British Glass Industry, 484
British Industries Fair, 73, 344, 366, 584
British Manufacturers Corporation, 444
British Westinghouse Employees' War Relief Fund, 425
Building After the War, 136
Cable between English and Irish Coasts, 652
Canteen at Crypto Elec. Co., 652
Channel Tunnel, 237, 565
Chartered Institute of Patent Agents, 136
Chemical Trades' Industrial Council, 366
China, Exports, 425
City and Guilds of London Institute, 94
Coal Control, 425, 444
Coal Controller's Monthly Return, 748
Coal Output, 196
Coal Prices, 237
Coal Rationing, 73
Coal Situation, 465, 565
Coal Trade, 216
Coalition Government, Premier's Statement, 703
Committee on Production, 626
County of London Royal Engineer Volunteers, 259
Crops, Growing, Application of Electricity, 729
Customs Decisions, 525, 583
Damages for Electric Shock, 94
Defence of the Realm Losses, Royal Commission, 565
Demobilisation Problems, 302
Disabled Soldiers' Training, 565
Drake & Gorham, Luncheon, 703
Dye Companies' Amalgamation, 136
Electrical Trades' Benevolent Institution, 31
Electricity, Fraudulent Use, 94, 259
Electrolytic Disinfectant Department, Poplar, 544
Employers and Employed, Relations, 444
Employment Returns, 626
Enemy Banks Bill, 282
Enemy Firms Wound Up, 18, 51, 94, 196, 407, 424, 504
Engineering Trades Unions, 344
Engineers' Club, 444
Exemptions from Military Service, 51
Exports, 74, 94, 237, 345, 407, 505, 627, 676
Exports, Prohibited and Restricted, 627, 676, 703 729
Factory Regulations, Breach, 484
Federation of British Industries, Second Report, 748
Fires, 114, 344, 387
Fuel and Lighting Order, 216, 302, 565, 583
Fuel Economy, 323
Furnaces, Elec., for Small Castings, 136
Gas Coke Order, 504
Gas, Calorific Power, 237
Greek Commercial Delegates' Tour, 444
Greek Commercial Mission, 565
Grimsby Automatic Telephone Exchange, 484
Home Office Regulations, Breach, 51
Imports, 74, 94, 237, 345, 407, 505, 627, 676
Income Tax Allowance for Depreciation of Plant, 323
Income Tax Up to Date, 323
Industrial Councils and Local Authorities, 196
Industrial Reconstruction Council, 73
Inquests, 73, 259, 344
Journalists, Prospective, Univeristy Curriculum to the Needs of, 749
King's Fund for the Disabled, 444
Kitchens, National, 323
Labour Party, 627
Lectures, Popular Science, 505
Libel on Public Official, 136
Liverpool Engineers' Wages, 302
London Munition Workers' Sports, 259
Lord Roberts' Memorial Workshops, 51
Magneto, Patents, 94
Manchester Ship Canal, 676
Marconi's Wireless Telegraph Co., 676
Military Service Act (1918) Order, 136
Miners' Lamp Approved, 323
Ministry of Munitions Soirée, 749
Motor Manufacturers' Society, 676
Munitions Dispute Inquiry, 323
Municipal Industrial Council, 504
National Association of Supervising Electricians, 465
National Employers' Federation, 73
National Joint Industrial Councils, 603
Naval Electricians, Retiring Rank, 73
Naval Rating, New, 504
New Transport Co., 544
Non-Ferrous Metal Industries, 366, 626
Non-Union Man, Alleged Threats to, 51
Occupations, Certified, 465
Officers' University Technical and Training Committee, 627
Overseas Buyers, Register, 114
Patent, Application for Extension, 31, 196
Patent Surrender, 73
Patents, Alien Enemies', 237, 259, 302, 323, 407, 464, 627
Petrol and Paraffin Prices, 676
Pipes for Soldiers and Sailors, 626
Presentations, 484, 652
Printers' Pie, 1918, 31
Punch's Almanack, 626
Radium Control Order, 344
Railway Wagons, Private Owners' Census, 302
Railway Working, 73
Reconstruction, Principles of, 544
Royal Assent, 237
Scholarships, 17
Schools for Elec. Welding Operators, 544
Scottish Fuel Order, 465
Scrap Disposal, 387
Shop Stewards Recognition, 748
Sports for the Benefit of the Blind, 387
Stokers, High-Duty, for Low-Grade Coal, 323
Strike, 626, 652
Submarine Cable between England and Ireland, 626
Superannuation Scheme, 565
Syndication, Complete Scheme, 525
Taunton Municipal Technical School, 676
Telephonists' Pay, 565, 584
Tin and Tungsten Research, 544
Trade Parliaments and their Work, 31
Trade Union Assault Case, 114
Trading with the Enemy, 282, 344, 583, 676, 729
Union Cable Co.'s Concert, 584
University Electors, Registration, 94
U.S.A. Submarine Cables, 626
Valuation Appeals, Scottish, 505
War Loan, National, 387
Warwickshire R.E. Volunteers, 282
Welfare Committee, Advisory, 73
Whitley Report and Government Establishments, 237
Winding-up Petitions, 74
Winter's Pie, 603
Workmen's Compensation, 652
Wireless Apparatus on Coasting Vessels, 603
Wireless Operators' Wages, 74
Wirelesss Telegraphy on Australian Ships, 505
Z Electric Lamp Mnfg Co. Club, 703

Companies' (Joint-Stock) Meetings, Reports, Dividends, Statutory Returns, &c.

Aabada Trust, 750
Aberdeen Suburban Tramways, 388
Adelaide Elec. Supply, 53, 654
Alby United Carbide Factories, 95
Allen (E.) & Co., 678
Altrincham Electric Supply, 53
Aluminium Corp., 197
Amalgamated Wireless (Australia), 654
Amazon Telegraph, 628, 654
American Telephone & Telegraph, 367, 486, 526
Anglian Engineering, 446
Anglo-American Telegraph, 32, 240, 526
Anglo-Argentine Tramways, 218
Anglo-Portuguese Telephone, 75, 95, 604
Arbroath Elec. Light & Power, 261
Argentine Tramways & Power, 75
Armstrong (Sir W. G.), Whitworth & Co., 446, 466
Associated Fire Alarms, 526
Auckland Elec. Tramways, 678, 704
Babcock & Wilcox, 53, 566
Barbados Electric Supply Corpn., 730
Barcelona Traction, Light & Power, 261, 526, 654, 749
Bath Electric Tramways, 53
Benn Brothers, 387
Blackpool & Fleetwood Tramroad, 346
Bombay Elec. Supply & Tramways, 261, 486
Bournemouth & Poole Electricity Supply, 284
Brazilian Traction, Light & Power, 138, 367, 408, 678
Brisbane Elec. Tramways Investment, 76, 526
British Aluminium, 446
British Coalite, 304, 730, 750
British Columbia Elec. Rly., 32, 566
British Columbia Telephone, 304
British Elec. Traction, 96, 158, 197, 654
British Elec. Transformer, 19
British Empire Trust, 325
British Ever-Ready, 54, 654
British Insulated & Helsby Cables, 54, 95, 158, 446, 466
British Thomson-Houston, 239, 283
British Tramways & Carriage, 346
British Westinghouse Elec. & Mfg., 19, 32, 604, 628, 653, 730
Bromley (Kent) Elec. Light & Power, 446
Brompton & Kensington Elec. Supply, 346
Brotherton Tubes & Conduits, 115
Brough (Westmoreland) Elec. Lighting, 363
Browett, Lindley & Co., 426
Brown, Boveri & Cie. (Soc. anon.), 346
Bruce Peebles & Co., 566
Brunner, Mond & Co., 20
Brush Elec. Engineering, 96, 158
Burma Corpn., 678
Calcutta Elec. Supply Corpn., 54, 95, 346, 566
Calcutta Tramways, 566
Callender's Cable & Construction, 239, 260, 546, 654
Cambridge Electric Supply, 326
Canadian General Electric, 75, 138, 749
Cape Electric Tramways, 604, 678
Cape Town Consolidated Tramways & Land, 526
Castner-Kellner Alkali, 96, 704, 749
Ceara Tramway, Light & Power, 654
Central London Railway, 262
Chadburn's (Ship) Telegraph, 325
Charing Cross, West End & City Elec. Supply, 326
Chatham & District Light Rlys., 326
Chili Telephone, 218, 239, 283
Chiswick Electricity Supply Corpn., 53
Chloride Electrical Storage, 54, 653
Cia de Electricidad de la Provincia de Buenos Aires, 367
Cia Francaise Pour L'Exploitation des Procedes Thomson-Houston, 368
City & S. London Railway, 262, 426
City of Buenos Ayres Co. (1904), 20
City of Buenos Ayres Tramways, 368, 604
City of London Elec. Lighting, 426
City of San Paulo Improvements & Freehold Land, 604
Clarke, Chapman & Co., 20, 54, 198
Cleveland Trust, 566
Clyde Valley Electrical Power, 408

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Companies' (Joint-Stock) Meetings, Reports, Dividends, Statutory Returns, &c.—*Continued.*

Coalite, 53
Colombo Elec. Tramways & Lighting, 304
Companies Struck Off the Register, 96, 326, 466, 486, 654, 704
County of London Elec. Supply, 426
Craigpark Electric Cable, 75
Crompton & Co., 239, 261
Cuba Submarine Telegraph, 32, 506
Delagoa Bay Development Corpn., 750
Delhi Elec. Tramways & Lighting, 218
Dick, Kerr & Co., 566, 584, **605**, 628
Direct Spanish Telegraph, 466
Direct United States Cable, 19, 53, 240, 506
Direct West India Cable, 486
Doulton & Co., 116
Drake & Gorham, 584, 628
Dublin United Tramways (1898), 240
Dumbarton Burgh & County Tramways, 486
Dundee, Broughty Ferry & District Tramways, 506
Duram, 566
Eastern Extension Australasia & China Telegraph, 76, 158, 218, 446, 526, 546, 584, 730
East London Railway, 749
Eastern Telegraph, 76, 198, 426, 526, 545, 730
Edison Swan Elec. (Limited & Reduced), 32, 54, 262, 368, 750
Edmundson's Electricity Corpn., 261
Electric & General Investment, 239
Electric Construction, 75, 115, 654
Electric Light & Power Co. of Cochabamba, 678
Electric Light & Power Supply Corn. (Sydney), 388
Electrical Securities Trust, 730
Electric Supply Co. of Victoria, 526, 546, 566
Electric Supply Corpn., 506
Electro-Bleach & By-Products, 346
Engineering Amalgamations, 262
Erinoid, 584
E.S. Co., 96
Evered & Co., 346
Falk, Stadelmann & Co., 446
Faringdon Elec. Light & Power, 388
Ferranti, 678, 730
Fellows Magneto, 261, 388
Fife Tramway, Light & Power, 326
Fraser & Chalmers, 262, 704, 750
Fuller Accumulator, 678, 704
Fullers Carbon & Electrical, 749
General Electric, 218, 239, 304
General Electric (U.S.A.), 325
German Submarine Cable Companies, 486
Globe Telegraph & Trust, 198, 217, 426, 678
Great Northern Telegraph (of Denmark), 75, 284
Green (G. W.) & Co., 654
Greenwood & Batley, 304
Guildford Elec. Supply, 426
Hadfields, 304
Halifax & Bermudas Cable, 486
Hamilton (Claud), 566
Havana Elec. Rly. Light & Power, 367
Henley's (W. T.) Telegraph Works, 218, 346
Hill Bros. (Magnetos), 96
Hong Kong Tramways, 368, 486
Hudson's Consolidated, 654
Hurst, Nelson & Co., 566
Imperial Tramways, 261
India Rubber, Gutta Percha & Telegraph Works, 198, 704
Indian Elec. Supply & Traction, 96, 604
Indo-European Telegraph, 19, 526
International Electric, 566
International Light & Power, 654
Isle of Thanet Elec. Tramways & Lighting, 54
Jackson, T. & J., 368
Johnson & Phillips, 19
Kensington & Knightsbridge Elec. Lighting, 304
Kidderminster & Dist. Elec. Lighting & Traction, 75, 95
Kinsolite Co., 96
Kalgoorlie Elec. Power & Lighting Corpn., 198
Kalgoorlie Elec. Tramways, 426
Keith (James) & Blackman, 158
Laing, Wharton, 368, 654
Lanarkshire Tramways, 346
Lancashire Dynamo & Motor, 346, 408, 486
Lancashire Power Construction, 198
La Plata Tramways, 198
Lewes & District Elec. Supply, 75
Lima Light, Power & Tramways, 526
Lisbon Elec. Tramways, 388, 408
Liverpool Overhead Railway, 304
London Electric Railways, 262
London Electric Supply, 20
London United Tramways, 19
London & Lancashire Fire Insurance, 53
London & Suburban Traction, 96, 137, 346
Lymington Elec. Light & Power, 53
Mackay Companies, 53, 446
Madras Elec. Supply Corpn., 262
Madras Electric Tramways (1904), 446
Malta Tramways, 749
Manaos Tramways & Light, 604
Manila Elec. Railroad & Lighting, 367
Manx Electric Railway, 704, 730
Marconi International Marine Communication, 198, 240, 749
Marconi Wireless Telegraph, 261, 325, 749
Marconi Wireless Telegraph Co. of America, 116
Mather & Platt, 304
Maxim Lamp Works, 96, 368
Melbourne Elec. Supply, 76, 654
Metropolitan Carriage, Wagon & Finance, 75, 96, 115
Metropolitan Elec. Supply, 284
Metropolitan Electric Tramways, 19
Merthyr Elec. Traction & Lighting, 75
Metropolitan District Railway, 262
Metropolitan Railway, 304
Mirrlees, Bickerton & Day, 138, 749
Mond Nickel, 566
Montevideo Telephone Co., 654, 704
Montreal Light, Heat & Power Consolidated, 566
Montreal Tramways, 604
Nairobi Elec. Power & Lighting, 76, 546
National Elec. Supply, 216
National Telewriter, 526
Newcastle-on-Tyne Elec. Supply, 408, 506, 526
New General Traction, 138
New Ross Gas & Electricity, 284
New Transport Co., 730
Nitrogen Products & Carbide, 54
Northampton Elec. Light & Power, 408
North Melbourne Elec. Tramways & Lighting, 326
North Metropolitan Elec. Power Supply, 54, 604
Northern Scotland Elec. Light & Power, 75
Northern General Transport, 75
Oldham, Ashton & Hyde Elec. Tramway, 19, 346
Omega Lamp Works, 566
Oriental Telephone & Electric, 304, 526, 654
Oxford Electric, 426
Palmer's Shipbuilding & Iron, 546
Para Elec. Railways & Lighting, 388
Paraguay Central Railway, 673
Peebles (Bruce) & Co., 284
Peel-Conner Telephone Works, 116
Platinum & Gold Corpn., 678
Portable Searchlight & Signalling, 368
Potteries Elec. Traction, 75
Power Gas Corporation, 653
Provincial Tramways, 96, 730
Richardsons, Westgarth, 284, 446
Rio de Janeiro Tramway, Light & Power, 388
River Plate Electricity, 75
Record Electrical, 326
Rees Roturbo Mfg., 446
Royce, 346
Ruston & Hornsby, 654
Sao Paulo Tramway, Light & Power, 388
Scott (Walter), 368
Shanghai Elec. Construction, 96, 116, 526
Shawnigan Water & Power, 153, 367, 446
Shropshire, Worcestershire & Staffs Elec. Power, 75
Siemens Bros. & Co., 32, 138, 240, 584, 654
Simplex Conduits, 96
Singapore Elec. Tramways, 261, 326
Small Electric Motors, 654
South American Light & Power, 388
South Brazil Electric, 506
South Metropolitan Elec. Tramways & Lighting, 20
South Wales Elec. Power Distribution, 76, 136
Southern Brazilian Railways, 426
St. James & Pall Mall Elec. Light, 284
Stewarts & Lloyds, 304
Stirling & Bridge of Allan Tramways Co., Ltd., 730
Stothert & Pitt, 604
Submarine Cables Trust, 32, 96, 137, 506
Sulphide Corpn., 749
Swansea Improvements & Tramways, 261
Telegraph Construction & Maintenance, 218, 704
Telephone Co. of Egypt, 262
Trafford Park Estates, 566
Trowbridge Elec. Supply, 326
Tyneside Tramways & Tramroads, 408
Underground Elec. Railways of London, 262, 408
United Electric Tramways of Caracas, 604
United Electric Tramways of Montevideo, 262
United River Plate Telephone, 116, 138, 158, 526
Urban Electric Supply, 20
Vickers, 20, 304, 446, 486, 506, 566
Victoria Falls & Transvaal Power, 193, 486, 526, 566
Vulcan Boiler & General Insurance, 138
Waste Heat & Gas Electrical Generating Stations, 408
Waygood-Otis, 240
Weaverham Electricity Supply, 566
Wellingborough Elec. Supply, 116
West African Telegraph, 526, 546, 604
West India & Panama Telegraph, 20, 76, 115, 604
West London & Provincial Elec. Supply, 76
Western Power Co. of Canada, 678
Western Telegraph, 116, 408, 654, 677, 678
Western Union Telegraph, 446, 628, 704
Westinghouse Elec. & Mfg., 368
Westminster Elec. Supply Corpn., 326
White (J. G.) & Co., 198
Winnipeg Elec. Railway, 368
Woking Elec. Supply, 262
Yorkshire Electric Power, 326, 704
Yorkshire (West Riding) Elec. Tramways, 730
Yorkshire Elec. Wiring & Motor, 326
Yorkshire (Woollen District) Elec. Tramways, 96, 198
Zinc Corpn., 678

Companies, Joint-Stock (New Electrical, &c.), Registered.

Aabada Dry Batteries, 566
Acme Sales Agency, 678
Alloy Welding Process, 116
A.M.T. Syndicate, 388
Anti-Rust & Metal Deposition, 262
Arma Mfg., 654
Asbestos Association, 678
Ayres (W. G.) & Co., 566
Basford Engineering, 20
Bat Motor Mfg., 326
Bowling & Co., 466
British Federation of Iron, Steel, Tinplate & Metal Merchants (Inc.), 566
British Gauge Manufacturers' Association, 506
British Metal Corp., 584
British Spiro Turbine, 730
British Steel Corp., 584
Brown, Bayley's Steel Works, 388
Cardiff Docks Engineering Works, 730
Chain Elevators, 506
Cliffords, 388
Cosmore, 302
Coventry Foremen's Association of Engineering and Allied Trades, 466
Davies (Hubert) & Co., 76
Domestic Electric, 368
East London Mica, 368
Eastern General Welding & Brazing Works, 20
Edinburgh Electrical Engineering, 262
Electrical Co. (Glasgow), 654
Electrical Components, 20
Electro-Leather Industries, 116
Expert Metal Workers, 304
Fabric Rubber, 506
Far Eastern Development, 388
Fermans (1918), Ltd., 566
Fleet Engineering, 304
General Engineering Co. (Hornsey), 730
Gordon Mfg., 566
Hamilton (R. F.) & Co., 388
Henley's Tyre & Rubber, 304
Hightensite, 240
Holden, J. B. (Engineers, Great Bridge), 262
Howard Electrical, 368
Howard, Reuson & Co., 584
Interallied Trade & Banking Corp., 654
Jacob & Partners (Port Talbot), 20
Knight & Kilbourne (European) Patents, 730
Leeds Flint Glass, 566
Lege (A.) & Co., 466
Lorival Mfg. Co., Ltd., 678
McBride (Wm.) & Sons, 240
McWhirter & Sons, 730
Magneto Spare Parts, 116
Manchester Aluminium, 654
Metallic Electrodes, 240
Metallurgical Research, 388
Metallurgists, 262
Monometer Mfg., 116
M.P. Mfg., 566
Mulcaster (J.) & Co., 388
Nash (E.) & Co., 466
National Alloys, 466
Newcastle Graphite, 506
Orbit Electrical, 730
Parkinson Motors, 76
Phœnix Armature Works, 76
Platit, 326
Pneumatic & Elec. Synd., 368
Portable Tool & Engineering, 730
Pratt Bros., 304
Protector, 506
Quain Electric, 116
Radio Electric Clothing, 304
Regent Shares, 730
Remco Carbon, 506
Richardson (A. W.) & Son, 506
Scriven & Co. (Leeds), 368
Small Tool Supply, 76
Smethurst & Co. (London), 506
Smith (Thos.) & Sons (Rodley), 326
Taranto Tramways & Electric Supply, 262
Technological Institute of Great Britain, 466
Telephone Third Hand, 262
Tucker (J. H.) & Co., 678
Turney (A. G.) Engineering, 466
Weston Elec. Instrument, 466
Wigan Electro-Metallurgical Works, 76
Winn (Charles) & Co., 368
Worthington Pump & Machinery, 76
Yorkshire Battery Mfg., 566

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CONTENTS.

NOTES	1
Arrangements for the Week	3
Electric Passenger Locomotives for the Chicago, Milwaukee & St. Paul Railway. Illustrated	4
Large Batteries for Power Purposes. By E. C. McKinnon.—*Concluded*	6
Elementary Principles of Continuous-Current Armature Winding. By F. M. Denton, A.C.G.I. Illustrated.—*Concluded*	8
Light and Vision	10
Trade Parliaments and Their Work. By E. J. P. Benn	11
COMBINATION FOR THE HOME TRADE	12
The Chamier-Turner "Trinity" Morse Set. By S. Turner, A.M.I.E.E., A.F.Ac.S. Illustrated	13
CORRESPONDENCE	14
The Control of Large Amounts of Power	14
15,000-volt Ironclad Cubicle Switchboard. Illustrated	15
LEGAL INTELLIGENCE	15
PARLIAMENTARY INTELLIGENCE	15
Patent Record	16
Volunteer Notices	16
Commercial Topics	16
Electricity Supply	17
Tenders Invited and Accepted	18
Companies' Meetings and Reports	19

Notes.

Large Passenger Locomotives in the U.S.A.

THERE are an unusual number of interesting points to be found in the design of the new electric passenger locomotives for the Chicago, Milwaukee & St. Paul Railway, which are described on another page. It will be remembered that these locomotives operate on a continuous-current system at 3,000 volts, and that heavy gradients are involved; consequently, large powers are necessary, and for this reason the present locomotives are designed so that the one-hour rating gives 4,000 H.P., and the starting tractive effort is 112,000 lb. The normal speed on the level is 60 miles per hour. Among the more interesting features, we may draw attention to the special means adopted to provide for regenerative control. When the ordinary motors are used for this purpose there is always some risk that the fields may not build up to give the required regenerative action. In the present design any such risk is eliminated by providing separate exciters, which are mounted on the pony trucks. These small generators also provide power for operating the air compressors and blower motors when not required for excitation, so that the air compressors are independent of the overhead trolley supply. Another feature is that reliance is not placed upon power from the trolley for heating. As the question of train heating is of vital importance, due to extreme weather conditions, the necessary heat is provided by means of a special oil-fired steam boiler on the locomotive. It may be noted that the main motors are of the double armature type, each armature being wound for 750 volts, so that the good commutating characteristics of low voltage motors are obtained. Since there are six motors, there are nine running positions without rheostatic losses. These are obtained by connecting the motors so that they are either all six in series, or three in series or two in series, additional running speeds being secured on each combination by means of inductive shunts on the main motor fields. Thus it is that a speed range is obtained from 8 to 56 miles per hour, depending upon the load.

The British Aluminium Co.'s Bill.

THERE is no accounting for the politician when it comes to "practical politics" as distinct from those of a Parliamentary nature. Last Tuesday the Bill of the British Aluminium Co. was to have been read a second time in the House of Lords. The object of the Bill was to enable the Company to develop further water-power in Scotland. It is recognised that the aluminium industry is a "key" industry for this country; it is, indeed, common knowledge that this industry has been of the greate t importance during the war. It is admitted that the measure has the support of the Board of Trade and the Ministry of Munitions, and yet the opposition was sufficient to lead to the withdrawal of the Bill. The chief objections seemed to be on the ground that natural resources for national objects should be utilised according to a national plan, and not in a piecemeal fashion by a commercial company for private profit, and that the control of "key" industries ought to be in public hands. What is not realised by Lord BALFOUR and by Lord CREWE is that very few water-powers can be developrd sufficiently cheaply for the purpose, and that if such power is not to be made available the industry will flourish in other countries instead of in Great Britain. Whether the scheme can be carried out under war conditions is a question of expediency and is a minor consideration. Certainly the net result of the opposition is not in the national interest.

Trade After the War.

THE Report of Lord BALFOUR OF BURLEIGH'S Committee on Commercial Industrial Policy after the War has been received with mixed feelings. It is inevitable that this should be so. One section of the community is clamouring for most drastic action against aliens and for the protection of the industries of this country in one form or another. A second section of the community objects to restrictions of any kind, as being against the economic interests of the country; and, on the other hand, probably a large section of the community disagrees with both these extreme views. Generally speaking, we think that the present Report voices the opinions of this intermediate section. The proposals that are made include the existing prohibitions against importing enemy goods for at least 12 months after peace and the continuance of the control of home and foreign trade for a certain period, but such restrictive measures are to be kept within the narrowest possible limits, the trades and industries themselves being entrusted with the control under Government authority. It is considered that any attempt to make the Empire self-supporting would be neither practicable nor economically sound, but there should be a general policy to make the Empire in an emergency independent of any single foreign country or combination of countries. The Committee favour industrial and commercial organisations, with a view to meeting foreign competition, and while they do not think it would be expedient for the Government to aim at positive control of trade combinations, they think some means should be devised for securing, to a responsible Government department, adequate information as to their formation. It is also proposed that combinations should be legalised so as to be enforceable between members. No suggestions are put forward to help

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industry financially. An Imperial Bank of Industry is not recommended; in fact, the view is taken that the remedy for shortage of capital after the war must be sought mainly in the increase of production and in saving. We do not think this is a view which will be received favourably, for the simple reason that present taxation permits very little in the way of saving to ensure stability in the future. We need scarcely remark that fiscal policy is a thorny subject. It is proposed that the Government should take action to promote and safeguard pivotal industries and give assistance to industries which are important for maintaining the Kingdom's industrial position, but otherwise comprehensive tariffs are condemned. Nevertheless, we are glad to see the recommendation that producers in this country should be protected against dumping and the introduction of sweated goods. The Committee feel the danger, which has often been emphasised, that political pressure would be brought to bear upon the Government to give protection to various industries, and in order to avoid this danger it is recommended that a strong and competent board, with an independent status should be formed to examine all applications for State assistance and to advise the Government upon them. This seems to us to be a good suggestion. Lastly, the Committee do not recommend either the metric system or decimal coinage, which will come as a shock to those who feel that the country is certainly ready for at least the latter.

Light and Vision.

THE Paper by Prof. W. M. BAYLISS at the last meeting of the Illuminating Engineering Society on April 16, dealt with some points of fascinating interest. There is much that is mysterious in the processes by which light falling upon the eye produce a nerve-impulse which in turn is transmitted to and analysed by the brain. Up to a point the nature of the operations can be clearly traced, with a wealth of confirmatory evidence, but at many stages our knowledge of physiological facts and interpretation of data seems to be incomplete. It appears to be now well recognised that the basis of light perception at the retinal layers is photo-chemical, and that visual purple is the essential element therein. Prof. BAYLISS pointed out the remarkable similarity between the absorption of the visual purple and the sensitiveness of the eye to light, throughout the spectrum. The fact that an appreciable time is necessary for the sensation of light to reach a maximum, and the formation of positive and negative after-images, are readily explicable on a photo-chemical basis, and the study of minute retinal currents following exposure to light seems to confirm this theory. The chief difficulty hitherto has been the absence of visual purple from the fovea centralis, where vision is most acute; but Dr. EDRIDGE GREEN has recently found that the purple flows into this region from adjacent areas. The question of the functions of the rods and cones appears unsettled, and the decision is evidently a matter of great difficulty. Of the nature of the nerve impulses by which light is conveyed from the retina to the brain, and of the process of analysis by which form and colour are distinguished, little is yet known. There is, indeed, much to be learned in this fascinating field of study.

Practical Applications.

IT is hardly surprising that when we come to the practical application of such knowledge to illuminating engineering there should be difficulties in getting accurate data. Lighting experts may form rules, based on practical experience regarding the avoidance of glare; and it is common knowledge that prolonged work by inadequate illumination is prejudicial to the eye-sight. Yet it is difficult to obtain from physiologists sufficient concrete physiological evidence on such points. The explanation lies, as Prof. BAYLISS suggested, partly in the extreme complexity of the problems with which the physiologist has to deal. But we think that there has not yet been a sufficiently close relation between those concerned with practical lighting problems and those engaged in the study of the physiology of the eye, and we hope that the co-operation promised by the eminent ophthalmic experts who took part in this meeting of the Illuminating Engineering Society may be fruitful in clearing up some of the points and in reinforcing practical experience by fuller evidence from the physiological side.

Technical Journalists and Trade.

WHILE the Government have shown considerable activity in organising the daily press for the prosecution of the war, and have fully recognised the influence that they can bring to bear in presenting the case of the Allies to the public, both in this and other countries, we think it will be agreed that comparatively little use has been made of the services of technical journalists. This point was emphasised in a Paper read before the Circle of Scientific Technical and Trade Journalists at the Stationers' Hall on April 29 by Mr. S. J. SEWELL. The author presented a comprehensive series of statistics showing the development of British Trade in the period 1869–1913, and referred to various ways in which technical journalists receive greater recognition in Germany than in this country. He mentioned, for example, that complete lists of all trade and technical journals, and their respective spheres of work, could be obtained at any post office in Germany, and he traced most of that country's phenomenal industrial progress to the systematic methods of educating merchants, in which the technical press plays an important part. Mr. J. L. GARVIN, President of the Institute of Journalists, delivered an address in which the value of technical journalism was further emphasised, and Mr. GASTER, Chairman of the Circle, referred to the closer relations which are now being established between the technical press and the Government of the U.S.A. Finally a resolution, urging upon the Board of Trade fuller co-operation with scientific, technical and trade journalists, was passed, and the President undertook to bring this to the notice of the authorities. With the general principle enunciated, most editors of technical journals will sympathise. They receive from the Government a constant stream of announcements and notices which occupy much of their limited space, but they are rarely consulted as to the framing of Orders and Regulations which they are asked to publish. In many cases their technical knowledge of the industries they represent would be useful to the authorities, and we hope that the representations now being made will receive sympathetic attention.

Institution of Electrical Engineers.—Mr. S. L. Pearce has been nominated for election as a vice-president, and Messrs. T. Roles and E. B. Wedmore have been nominated as members of the council of the Institution of Electrical Engineers.

Institution of Electrical Engineers.—Manchester Local Section.—The Committee for the year 1918–19 is as follows: *Chairman*, A. P. M. Fleming; *Vice-Chairmen*, J. A. Robertson and Ald. W. Walker; *Committee*, A. S. Barnard, W. Cotsworth, *A. G. Ellis*, E. M. Hollingsworth, *G. A. Juhlin*, A. G. Livesay, Prof. E. W. Marchant, *S. L. Pearce*, Prof. Miles Walker, *S. J. Watson*, H. T. Wilkinson and W. J. A. Wood. The members of the Committee whose names are in italics were elected at the annual general meeting held on the 23rd ult.

Institute of Chemistry.—Part II. (1918) of the "Proceedings" of the Institute of Chemistry contains an account of the Fortieth Annual Meeting, held on March 1. The report of

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the retiring President, Sir James Dobbie, deals largely with the regulations for the admission of new members and with professional organisation. A special step necessitated by the present circumstances is the admission, under certain conditions, of candidates for associateship without examination during the war. Conferences have taken place with the Pharmaceutical Society regarding the legal definition of the word "chemist."

Exhibition of Scientific Products of British Manufacture.—We understand that the British Science Guild is organising an exhibition of products and appliances of scientific interest which are now being produced in the United Kingdom, but which, previous to the war, were mainly obtained from abroad. It is stated that the exhibition will be held at King's College, London, and will probably be open for four weeks during the summer.

Co-ordination of Scientific Publications.—At the meeting of the Institution of Electrical Engineers on Thursday, April 25, the President announced the receipt of a letter from the Faraday Society inviting the President, Council, Secretary and Members of the Institution to attend a discussion on "The Co-ordination of Scientific Publications," at 5.30 p.m., on May 7, at the rooms of the Chemical Society, Burlington House, London. Sir Robert Hadfield (President of the Faraday Society) will open the discussion.

National Electricity Supply.—We have received a pamphlet by Mr. Ernest Hatton, engineer and general manager of the Corporation tramways and electricity undertaking at Newcastle-on-Tyne, dealing with the question of national electricity supply and the interim report on Electric Power Supply in Great Britain. Mr. Hatton discusses in some detail the possible saving in coal that may be effected by large generating stations. It is shown that there is very little chance of securing the saving of 55 million tons of coal per annum which was suggested in the report. Mr. Hatton also deals adversely with the financial aspects. We are inclined to think, however, that the intentions of the report have not been very correctly interpreted.

Ball Bearings for Electric Motors.—The application of ball bearings to electric motors, which was discussed in an article by H. N. Treemball in the "Electrical Review and Western Electrician" last year, is an interesting suggestion. Apart from diminished friction and reduced costs of lubrication and maintenance it is claimed that such bearings facilitate short air-gaps and good permanent alignment. It is also stated that the overall length of the bearing can be reduced by 10 to 27 per cent. Ball bearings are considered specially suitable in cases where there is much vibration and shock, but require to be refilled with lubricants at intervals varying from 1 week to 6 months. As a special instance of their utility the author mentions some experience with axle-driven lighting generators on railway coaches. The cost of maintenance was reduced 46 per cent. on dining cars and 66 per cent. on ordinary coaches by the substitution of ball bearings for ordinary ones, and many common faults arising from hot bearings were practically eliminated.

Institute of Metals.—The Presidential Address, delivered before the Institute of Metals by Prof. H. C. H. Carpenter on March 13, referred to the steady progress made by the Institute since its inception in 1908; in the past year the growth in membership has been specially rapid. Copper and its alloys figure very largely in the Institute's proceedings, but the development of many special alloys of aluminium, nickel, tin, lead and antimony has focussed increased attention on these metals. A considerable amount of work has been done by the Corrosion Research Committee on the corrosion of brass marine condenser tubes by salt water. Originally, experiments were conducted on simple alloys, but the foundation of a complete series of researches starting from the pure metals are now being initiated at the Royal School of Mines. The latter part of the Address dealt with the training of metallurgical engineers, various combinations of experience at technical colleges and in the works being discussed. Prof. Carpenter laid stress on the cultivation of the critical faculty, The power to acquire knowledge should be united with the capacity of estimating just how much weight should be attached to it.

Obituary.

The many friends of the late J. M. Ralph will be interested to hear that a memorial is being organised to perpetuate his work in connection with the B.T.-H. Co. Funds have come readily to hand, but, due to the exigencies of the times, a number of letters have failed to reach their objectives. Old friends who are interested and have not received a notification, should communicate with Mr. R. G. Hosking, 3, Bilton-road, Rugby.

DEATHS ON ACTIVE SERVICE.—The following deaths are reported:

Major Ernest Jackson (R.E.), M.C., who died of wounds on April 18, had studied engineering at Sheffield University, and in 1914 obtained a first class in the City and Guilds examination in engineering, and was awarded a research scholarship by his university.

Sec.-Lieut. Claude Neville Madeley (R.A.F.), 24 years of age, who was killed during a combat in the air on Jan. 19, was formerly engaged at the British Westinghouse Co.'s works at Manchester.

Sec.-Lieut. R. B. Sanderson (R.G.A.), who died of wounds on April 17, was on the staff of the Royal Naval College, Osborne, prior to the war. He had been a pupil to the chief engineer of the L. & N.W. Railway, after graduating in the mathematical and mechanical tripos at Cambridge.

Sergt. W. Partington and Gunner H. Crozier (R.F.A.), formerly employed by Messrs. Dick, Kerr & Co., have died in action.

Pte. A. Hensley (R.F.A.), formerly a Burnley tramway employee, has been killed in action.

Pte. Fredk. Cooke (M.G.C.), aged 28, who has died from wounds, was formerly employed by Messrs. Dick, Kerr & Co.

Pte. G. H. Lukins (S. Wales Borderers), formerly employed in the Cardiff electricity department, was killed in action on April 12.

Personal.

Capt. Higgins (R.E.), who has been senior instructor at the London District R.E. School of Engineering at Esher for the last two years, after active service in France, has now been appointed Adjutant to the County of London Engineer Volunteers.

WAR CASUALTIES.—The following casualties are reported:—

Pte. A. Brown (Manchester Regt.), who was formerly employed in the Manchester Corporation Tramways Department, is reported missing as from March 23.

Pte. B. V. Edmondson (Artillery H.Q. Staff), formerly a Burnley tramcar conductor, has been wounded in both legs.

Pte. A. E. Smith (Manchester Regt.), also a Burnley tramwayman, is a prisoner in Germany.

Arrangements for the Week.

FRIDAY, May 3rd (to-day).

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. Discussion on Paper, "Employment of Women in Munition Factories," by Miss O. E. Monkhouse.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, Westminster, London, S.W. Paper on "Power Plants: National, Communal or Industrial?" by Mr. W. A. Tookey.

MONDAY, May 6th.

INSTITUTION OF ELECTRICAL ENGINEERS, NEWCASTLE LOCAL SECTION.

6.45 p.m. The Mining Institute, Newcastle. Informal discussion on "The Proposed Regulations for the Electrical Equipment of Ships," opened by Mr. A. P. Pyne.

TUESDAY, May 7th.

FARADAY SOCIETY.

5.30 p.m. At the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W. 1. General discussion on "The Co-ordination of Scientific Publication," opened by Sir Robert Hadfield, Bart., F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, SCOTTISH LOCAL SECTION.

7.30 p.m. At the Rooms, 207, Path-street, Glasgow. Informal discussion on "The Proposed Regulations for Electrical Equipment of Ships," opened by Mr. J. F. Nielsen.

THURSDAY, May 9th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. Discussion on "A British Electrical Proving House." Introductory Paper by Mr. C. Turnbull.

FRIDAY, May 10th.

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W.

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Electric Passenger Locomotives for the Chicago, Milwaukee & St. Paul Railway.

The concentration of enormous horse-power in a single locomotive unit has long been the recognised tendency in railway practice, originating from considerations of crew economy and the greater efficiency of large units. The limits of the two-man crew have now been reached, while further increase in size will yield but small improvement in efficiency. Recourse must be had to some new form of motive power if necessary gain in hauling capacity is to be made.

It is fortunate in many ways that electricity has thoroughly proved itself for this purpose. On the Chicago, Milwaukee and St. Paul Railway its use over the 440 miles of line over the Rocky Mountains has been so satisfactory in cutting down power costs, hauling heavier trains and keeping traffic moving in all weathers that the decision has recently been made to electrify another mountain division—the 211 miles from Othello, Washington, over the Cascade Range to Seattle and Tacoma. With the completion of this work a distance equal to that from New York to Cleveland will be under electrical operation. To handle passenger traffic over this and the Rocky Mountain division the St. Paul has ordered 10 Baldwin-Westinghouse electric locomotives.

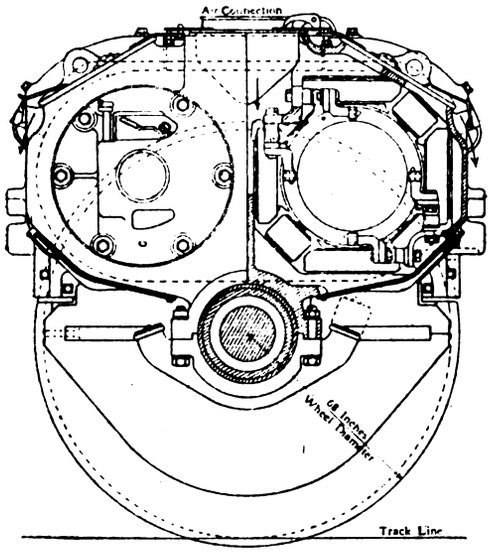

FIG. 1.—END VIEW AND PART SECTION OF THE MOTOR IN POSITION.

The main running gear centre pins are located midway between the first and second driving axles of each running gear. On one running gear the centre pin is designed to restrain the cab both longitudinally and laterally, while on the other running gear the centre pin restrains the cab only laterally, permitting free longitudinal movement. This arrangement of riding and floating pins relieves the cab of all pulling and buffing strains due to train load, as these strains are taken directly through the running gear side frames and bumpers.

The driving wheels are 68 in. in diameter, and carry 55,000 lb. per axle. Guiding trucks have 36 in. wheels, while the two-wheel trucks each have a load of 38,500 lb. at the rail, with approximately 62,000 lb distributed on each of the four-wheel trucks. On any single driving wheel, the non-spring supported weight is that of wheels, axles and driving boxes only.

The flexible type of quill drive used affords a means of permitting a motor located well above the road bed to drive an axle which, with its wheels, is free to follow the rail independently. It is evident that this drive secures all the advantages of a flexible gear in cushioning the transmittal of torque, and avoids the road shock far more effectively than with the common flexible gear construction and mounting.

Each main running gear has three-point equalisation with a single point toward the end of the locomotive, in accordance with accepted steam locomotive practice. The four-wheel guiding truck centre pin and cross-equalised leading pair of driving wheels are equalised together on the longitudinal centre line of the locomotive. This arrangement combines all the advantages of the standard front-end construction of the American and consolidation types of steam locomotives. The two remaining pairs of driving wheels and the two trailing wheels of the main running gear are side-equalised together, again following accepted steam locomotive practice.

The centre of gravity of the main running gear, including motors, is 41½ in. above the rail, and the height of the centre of gravity of the complete locomotive is 63 in. above the rail.

Among the novel features which will be found in these locomotives are:—

1. Large capacity in single-cab unit.
2. Flexibility of running speeds with small rheostatic losses.
3. Twin motor design with quill drive.
4. Low-voltage auxiliaries, simplifying inspection, maintenance and operation.
5. Simple and effective regeneration.
6. Improved equalisation to minimise weight transfer in trucks.
7. Auxiliary train-heating plant.

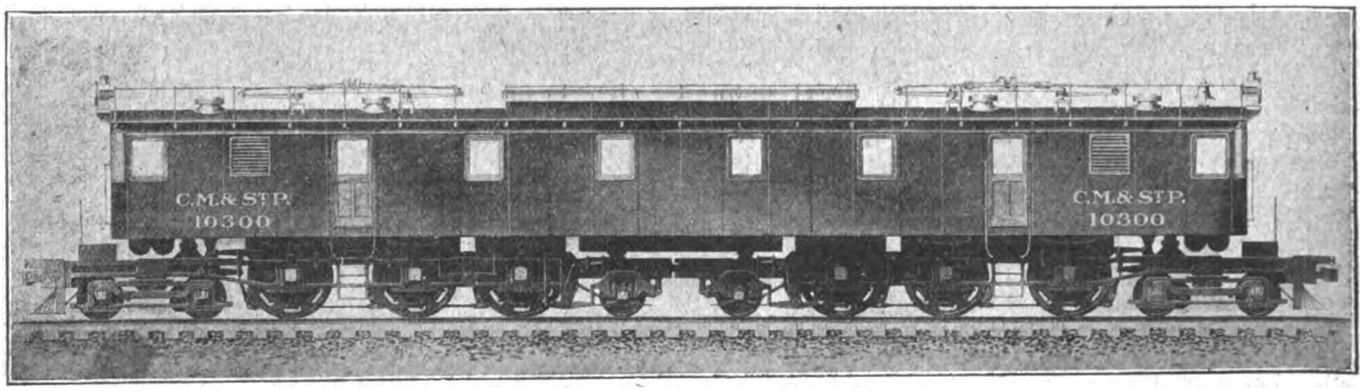

FIG. 2.—PHOTOGRAPH OF THE LOCOMOTIVE.

The complete locomotive, with a total length over couplings of 90 ft., weighs, ready for service, 266 tons, with an adhesive weight of 330,000 lb. Following the modern tendency in design toward conservation of weight and space, these new locomotives will be single-cab units, although the horse-power capacity is much greater than for any double-cab engines now in service. The cab is carried on the two main running gears, each having a four-wheel guiding truck, three driving axles in a 16 ft. 9 in. rigid wheel base, and a two-wheel trailing truck. It thus corresponds to two Pacific-type running gears coupled with a link and having two-wheel trucks on the adjacent ends.

Regeneration.—The use of regenerative control for holding trains on descending grades is such an important function in these locomotives that special arrangements have been perfected to secure positive operation of this feature over widely varying speeds. The same main motor combinations for "motoring" are used for "regenerating," except that the fields of the main motors are separately excited over a wide range by axle driven generators. These are so connected with balancing resistance that inherent stability in the motor characteristics during regeneration is assured, irrespective of whether the changes in line voltage are sudden or gradual.

While the regenerative braking of trains lessens the duty on the

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air brake equipment, further safety in braking with electric engines is introduced with the axle-driven generators. These machines are mounted on the pony trucks of the locomotive, and, in addition to exciting the motors during regeneration, furnish the power for operating the air compressors and blower motors when the locomotive is hauling. This method ensures a current supply to the air compressor motors irrespective of the overhead trolley supply, and provides that compressed air will always be available for use of the air brakes.

Weight Transfer.—In electric locomotives without connected wheels weight transfer due to tractive effort is an important point of interest. This is caused by the drawbar pull being exerted at the coupler height, which, with the reaction at the rail, tends to lift the leading end and depress the trailing end. This changes the weight distribution and increases the tendency of the wheels to slip. The method of equalisation described above reduces the weight variation on the driving wheels to only 6 per cent. from normal when pulling at 30 per cent. adhesion.

Train Heating.—The question of passenger train heating is of vital importance, due to extreme weather conditions encountered in that section of the country. Heat must be assured under all conditions of failure of equipment and delays of trains. The heating plant, therefore, must be entirely independent of the electrification. Each locomotive is equipped with an oil-fired steam boiler, designed to burn ordinary fuel oil used by the railway company. Provision is made for a storage of 7,500 gallons of water and 750 gallons of oil in each engine.

The careful attention given to improve the details of design and operation ensures that these new engines will mark an epoch in the development of the electric locomotive for steam railroad passenger service

Capacity.—These will be the most powerful locomotives running in passenger service. A single unit is able to haul a 950-ton train (12 coaches) over the entire mountain section at the same speeds as called for by the present schedules. The one-hour rating for one of these locomotives is 4,000 H.P., and its continuous rating is 3,200 H.P., with a starting tractive effort of 112,000 lb. The normal speed on level track is 60 miles per hour; on a 2 per cent. grade about 25 miles per hour.

Flexibility.—One of the noteworthy characteristics of these units, which is very desirable in passenger service, but which has not heretofore been attained with this type of electric locomotives, except at the expense of heavy rheostatic losses, is the flexibility of running speeds.

There are nine running positions without rheostatic loss. This is accomplished by the use of six 1,500-volt twin motors on the locomotive, arranged for three-speed combinations as follows:—

Position No. 1.—1 set, six motors in series.
Position No. 2.—Two sets, three motors in series.
Position No. 3.—Three sets, two motors in series.

During the change from one speed combination to another tractive effort is maintained.

Two additional running speeds are obtained on each speed combination by means of inductive shunts on the main motor fields, which assist in cutting down current peaks as well as saving rheostatic losses, and enabling the power demand over the varying profile to be kept more nearly constant. The speed range is from 8 to 56 miles per hour, depending on the load.

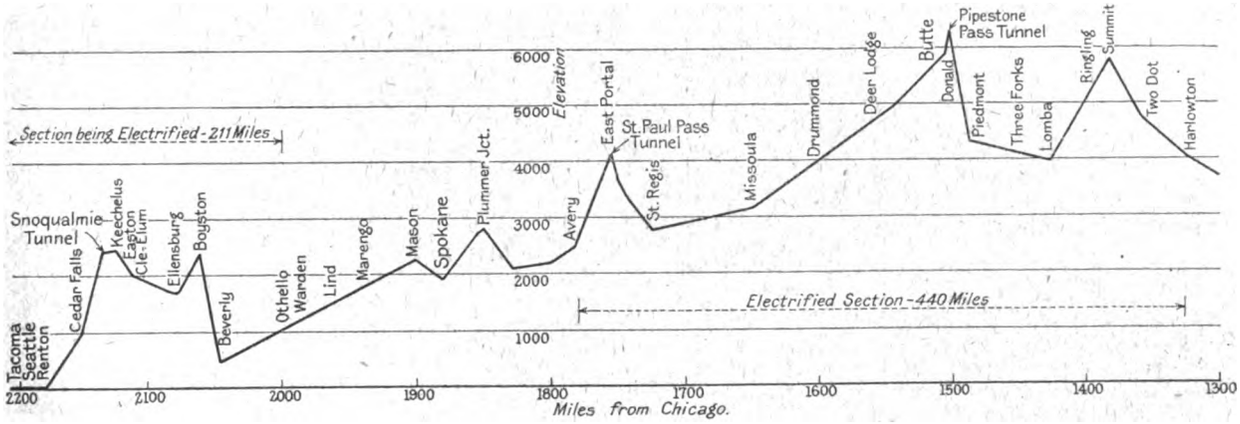

FIG. 3.—DIAGRAMMATIC CONTOUR OF THE LINE.

Main Motors.—The use of the twin motor design with quill drive not only permits the most effective use of space between the driving wheels, but enables the use of two armatures, each wound for 750 volts direct current, and geared to the same quill. This also makes possible the advantage of better commutating characteristics inherent in the lower voltage motors.

Auxiliaries.—Low-voltage auxiliaries considerably reduce the complication and hazard of high voltage on these locomotives. The only high-voltage apparatus among the auxiliaries is the motor of the small motor-generator which is used for train lighting and charging the storage battery. The resultant simplification secured by the use of low-voltage appliances decreases the complication of installation, maintenance and operation. Ordinary inspection can be carried on, including the functioning of switches and auxiliaries with the complete absence of 3,000-volt power on the locomotive.

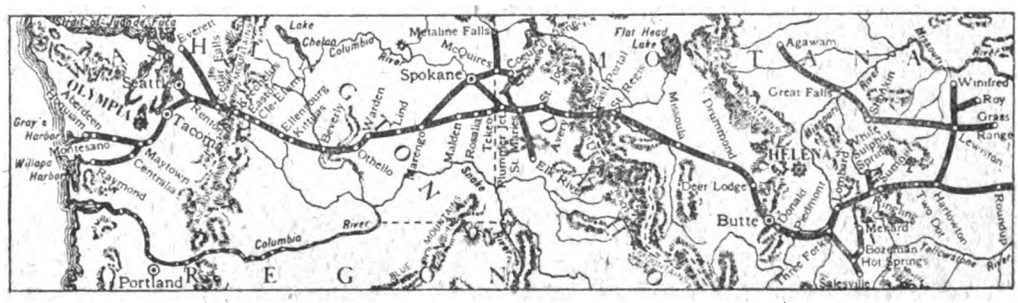

FIG. 4.—MAP OF THE COUNTRY THROUGH WHICH THE LINE PASSES.

Checking the Working Temperature of Generators.—A contribution to the above subject in the "Electrical World," by Mr. H. D. Stephens, gives an interesting account of present-day methods of recording temperatures within the structure of generators, when in use. Devices of this type are extremely useful in enabling any undue heating to be noted and incipient breakdowns avoided. Many large generators in the present day are built with suitable indicators mounted at the "danger-points," *i.e.*, the positions where, according to experience, undue temperatures are most likely to be developed. Such devices take the form of exploring coils, embedded in the winding, the resistance of which can be readily noted by some extraneous measuring apparatus. Indicating apparatus can be graduated direct in temperature.

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Large Batteries for Power Purposes.*

(*Concluded from p*, 893, *Vol. LXXX.*)

By E. C. McKINNON.

CONTROL OF LARGE BATTERIES.

The principles on which large batteries are controlled have not changed materially during recent years, but the policy adopted in practice has undergone an appreciable change. The choice lies between end-cell switches and boosters. Continental practice is solidly in favour of end-cell regulation. Until five years ago American practice favoured automatic boosters for almost all purposes, but now the trend in the United States is to employ motor-driven end-cell switches where the battery is used for lighting service (on peak work or for stand-by service) and automatic reversible boosters only where the control is required for rapid momentary fluctuations. Very few reversible boosters are now being installed in large power plants in the States, the explanation given being that this regulation of momentary fluctuations is falling into disuse in connection with large power systems, due in part at least to the combination of small systems into large ones, whereby the loads formerly carried by a number of power plants have been concentrated on a few large power houses, and the momentary fluctuations have thus become a smaller percentage of the total, and, therefore, of minor importance.

In this country, where so many types of boosters have been invented and exploited, it is natural to find that boosters have so far formed the predominant method of controlling large batteries, despite the strong aversion on the part of some British manufacturers to build these special machines. There is undoubtedly much to be said in favour of booster control for even the largest batteries which have so far been installed in this country.

It has to be remembered that a booster is required for charging the battery in every instance, and it would therefore appear economical at first sight to make use of the booster on discharge also; but this entails a very considerable increase in the size of the booster if it is to be capable of carrying the battery overload ratings and also supply the necessary voltage to allow for the falling characteristic of the battery pressure on discharge at high rates. There is consequently an increase in the energy consumed in running the booster set.

END CELL SWITCHES.

The cell switch is a vital part of the stand-by battery installation. Its importance can hardly be over estimated. Unless this part of the installation is absolutely reliable and capable of handling the battery output under all conditions the value of the battery as an emergency reserve is seriously impaired. In this country engineers have been accustomed to regard German manufacturers as having a monopoly of large cell switches, but if this has been true in the past, it is equally true that it is quite unnecessary to go to Germany now for a reliable article. The Electric Storage Battery Co. of Philadelphia have supplied about 700 motor-driven end-cell switches in one or other of their three standard sizes, which have continuous rated capacities respectively of 3,000, 5,000, and 10,000 amperes. In this country manufacturers have not devoted much attention to the design of very large switches until comparatively recently, but one firm at least, Messrs. Bertram Thomas, has tackled the problem successfully. In view of the importance, a brief description of the switches of the two firms mentioned may be of interest. The continuous rating of the end-cell switches should correspond to the one-hour rating of the battery. The overload capacity of the switches is then sufficient to handle any output which the battery can furnish.

The British-made end-cell switch as supplied by Messrs. Bertram Thomas is a remote-controlled regulator fitted with a lead-saving device, which is described in the original Paper.

THE FUTURE ASPECT AS REGARDS STORAGE BATTERIES.

The author will not attempt to forecast the future with regard to the installation of large batteries, but the Paper may be deemed ncomplete if no reference is made to the matter. The effect of war conditions, the increase in the size of power stations with their increased area and improved diversity factor, and the tendency to insist on three-phase alternating-current supply for power purposes, are all bound to influence future policy. It may be of interest to note that the general trend of practice in the United States in the application of large storage batteries for power purpose is to limit these battery installations to strictly stand-by service. The reason for this appears to be found in the fact that absolute assurance of continuity of service in the congested centres of large cities is becoming of greater and greater importance, whereas the efforts of public service corporations to improve their load factors by making attractive rates for off-peak load, as well as the improvements effected in modern machinery in the matter of overload capacity for short periods of time, tend to render the use of batteries on a daily peak of considerably less importance. It appears to be the general experience in the United States that the average load on central stations is increasing faster than the peak load, so that the latter falls more nearly within the overload capacity of the machinery necessary for carrying the average load on continuous ratings. It should not be assumed from this statement that the use of batteries is decreasing in the United States, but the purpose to which the batteries are put have changed very considerably in the course of the last 10 years.

* Abstract of a Paper read before the Institution of Electrical Engineers.

DISCUSSION.

The PRESIDENT said it would be helpful if speakers would touch upon the subject of standardisation. He thought there should be no difficulty in the Engineering Standards Committee taking up the subject of the standardisation of specifications and tests, but with regard to questions of design, the Committee preferred only to specify results and dimensions. The subject of maintenance agreements was one on which the Institution should lend a helping hand. They might consider the formation of a Committee to deal with it. The question of paint for cells might be referred to one of the panels of the Insulating Materials Committee. The Engineering Standards Committee's specifications came up every year for reconsideration.

Capt. A. M. TAYLOR was particularly interested in the author's remarks relative to "stand-by" batteries. Opinions might be somewhat divided as to whether it would be better to have a battery which would give, say, 80,000 amperes for 10 minutes or 25,000 amperes for one hour; but if the same battery would give either, then that was an asset of great value. It would be very interesting to know what was the relative capital cost of such a cell, which he believed was made out of thin plates, as compared with a cell intended for discharges up to three hours or more regularly. It might not be out of place to raise again the question as to whether a battery really paid its way—not, of course, at the present price of lead, but at pre-war prices. To begin with, it was essential that station engineers should agree as to the actual cost of the current put into the cells, if put in at non-peak hours. This charging current only cost the station about 0·15d. per unit (*see* table published in THE ELECTRICIAN for December 4, 1907, for an analysis of costs on which this and other charges are based(. If this be granted, and if one took the fixed charges—included up to the sub-station low-tension 'bus bars—for one of the largest municipal generating stations (*see* table in THE ELECTRICIAN referred to above) at £5. 8s. per kilowatt of maximum demand per annum, and stand-by coal at 10s. per kilowatt of maximum demand, and pure running charge at 0·15d. per unit, one obtained the following: (*a*) With a load factor of 20 per cent., the cost of 1,752 units is at the rate of 0·959d. per unit; (*b*) with a load factor of 30 per cent., the cost of 2,660 units is at the rate of 0·684d. per unit; in each case with steam alone. Taking into consideration the extra expense to the steam side of the station caused by the charging of the cells, neglecting for the moment the reduction in steam plant effected for a given maximum demand, 25 per cent. of the load curve area being put into the cells in the case of (*a*), and 33 per cent. in the case of (*b*), and 50 per cent. total loss, including boosters, being allowed in each case, one gets the following: (*a*) 20 per cent. load factor, 1,752 units at 0·959d., 219 waste at 0·15d. = 0·98d. average per unit effective. (Lost units represent only 1·6 per cent. of the total cost of the whole station.) (*b*) 30 per cent. load factor, 2,660 units at 0·684d., 443 (waste) at 0·15d. = 0·707d. average per effective unit. (Lost units represent only 3·64 per cent. of the total cost of the whole station. Next, taking the cost (including all charges of every sort) of the useful units actually obtained out of the cells (taking fixed charges for cells, as in Fig. 1 of article in THE ELECTRICIAN of December 4, 1907) delivered, as in the case of steam, at sub-station 'bus bars (where battery would be placed), one had: (*a*) 20 per cent. load factor, 1·2 hour rate, fixed charge = £1. 12s. per kilowatt per annum. 438 units at 0·88d. +0·15d., 219 (waste) at 0·15d. = 1·03d. (Cost per "effective" unit = 1·105d. per unit, as against *steam* at 0·959d.) (*b*) 30 per cent. load factor, 2·43 hour rate, fixed charge £2 per kilowatt per annum. 886 units at 0·52d. +0·15d., 443 (waste) at 0·15d. = 0·92d. (Cost per "effective" unit = 0·765d. per unit, as against *steam* at 0·684d. The difference between the two costs would disappear if a rather smaller steam station had been considered.

Mr. F. CRAWTER said he was glad the old idea of tiled floors for battery rooms was going out, as acid got under the tiles and formed large blobs all over the floor. A concrete floor rendered with cement or asphalt was as good as any, provided the asphalt would bear a reasonable weight and would not soften. The weight of large batteries should be on the building itself, and not on the floor. The fact that the temperature of the room might materially affect the gravity of the battery should be borne in mind, as damage might accrue if the attendant ignored the temperature and tried to keep the gravity up to standard. The variation in gravity was about 1 deg. for every 3° F. above or below 60 deg. Connections could not be made so neatly with aluminium rod as with copper.

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but for simply running from the cells to the switchboard without any joints it was satisfactory. In America there was a stand-by battery giving 30,000 amperes for 10 minutes.

Mr. H. BRAZIL agreed that tiles were unsuitable for floors and asphalt was too soft, and the cells did not sink in evenly. Powdered glass and cement was satisfactory for floors. The author said the effect of temperature on batteries was not important in this country. Batteries were often beside or above engine or machinery rooms, which generated a considerable amount of heat. He had known battery rooms to rise to 80 deg. or more. Copper rod bridging across from one row to the other was very satisfactory, even without being painted. From the terminals of the battery lead-covered cables were best. On the whole the wooden separators were good, but much trouble arose if the plates buckled, as the wood could not be renewed without taking the plates out. A sensitive galvanometer put across two plates was ample to find faults, but a galvanometer indicating 20,000ths of an ampere could not be put into the hands of a labourer. The author's remark that "merely to discharge a battery for a given number of hours and be satisfied if the result of the final voltage is not below a guaranteed minimum is crude and non-technical" was a bit harsh. This test gave practically what it was desired to know. Maintenance agreements were satisfactory if made with reliable firms and if the user observed the maker's conditions. He thought a booster coupled direct to a rotary converter constantly running was one of the most efficient arrangements. One got a better result that way than with a battery in an ordinary booster run from direct-current mains and transforming down from 10,000 volts, in which case one only got out of the battery about 50 per cent. of what was put in on the high-tension side.

Mr. E. S. NEW said battery makers would welcome a standard specification. The Government Departments were the worst offenders in making impossible specifications. His company suggested to the War Office that the same battery could not possibly cover the requirements of their specification, both as to 10-hour and three-hour rating. They said the three-hour rate was what they really wanted, and the 10-hour was only the nominal capacity It took 12 months to get an agreement with the War Office as to tests It was more difficult to standardise maintenance agreements. Carbolinum was a good alternative to painting. It lasted 10 to 20 years, and did not peel off. The author said Planté cells required 2·75 volts at the end of the change at the normal rate. He thought 2·6 or 2·7 a safer figure. He thought the cost of plant had been doubled, but that of batteries had not increased to any great extent.

Mr. LL. B. ATKINSON said a year or two ago he had some floors laid with Staffordshire blue bricks, which were proof against acids at all concentrations and for all time. For jointing and for placing underneath the bricks a London gas company supplied him with coal tar pitch, which would stand acids indefinitely.

Mr. R. RANKIN said perhaps the Committee mentioned by the President would succeed in getting over some of the obstructions mentioned by the author. The author said if the mean voltage on discharge was lower more current was required for the same number of watts. The question of the hand-regulated booster then came in. The author spoke of the enormous forces between current-carrying conductors. Taking the Eagle-street battery at 6,000 amperes, the conductors would have a cross-section area of 1½ sq. in., and they would be 4 in. apart, and the force of attraction between the two conductors with the currents going in the same direction was 3½ lb. per foot run, which was not enormous. He was not in favour of standardising minimum weight per ampere-hour. If one cell were deep and another shallow, while both had the same capacity, the same amount of electrolyte would be dissipated in each case; but the drop of the electrolyte would be much smaller in the shallow cell than in the deeper one, and that wanted careful watching. Cadmium readings varied on charge and on discharge. Also the cadmium readings varied from point to point in the cells.

Mr. E. T. WILLIAMS said prejudice had been the greatest difficulty battery people had had to get over. Engineers should take steps to see that batteries were intelligently used. He recently got out a scheme for supplying three towns. He put in three batteries, all supplied from a central station. It enabled smaller generating plant and smaller mains to be used, and gave a good load factor. By installing batteries on consumers' premises load factors could be improved and better charges got from the power companies.

Mr. C. F. ALLAN said humidity of the atmosphere had a considerable effect on the working of a battery, and particularly on the safe working of the end cell switches. The conditions in countries where batteries became furred over in a night should be considered when standard specifications were made.

Mr. J. BROUGHALL said the system with which he was connected had battery room floors of concrete covered with cement, and they had had no trouble with them. For railway work, where there were considerable fluctuations of load and frequent short-circuits, one must have a quick-acting reversible booster. They had a booster which picked up the load very quickly. Some of their peak loads were more than five times the average load on sub-stations. The rotary did less than one-third, and the battery did the rest. It picked it up instantly.

The AUTHOR said, in reply to the discussion, some of the leading consulting engineers still sent out specifications for large batteries, and if this were continued the specifications should be standardised. Large stand-by batteries were still confined to the United States, and that was why he had given so much data regarding American batteries. They were used more in America, because penalties for failure of supply were more severe. In comparing the cost of batteries and machinery one really wanted the prices after the war. Battery-room floors were usually dusty, and there was no acid floating about. Cement floors were durable and tiled floors were satisfactory if properly jointed, and they were common in the States. He referred in the Paper to climatic effects, rather than abnormal temperatures due to unsuitable housing. He found bare aluminium cables deteriorated, but kept good if covered with vaseline. Aluminium was all right for bolted joints, but was difficult to weld. By inserting wood separators in a battery on a consumer's service the capacity could be increased by perhaps 25 per cent. He could scarcely remember seeing plates buckled. In regard to the tests, the crudeness lay in taking the battery as a whole, the internal working being ignored. He thought users of large batteries would agree that at least 2·75 volts per cell were necessary. With reference to the forces in the conductors, he remembered that at Manchester a painter was killed through laying his can across an adjacent conductor. The human element came in so much that it was not to the maker's advantage to have a universal maintenance agreement. Probably batteries were more advantageous at the central station, where they could feed the network, than at consumers' premises.

DISCUSSION AT BIRMINGHAM.

Mr. G. ROGERS said the Paper was calculated to disarm a great deal of the unjust and unreasonable prejudice which has for so long dogged the storage battery in its relation to power supplies. The author was rather severe upon the engineers who had been responsible for the drafting of battery specifications; but it must be remembered that the educational facilities for large battery work had been non-existent. The subject had been only a side issue, and any knowledge gained had been due to individual effort on the part of engineers to master the chemical and engineering problems peculiar to storage batteries. Needless to say, very few (apart from those directly interested in the business) had taken the trouble to do this. With regard to the author's remarks upon the obstructing factors which had caused delay in the progress of battery installations, he would like to draw attention to another factor—the failure of battery makers in meeting their responsibilities under maintenance contracts. An unhealthy battery peculiarly lent itself to variable diagnosis, and the trouble was invariably laid at the door of the owner of the plant. The battery makers neglected to watch the daily records, which they required sent to them throughout the life of the battery, and when trouble arose delay ensued in carrying out the necessary repairs. The terms of the maintenance contracts, and the representations of the manufacturers to their customers as to the treatment of their battery plant, had largely been responsible for the idea that batteries had to be treated as invalids. The danger was that ultimately the owner began to regard them as chronic invalids, and became dissatisfied with them. The maintenance department should be in constant touch with all records, and be regular in the periodical inspections. There seemed to be a note of apprehension in the author's view of the future of large batteries as applied to the electrical industry. He (the speaker) was inclined to think that in this country the developments of electrical supply, which were now being seriously considered, were likely to cause a decreasing demand for batteries. Even the country-house battery plant was likely to be superseded sooner or later by the transformer. There was, however, likely to be a demand for buffer batteries for use with traction systems if direct-current drive was eventually adopted for the electrification of suburban and main line railway systems.

Mr. F. FORREST said the author's Paper did not bring to light anything very new, but set out with great clearness points which should be thoroughly well understood by all users or potential users of storage batteries. Large batteries, whether for stand-by purposes or for more general use, were likely to be installed in stations situated in crowded areas. Owing to the great volume of acid-laden air which would be discharged from battery rooms containing large batteries, it was necessary to take steps to prevent this being a nuisance to surrounding property owners, and one way of rendering the discharged air less objectionable was to pass it through acid filters or "acid neutralisers." These "acid neutralisers" consisted of a number of finely perforated lead screens, through which the acid-laden air passed, and down which water flowed slowly and cleared the air of the acid in suspension. Many of these "acid neutralisers" had been in use for years in the States, but very few have been installed in this country. Two are erected in one of the sub-stations in Birmingham, and had proved very satisfactory, these having been built to designs kindly supplied by the chief engineer of the New York Edison Co. As only distilled water should be used for make-up purposes, an efficient distiller should form part of a large battery equipment, which must be capable of easily supplying the requirements of the battery during the warmest weather. A portable milking booster was also a necessary accessory, and a very good form to adopt was one which combined on a single carriage the small motor-generator together with all necessary switchgear and instruments. A number of concentric plugs should be arranged round the battery room so that the polarity could not be altered, and as far as possible the machine should be rendered "fool-proof." The whole equipment was mounted on rubber tyred wheels and arranged to turn into any of the gangways with ease. The watt-hour efficiency of a battery was so difficult to determine accurately that he ventured to suggest that it should be no longer included in battery specifications. Ampere-hour efficiency was really all that one wanted to know, and as this could be obtained without any loop hole for error that should be the standard upon which to frame guarantees. With regard to the control of large batteries, there were in use in Birmingham a number of regulating cells, generally of the type illustrated in the Paper; but, unfortunately, these were obtained from abroad, and in this country small batteries had been the rule in the past.

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Elementary Principles of Continuous-Current Armature Winding.

By F. M. DENTON, A.C.G.I.

(*Concluded from page* 897, *Vol. LXXX.*)

Summary.—Continuous-current armature windings are first classified, the nature of the various classes of winding is then explained, and special terms used are defined. The derivation of the usual winding rules is developed by a simple method based upon an understanding of the ordinary Gramme ring. The rules derived apply to multiplex windings as well as to simplex. The use of multiplex windings is discussed, and reasons are given for the avoidance of their use. The simple theory of equalising connections is explained and rules are derived for the application of such connections. Chord winding is explained, followed by the use of interpolated commutator segments, and, finally, special consideration is given to the question of the number of slots that should be used for a given winding, taking into account the inductance of the parallel paths. The article concludes with a schedule of winding rules.

Choice of Number of Commutator Segments.

Coils for armature winding are almost invariably former wound, each coil being wound, insulated, baked and put into the slots as a separate unit. The inter-connection of the coils is conveniently made either at the commutator segments themselves or at the risers which go out radially from them; that is to say, the end of one coil and the beginning of the next are joined to one and the same commutator segment. There are thus as many segments as coils, or K, the number of commutator segments is usually equal to $z/2$, half the number of coil sides.

In laying out a lap winding, z should be chosen so that $z/2(=K)$ is an exact multiple of the number of pairs of poles, and that pairs of segments are therefore available, exactly a double-pole pitch apart, for the equalising connectors.

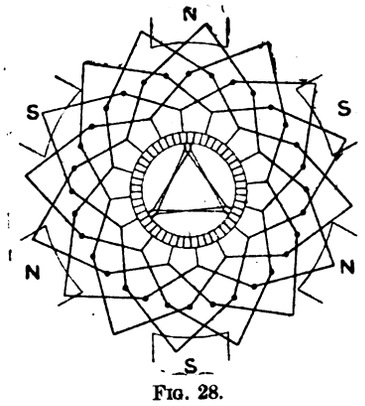

Fig. 28.

It is customary, for each type of machine to fix a limit to the voltage per segment, and in order to keep within this limit the method has been used of introducing additional commutator segments. Corresponding to each ordinary segment there are provided additional ones, multiples of two pole pitches away, to which it is permanently connected by a copper connector. An example of a six-pole wave winding in which each segment is joined to two other segments one and two double pole-pitches away respectively is given in Fig. 28., in which, however, for clearness, two only of the 16 triangular cross-connectors are shown. This winding is typical of those used by M. Thury in the generators of the St. Maurice-Lausanne 22,500-volt continuous-current transmission system. Each generator is rated 340 kw., six-pole, 300 revs. per min., 2,250 volt, 150 amperes. The armature winding is a simplex wave having 190 coils, each of two turns. Instead of 190 commutator segments as in an ordinary armature having 190 coils, the commutators of these machines have 570 segments, each ordinary segment being joined to two additional interpolated segments one and two double-pole pitches away respectively. Four brushes are used, two positive and two negative.

Choice of Number of Slots.

The mechanical problem of accommodating the end connections of an armature winding is most effectively solved by putting two layers of coil sides in each slot, one above the other, the two sides of a given coil occupying one the top of a slot and the other the bottom of a distant slot. Former wound coils can then be used, all exactly alike.

The desired distribution of the bars, numbered consecutively as in the winding diagram, is simply brought about by placing the odd numbered bars consecutively in, say, the lower layer, and the even numbered bars in the upper layer in the slots. Such an arrangement is feasible only when both y_f and y_b are odd.

For simplex wave windings the number of coils required is often odd and the number of slots odd. The formula for a simplex wave is $z=py\pm2$ or $z/2$ the number of *coils* $=py/2\pm1$ and as $py/2$ is often even, it follows that $z/2$ is often odd.

For simplex lap windings the number of coils and also of slots should be a multiple of the number of pairs of poles, in order that equalising connections may be placed symmetrically.

The Bearing of the Choice of the Number of Slots upon Commutation.

The choice of the number and size of slots is determined, not entirely by the questions of the mechanical accommodation of the bars and of the magnetic reluctance of the main flux path. An important question that should not be neglected if the best conditions of commutation are being aimed at, is that of the inductance of the parallel paths through the armature. All the "a" parallel paths should have equal inductance. Failure to satisfy this condition entails unequal distribution of the total armature current, between the several parallel paths, at moments when the load is fluctuating.

The inductance of a path depends not only upon the number and length of the armature bars it contains, but also upon the positions of these bars within the slots. A bar in the middle of a slot will have, usually, a smaller self-inductance than a bar lying close to one side, and a bar at the bottom will have a greater self-inductance than one at the top.*

In a simplex ring winding the conditions thus imposed upon the number of the slots may readily be seen. Each path consists of all the bars lying between one brush and the next. If these bars be put into "n" slots which they fill completely, then the bars forming every other parallel path will also fill "n" slots and the inductances of all the paths will be alike. Or if "n" plus a half slot be used for the first path then the remaining half slot plus "n" others will accommodate the next path, and so on. And since a bar lying near to the left hand side of a slot will have the same inductance as one lying near to the right hand side, the condition of equality of inductance for all the paths will again have been satisfied.

But if the first path had occupied "n" slots plus a third of a slot, then the bars of the next path would have had to use the still unoccupied two-thirds of a slot, plus $(n-1)$ other slots plus two-thirds of still another slot, and the inductance of this path would have been slightly less than that of the preceding path—since the central bars of the "two-thirds" slots would have had a lower average inductance than the others.

Thus the rule for the number of slots in a simplex ring winding is that each of the "a" parallel paths shall employ some exact whole number of half slots; that is to say, *twice the total number of slots shall be a multiple of the number of parallel paths.*

* *See* "The Experimental Determination of the Induction of Linear Conductors," by A. C. Jolley and A. F. Burgess, B.Sc., published in THE ELECTRICIAN, Nov. 24, Dec. 1 and 8, 1911.

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The same rule is suitable for duplex ring windings, but the rules to be satisfied in choosing the number of slots for a multiplex ring-winding of higher multiplicity than two are more interesting, though the author is not aware that the question of the choice of the number of slots as bearing upon the inductance of the parallel paths of multiplex windings has ever before been considered. The nature of the difficulty that arises may be explained by reference to Figs. 29 and 30. Fig. 29 represents the development of a triplex ring winding, the three component windings or plexes being shown by the thick, the dotted and the thin lines respectively. Fig. 30 shows one way in which this winding might be put into slots. Such a choice of slots (3 bars per slot) might be consistent with the rule that twice the number of slots should be a multiple of the number of paralled paths. If, for instance, the armature were for a two-pole machine, "a" would, in this case, be six, and the number of slots might quite well be, say, 120. But, with the arrangement of Fig. 30 all the bars

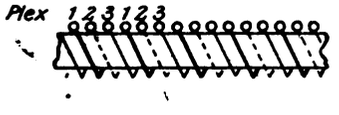

FIG. 29.

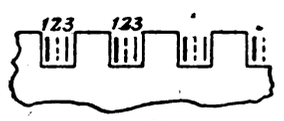

FIG. 30.

of plexes 1 and 3 lie near to one wall of a slot, whilst those of plex 2 lie in the middle. Hence the inductance of the parallel path formed by plex 2 is less than that of the paths formed by the other two plexes.

The same inequality would arise if each slot held six or indeed any multiple of "m"(=3) bars, but it would be avoided by making the bars per slot equal to $(m \pm 1)$ or to $(bm \pm 1)$ where b is an integer. Then slot number one would begin with, say, a bar belonging to the first plex, slot two would begin with a bar of plex two, and so on, and the plexes would, on the average, lie similarly in the slots, provided that the number of slots were divisible by the multiplicity "m." That is to say, equality of inductance of the parallel paths in a multiplex multiple circuit ring winding of short pitch demands fulfilment of the two conditions :—

Bars per slot$=(bm \pm 1)$ where b is a whole number, and that the number of slots shall be divisible by "m."

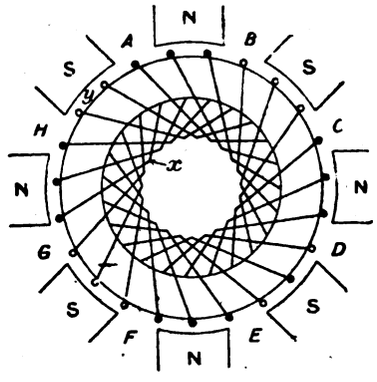

FIG. 31.

The latter of these conditions is satisfied when the rule that twice the number of slots shall be divisible by "a" has been obeyed.

In a multiplex two-circuit ring winding of long pitch (that is to say, a ring suitable for conversion into a wave winding), all the bars lying between one set of brushes and the next belong to one only of the two parallel paths—as may be seen by reference to Fig. 31 (a two-circuit ring winding in which the bars of the one parallel path are indicated by full dots and those of the other path by open dots, the brush position being at A, B, C, D, E, F, G and H)—and the rule given for the simplex ring again applies. The problem of the multiplex multiple-circuit ring suitable for conversion into a multiple circuit wave (series-parallel) winding is similar to that of the multiplex ring of short pitch and demands, like it, the fulfilment of the conditions,

Bars per slot$=(bm \pm 1)$,
and Number of slots divisible by "m."

The rules for drum windings whether simplex or multiplex correspond with those for the ring windings from which they may be derived. For the idle bars of the ring winding are equal in number to the active bars, and the drum is derived from the ring by putting the latter's idle bars in the bottom of slots containing active bars, whilst the idle bars per path, being equal in number to the active bars, may be arranged in the slots in a corresponding manner, so as to give equal average inductance per path.

Summarising then we may say that the conditions to be satisfied in order to ensure equality of inductance for the several parallel paths of a drum winding, are :—

Simplex windings—whether lap or wave—

Twice the number of slots shall be a multiple of "a."

Multiplex windings—

1. Bars per slot$=(2bm \pm 2)$, where $2b$ is an even whole number.
2. Number of slots shall be divisible by "m."

Numerous examples may be taken from practice of machines, working successfully, in which these rules have not been observed, but the author submits that improved running might have been obtained by their strict observance.

The published data of a 55 kw. 6 pole 610 revs. per min. 120-volt shunt generator, built by the Verein gte E.-A.-G., of Vienna, show it to be a machine with a six circuit series-parallel winding having :—

$$p=6,\ z=438,\ \text{slots}=73,\ m=3,\ a=6.$$

The bars per slot=6, a number which does not satisfy the condition, bars per slot$=2bm \pm 2$. Analysis shows (using the formula $z=py \pm 2m$) that "y" must be either 72 or 74, and that the re-entrancy (r=G.C.F. of y and m) must be unity.

The author would sunmit that better results might have been obtained by taking

$$p=6,\ z=432,\ \text{slots}=108 \text{ or } 54,\ m=3,\ a=6,$$

giving, bars per slot 8 or 4, either of which numbers satisfies the condition, bars per slot$=(2m \pm 2)$. The design would, however, have been more expensive on account of the enhanced difficulty of carrying away the armature heat. Using 108 slots the space factor would have been reduced and so the total iron section in the teeth reduced and the iron loss increased. Using 54 slots the amperes per slot would have been greater and the copper heat less readily dissipated.

The restriction imposed by the fulfilment of these conditions upon the choice of the number of slots for an armature, forms an additional disadvantage of multiplex windings as compared with the simplex type.

SCHEDULE OF WINDING RULES.

Symbols.

z=number of coil sides

K=number of commutator segments=(usually) $z/2$.

y_f and y_b=number of spaces bridged over by a front and a back end connection respectively (referring to a winding diagram in which the coil sides are laid consecutively, evenly spaced in a single layer around the circumference of a circle).

$y=(y_f+y_b)/2$=the arithmetic mean of y_f and y_b.

p=number of poles.

a=number of parallel paths through the armature from the positive to the negative terminal ($a=p$ in the case of a simplex lap and 2 in the case of a simplex wave).

b=any whole number.

m=multiplicity (the multiplicity of a winding tells the number of simplex windings in parallel to which it is equivalent; it is indicated by the total number of loops in the symbol of the winding. Note that $a=2mp$ for a multiplex lap or $2m$ for a multiplex wave winding).

r=re-entrancy=number of separate and distinct closed circuits in the winding=the number of separate parts in the symbol of the winding.

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$x = m/r$ may be called the "plexity"; it is indicated by the number of loops in each re-entrant section in the symbol of the winding; it is the multiplicity of each re-entrant section.

Rules for a Simplex Lap.

z must be even.

y_f and y_b must each be odd and they must differ by 2.

y should be about equal to z/p except in chord windings when it must be less than z/p.

Multiplex Lap.

z must be even.

y_f and y_b should both be odd, and they must differ by $2m$.

r=G.C.F. of $z/2$ and m.

Simplex Wave.

z must be even and equal to $py \pm 2$.

y_f and y_b must both be odd and they *may* be equal.

Multiplex Wave.

z must be even and equal to $py \pm 2m$.

y_f and y_b should be odd and *may* be equal.

r=G.C.F. of y and m.

Choice of Winding.

The voltage allowable between adjacent commutator segments, as well as the current per brush and per armature bar, affect the choice of winding. The current per armature bar and the voltage per segment, for the various windings may be tabulated as follows :—

Type of winding.	Current per armature conductor in amperes.	Voltage between adjacent commutator segments.
Simplex lap	Load current/p	Voltage per coil
Multiplex lap	Load current/mp	(p/a) (volts per coil)
Simplex wave.....	Load current/2	($p/2$) (volts per coil)
Multiplex wave	Load current/$2m$	($p/2m$) (volts per coil)

The derivation of the values given in the table for the wave windings becomes obvious if it be noted that a wave winding (of whatever multiplicity) progresses through $p/2$ complete coils before reaching the next segment of the same "plex," and that successive segments in a given plex are *adjacent* for a simplex wave, but are separated by $(m-1)$ segments (one belonging to each of the remaining plexes) and therefore by m insulating plates in the case of a multiplex wave.

1. *Simplex lap* windings are often used when the current output exceeds 300 to 500 amperes, provided the number of poles is great enough to make the current per armature bar not greater than 150 to 250 amperes. Equalising connections having a cross-section, say half that of an armature bar, should be provided, connecting every sixth to twelfth commutator segment with all segments which are a multiple of two pole-pitches away.

2. *Multiplex lap* windings should be avoided, but have been used in cases in which more than p paths in parallel are required to make the current per path less than 250 amperes. The multiplicity should seldom exceed two, and from the point of view of ease of examination, of localisation of faults, and of repair, windings are to be preferred in which the re-entrancy is equal to the multiplicity. The use of equalising connections is advisable only in special cases. See also the *Note* given below, as to the number of slots.

3. *Simplex wave* windings are often used when the current output does not exceed 300 to 500 amperes. No equalising connections are required or possible.

4. *Multiplex wave* windings should, like all forms of multiplex windings, be avoided, but have been used in cases in which the number of parallel paths required to give the current per path the desired value cannot be obtained by a simplex wave or lap winding. When, for instance, the current output of the machine is greater than 300 to 500 amperes, but less than ($p \times 150$ to 250) amperes, m may be so chosen that $2m \times (150 \text{ to } 250) \leq$ the current output, but the condition must be satisfied that p shall be divisible by $2m(=a)$. See also the *Note* given below, as to the number of slots.

Equalising connections joining series of points on the commutator exactly two pole-pitches apart should be provided every sixth to twelfth segment.

Note.—To ensure exact similarity in resistance and inductance of all the a parallel paths in the winding (a condition demanded by commutation, efficiency and temperature rise), it is essential not only that the total number of coils shall be exactly divisible by a, but also that the winding shall be symmetrical. The conditions that a winding shall be symmetrical and that, at the same time, its several re-entrant sections shall be in synchronism, may be assured by making z, p and twice the number of slots, all exactly divisible by a. Every winding should, if possible, satisfy these conditions.

Special conditions which, it is suggested, ought to be satisfied by all multiplex drum windings are :—

1. Bars per slot $= 2b/m \pm 2$, where $2b$ is an even whole number.
2. The number of slots shall be divisible by m.

In conclusion, the author wishes to thank Mr. A. F. Burgess, B.Sc., for valuable help in the preparation of this article.

Light and Vision.

THE PHYSIOLOGY OF THE RETINA.

A Paper on the above subject was read before the Illuminating Engineering Society, on April 16, by Prof. W. M. Bayliss, the president (Mr. A. P. Trotter) in the chair.

The first portion of the Paper was devoted to a discussion of the perception of light by the eye. There are three chief processes: (1) The production of an image by the dioptric system of the eye; (2) the excitation thereby, on the layer of the retina containing the rods and cones, of a photo-chemical change which in turn acts upon the terminations of the optic nerve fibres, which transmit a series of nerve-impulses; and (3) the distribution of these impulses to the complex system of nerve cells in the brain, where the consciousness of illuminated objects is developed. The sensation is essentially an affair of the brain—the "cerebral analysers." The nature of the nerve-impulse is obscure. It has much about it that resembles an electric current. But whatever its nature it appears to be substantially the same for all nerves, *e.g.*, both visual and auditory. The sensitiveness of the retina is exceedingly great, being estimated to be about 3,000 times that of the most rapid photographic plate. For the purpose of increasing the stimulus there are present in many sense organs devices analogous to electrical relays. In the eye this extraneous energy is provided by chemical oxidations in the living cells of the sense organs.

The only satisfactory explanation of the behaviour of the retina is based on stimulation through the intermediary of chemical action. At present only one photo-chemical substance, the visual purple, has been identified in the eye, but practically nothing is known as to its chemical constitution. The fact that apparently visual purple did not occur in the central region of the retina, where visual acuteness is greatest, presented a difficulty, but according to Edridge Green it flows into this area from adjacent parts of the retina. The lecturer presented three curves illustrating respectively the amount of energy required to produce the sensation of light, and action on and absorption by the visual purple throughout the spectrum. The close resemblance between these curves shows that the visual purple is closely associated with the process of perception of light. Visual purple is bleached by light but reappears in darkness. The chemical process is apparently reversed so soon as light ceases, and when a luminous impression is received a progressive change occurs, until a state of equilibrium is established. This explains the fact that an appreciable interval is required for a luminous sensation to reach its full value, while the reaction that occurs after the light-impulse is removed would account for the positive and negative after-images. Other information is obtained on this point by studying the electrical changes which accompany the action of light, and diagrams, illustrating the growth and decay of such retinal currents in the retinæ of pigeons, &c., were presented by the lecturer. The exact functions of the rods and cones have been the subject of much discussion, and the decision is evidently one of great difficulty.

In the latter part of the Paper the lecturer discussed the bearing of a knowledge of the retina on various problems in illuminating engineering. There seems to be a general impression that vision is assisted when the illuminated area viewed by the fovea is sur-

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rounded by an area of moderate brightness, so that the peripheral regions of the retina are also stimulated. The sensation of glare, due to excessive contrast, is well recognised, but is difficult to explain completely on physiological grounds; when the exposure to excessive brightness is very severe or prolonged detectable damage to the cell structures can be made out. While it would be premature to say that a physiological basis for a numerical value for the "glare-limit" has been established, the suggestion that, for complete comfort of vision, a ratio of brightness not exceeding 100 : 1 should be adopted seems to be a reasonable one. It has been shown, however, that the effect of lateral illumination in causing discomfort, and its influence on acuteness of vision, are distinct things. It is even possible for an adjacent bright light to cause a temporary gain in acuteness of vision, though possibly at the expense of discomfort and ultimate strain. Glare is closely associated with the effect of the adaptation of the eye. A source which can be viewed without discomfort in a high illumination may be a source of glare when the eye is more or less adapted to darkness.

Another point of great interest to lighting engineers is the determination of a method of testing fatigue of the eye due to inadequate illumination. The matter, is, however, complicated by the effect of many extraneous factors, which it is difficult to dissociate from the effect of light. Little is known regarding the effects of light of different colours on the eye, though here again the quality which is most conducive to fatigue is not necessarily that least favourable to great acuteness of vision. On many practical points such as the effect of inadequate illumination in causing defects of eyesight, especially in school children, and its influence on the vision of workers in factories, fuller statistical information is required. On such points the co-operation of medical officers of health would be very useful.

In the subsequent discussion a number of oculists and physiologists took part, including Mr. Treacher Collins (president of the Ophthalmic Society), Mr. Lawford (past president of the Ophthalmic Society), Col. J. Herbert Parsons (Ophthalmological Society) and Dr. James Kerr (president of the Medical Officers in Schools Association). The desirability of closer co-operation between physiologists and lighting experts in connection with many of these debateable problems was strongly emphasised.

Trade Parliaments and Their Work.

By E. J. P. BENN.

II. ORGANISING ORGANISATIONS.

Before proceeding to consider the formation of Joint Standing Industrial Councils, Trade Parliaments, or Whitley Councils, as they are variously described, it may be well to glance very briefly at existing trade organisation and to have our minds clear as to the place that will be occupied by the very large class of new bodies which it is proposed to create. There never were so many trade organisations as there are to-day, and one would be inclined to imagine that every possible function was covered by existing bodies. There is, unfortunately, a great deal of overlapping, a certain amount of competition, and considerable confusion among trade associations as we now know them. To begin with, seeing that the essence of the association movement is the limitation of competition, it ought to be agreed on all hands that there should be no unnecessary competition between associations. Associations should be made to take the medicine which they so freely prescribe to their members and go in for a strict system of specialisation, so that each has a special function and carefully avoids encroachment upon the functions of others. Much of the confusion and difficulty that now arises between different kinds of associations is due to the fact that few of them can resist the temptation continually to enlarge their functions, whereas they should concentrate the whole of their attention on the special objects that brought their members together. The aim of these bodies is to reduce competition as between traders and as between Capital and Labour, and we must be very careful that we do not substitute another and a worse form of competition, as between organisations. There are various forms of commercial organisations which are obviously necessary to the health and well-being of each industry.

1. First of all comes the professional or scientific organisation, which will deal exclusively with the theory of the practical side of the business.

2. Perhaps next in importance is the Employers' Federation, such as those in engineering, shipping, building, and the new "National." These exist, or should exist, for the one and only purpose of carrying on negotiations with Labour.

3. Next come what might be called "Development Associations" such as the British Engineers' Association and the Machine Tool Association. These are concerned with the development of the commercial side of their businesses, and they surely have enough to do.

4. Then we come to Chambers of Commerce, which, like employers' federations, accept members from more than one trade and whose functions may be described as largely local. It is to the Chambers of Commerce that one looks for protection and assistance in those matters which concern the trade of a locality rather than any particular industry. Chambers of Commerce, of course, are especially concerned with the important interests of the merchants, factors, brokers, and importers and exporters.

All the above are bodies of a permanent character, whose functions will continue so long as trade continues. There is, in addition, another class of organisation which has sprung into being as the result of the war, and whose functions are simply propagandist. Of this class the more we have the better. It is one of the healthiest and most promising signs that there should be a large number of organisations preaching various forms of trade development and trade improvement. In this connection may be specially mentioned the new Industrial Reconstruction Council, which is to preach the doctrine of trade self-government, the Industrial League, and the National Alliance of Employers and Employed, whose avowed objects are the bringing together of capital and labour. There are also many bodies, such as the Labour Co-partnership Association and others, which are out to preach profit sharing, the prevention of bribery and corruption, currency reform, Free Trade, Tariff Reform, early closing, and quite a number of other special subjects. This class differs from those mentioned above in that no objection can be taken to its indefinite multiplication. The more people with ideas are encouraged to go out and preach them the better for trade and industry generally.

5. After these comes a group of organisations, of which the Federation of British Industries is the best example, which are concerned with general and national commercial problems. Matters like financial facilities, relations between Government Departments and trade, legislation affecting industry, shipping, railways and the like, are exclusively the province of this sort of association.

6. We then come to a very large group of retail organisations, and

7. Lastly, but by no means least important, protection associations, whose only function is the giving of advice on credit and the collection of accounts.

There are, therefore, no less than seven classes of trade organisations, each class having its special functions, and in the work of re-arranging and co-ordinating most of these bodies work which is now urgent and imperative—it should be understood that each association would confine its activities to those functions which properly come within its class. We are, of course, only talking here of what are known as employers' associations. The question is further complicated by the sub-divisions which exist between trade unions—the craft union, the industrial union, and the local union.

Whitley Councils will take into their consideration subjects which belong to several of the above classes of associations. Th difference between a Whitley Council and a Development Associar tion is simply that the Council is a joint body on which Labour and Capital are equally represented, while a Development Associa tion confines its membership to employers, and will naturally consider only the employers' point of view. The Whitley Council should have among its members representatives of nearly all different classes of trade organisations if it is to perform its functions in the most thorough manner. It will in most trades probably ignore the retail and the protection bodies mentioned in 6 and 7 above; it will certainly ignore the Chambers of Commerce except in so far as they may possess special sections for special trades, and it will also ignore employers' federations where these bodies are constituted upon a local rather than an industrial basis.

American Legislation on Factory Lighting.—In a recent issue of "Industrial Management" Mr. C. E. Clewell gives a useful summary of the principles of industrial lighting, dwelling specially on the codes introduced into the legislation of various American States. Wisconsin, one of the earliest States to deal with the matter, has recently revised its code, the requirements for various classes of work being now expressed in foot-candles. Pennsylvania and New Jersey have likewise introduced legislation, based largely on the code prepared by the American Illuminating Engineering Society, and in the State of Ohio a suitable code is in course of preparation.

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SPECIAL NOTICE.

Last week's number of "THE ELECTRICIAN" completed Vol. LXXX. With next week's number will be issued the Index to the Volume.

Combination for the Home Trade.

Last week we dealt with the important question of developing our export trade and with the methods that might be adopted by the smaller British firms for this purpose. We need scarcely say that foreign trade is only one sphere of activity, and that in many respects the home trade is even more important, for if we do not look after the home market, and ensure the stability of our manufacturers in this field of work, we need not expect the fullest success in trade abroad. It is very natural, therefore, that combinations with the object of rendering the home market secure is in the minds of many of our manufacturers.

The idea of large combines has never been very favourably received in this country. They have generally been viewed with suspicion, and attention has not unnaturally been drawn to the undesirable results that have followed large combinations in the United States. In this connection the following words of Sir WILLIAM ASHLEY, which appeared in the "Bulletin" of the Federation of British Industries, deserve attention :—

> If combinations are to be tolerated by public opinion, still more if they are to be viewed with what I may call benevolent neutrality, instead of general suspicion, they must come out into the open. They must form themselves in the daylight and permit of a reasonable publicity. They aim, it is obvious, at the material interests of their members; but, unless I am profoundly mistaken, they may be justified on public grounds. The typical men of the age of individualist competition not only sought their own interest; they also honestly believed that the policy of "every man for himself" was for the public good. The typical men of the coming age believe that combination is for the public good, and I trust they will have the courage of their opinions.

We agree that, if such combinations are to be formed, their operations must be clearly understood, and their actions must not be shrouded in obscurity. Moreover, we disagree with those who are in favour of the lowest possible prices. The inordinate cutting of prices has led to technical difficulties and to financial weakness, so that any industry subjected to this evil becomes a ready prey to foreign competition. In our opinion, the reasonable maintenance of prices is desirable so long as this does not lead to inefficiency in production, and so long as these prices are not so maintained as to be detrimental to the public interest.

Among the various schemes of combination that have been proposed we notice one by Mr. HOWARD F. SMITH, who has at times contributed to our correspondence columns and who is actively engaged in the brass trade. Although Mr. SMITH'S scheme is concerned primarily with the brass industry, it is more or less applicable to other trades. In this instance it is proposed that firms should be divided into three groups, so that their activities are concerned with the class of work for which they are more particularly fitted. This means, of course, that side lines and the smaller lines of activity which are less remunerative would be given up, and would be pursued only by such firms as are particularly qualified for them. In other words, it means the development of repetition work as far as possible. It is in this way that overhead charges can be reduced to a minimum, and it should be no surprise to those who are familiar with such matters to learn how very cheaply munitions have been produced during the war simply on account of the large amount of repetition work involved.

It is proposed that each of these three main divisions in the brass trade should form themselves into a combine, which would conduct all important matters of business for the firms in its own jurisdiction with the exception of the purchasing of raw material. This would be carried out by a central purchasing and legislative board, which would have no power in respect to management, but would go into the world's markets for all purposes for the three combines, and would produce the required raw material in the rolled or cast form.

The distribution and selling is a more difficult matter, but that is no reason for leaving things as they stand at present. It is certainly desirable that we should no longer have the spectacle of half-a-dozen or more travellers visiting the same town in the same month, offering the same patterns to the same buyers. This overlapping of effort is, of course, pure waste, and merely increases the cost. Here, again, it is suggested that selling efforts should be pooled, the whole of the United Kingdom being divided up into a number of sections, each section having its own permanent offices and showrooms, and handling the products of all firms in its particular combine.

It appears to us that the difficulty of all such schemes is that they necessitate the curtailment of development along new lines. What would be the position of firms who in the past dealt during a number of years with one particular line, and have then developed another line which has been highly successful after the initial stages? Then, again, there is the question of new firms. It is a difficult enough struggle in any case to launch a new firm; but if the new firm is, in addition, faced by a combine which would probably not desire to receive it within their membership, the position is still more difficult. In many cases we agree that new firms are not desirable, as they merely lead to weakness. On the other hand, new methods are developed from time to time, and it is often desirable that new firms should be formed if advantage is to be taken of such developments.

Apart from points of this kind, there is the great question whether pooling may lead to inefficiency, like the pooling of individual effort and remuneration by State wages, which inevitably leads to the lowering of individual effort. In the present scheme it is proposed to eliminate some of these difficulties by pooling not less than 51 per cent. of the capital, leaving a substantial part of the capital of each firm, so that the return upon this portion would depend upon the initiative and efficient working of the firm concerned. It is also proposed that every three years a valuation of each firm should be made, so that those showing enterprise would receive a larger return, and those showing lethargy would reap a smaller reward, the equivalent capital being reduced. This appears to be a workable suggestion. Nevertheless, combination in selling is by no means an easy object to attain. Many manufacturers will feel that the pushing of their goods at the hands of individuals with whom they are not directly linked will be less efficient than dealings through individuals who are free from similar interests. Combination in the purchase of raw materials does not seem to present the same difficulties.

We do not suppose that any one scheme is likely to possess all the virtues that are desirable, but there is no question that combinations in one form or another must become much more prevalent if we are to increase our production in the future to the degree which will be essential, and it is therefore well that every serious scheme should be considered on its merits.

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The Chamier-Turner "Trinity" Morse Set.

By S. TURNER, A.M.I.E.E., A.F.Ae.S.

The teaching of the Morse code in the various naval and military establishments may be regarded as of almost vital importance. The instructional apparatus described in this article was invented to accelerate the progress of Morse pupils.

Bearing in mind the frequent necessity for pupils to master the transmission and reception of both audible and visual signals, it is evident that at least three senses are employed—viz., hearing, sight and touch. If the pupil be taught at the commencement to receive, say, audible signals and afterwards taught to receive visual signals—or vice versa—considerable delay and confusion may result. Also in teaching the transmission of the Morse code, the method of supplying the pupil with a printed card and expecting him to translate the printed dots and dashes into periodical depressions of a key, may be sure, but is apt to be slow with the average pupil, and, moreover, often results in faulty sending—clipping of dots, bad spacing, &c.

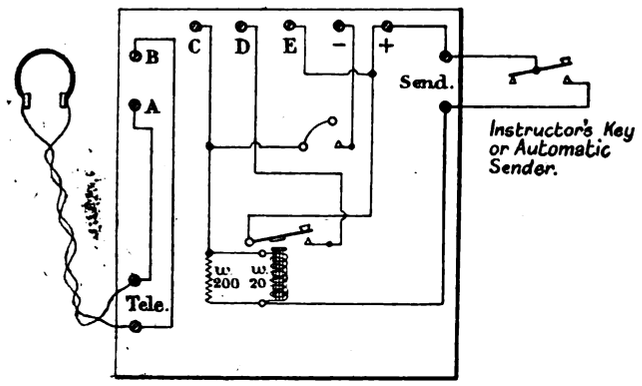

FIG. 1.—ELECTROMAGNETIC KEY.

The fundamental principle of the "Trinity Set," as its name implies, is to appeal to the pupil's three senses simultaneously. The instructor sends, say, the alphabet, and the pupil "grips" in the approved manner the electromagnetic key shown in Figs. 1, 3 and 4. This latter key reproduces faithfully the

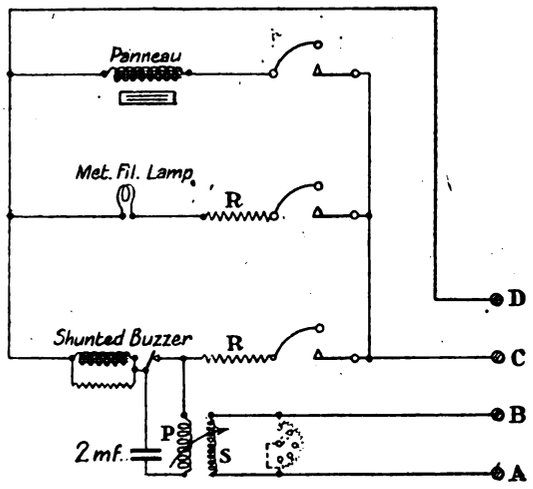

FIG 2.—INTERNAL CONNECTIONS OF MORSE SET USED IN CONJUNCTION WITH ELECTROMAGNETIC KEY, FIGS. 1 & 3.

movements of the instructor's key, and the resulting appeal to the pupil's sense of touch proves most effective in impressing the combination of dots and dashes on his memory. After a little practice the pupil attempts the letters himself, and gradually assumes—often unconsciously—the control of the sending, until eventually the instructor ceases, and merely participates occasionally to prevent any irregularities creeping in.

Simultaneously with this gymnastic training of the pupil's muscles, his headgear telephones respond to the sequence of audible sounds produced by the buzzer, and a visual signal appeals to his sense of sight.

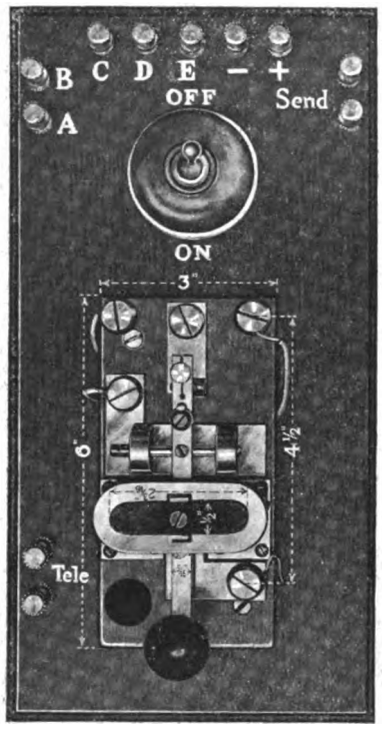

FIG. 3.—PLAN VIEW OF KEY.

Statistics of the time taken to master the code cannot be given here, but it will be found that Morse instruction based on the above principle will tend to reduce the period considerably.

The accompanying illustrations and diagrams demonstrate the simplicity and robustness of the apparatus employed. The set is divided into two parts, the electromagnetic key with controlling switch (Figs. 1, 3 and 4), which is placed in front of the pupil, and a case containing the visual signals, buzzer and transformers, is mounted separately, as shown in Figs. 2 and 5,

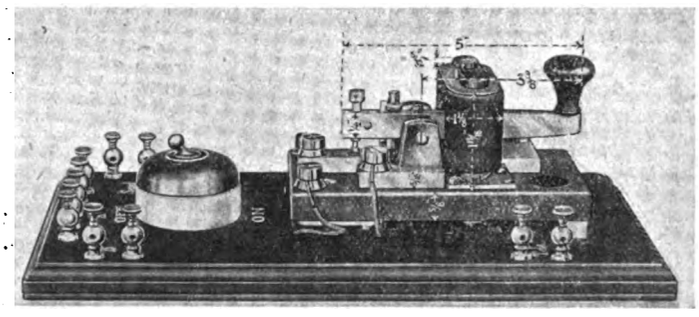

FIG. 4.—VIEW OF KEY.

and placed at a convenient distance from the pupil. Terminals A, B, C and D on each set are wired together, and a six-cell accumulator battery is connected to the terminals marked + and − on the electromagnetic key base. The instructor's key (or automatic sender) is connected to the terminals marked "send," and the set is ready for use.

Electromagnetic Set.—The internal wiring calls for no particular comment. The telephone terminals may, of course, be multipled to any convenient number of telephones. The

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electromagnet is wound with single silk-covered copper wire of 14 mils diameter to a resistance of 20 ohms, a non-inductive platinoid winding of 200 ohms, resistance being permanently connected in parallel to minimise sparking at the contacts.

As regards the mechanical construction, it should be borne in mind that the set receives constant rough usage, hence every part of the armature, axle, pivot bearings, &c., should be true and well balanced. Full dimensions are given in Figs. 3 and 4.

Distant Visual Signal Set.—The internal wiring is shown in Fig. 2. The electromagnet visual signal and the alternative lamp visual signal are controlled by the corresponding tumbler switches. The shunted buzzer, which should be of a robust type, is also controlled by a tumbler switch, and the primary winding of the transformer is connected (in series with a 2 M.F. condenser) across the "break" contacts. It is, of course,

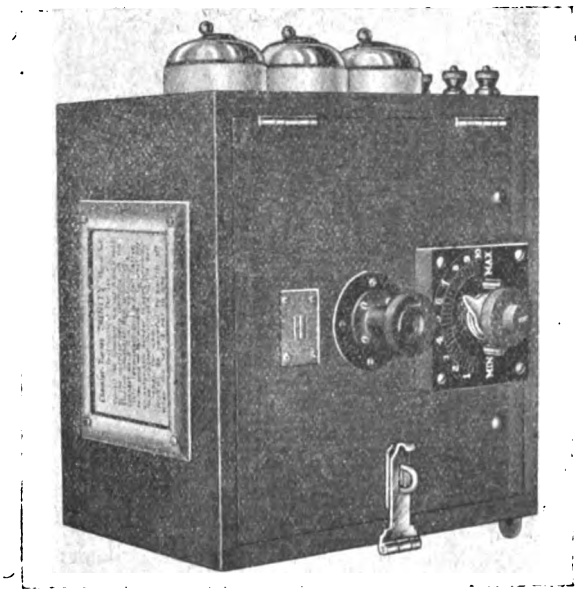

FIG. 5.—SIGNALLING SET.

desirable to vary the intensity of the sound in the headgear telephones, and in the present set the coupling between the primary and secondary windings (which are of the "pancake" type) is varied. An alternative, and possibly a more convenient method, is to insert an adjustable resistance across the secondary winding. From Fig. 5 it will be seen that the lamp mounting (centre) is provided with an adjustable aperture to reduce the effective area of the lamp to any desired extent. The lowest mounting (Fig. 5) shows the coupling handle with the locking screw and scale. Normally the lamp, buzzer and key are used simultaneously. It is not, of course, desirable to use both visual signals at the same time.

In conclusion, it may be remarked that any convenient number of sets may be used simultaneously, and all the usual telegraphic adjustments, width of gap, tension of antagonistic spring, &c., may be readily effected.

Correspondence.

ELEMENTARY PRINCIPLES OF C.C. ARMATURE WINDING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In connection with Mr. F. M. Denton's articles on the above subject, I should like to make some suggestions on the question of nomenclature.

Firstly with regard to re-entrant and re-entrancy. As pointed out on pp. 808 and 832, these words are used by different writers with quite different meanings. Without discussing which method is preferable, I suggest that the term be dropped to avoid confusion. If a single word is required to express the number of separate sections in the winding, it might be called the "sectionality" or the "closure" (symbol *r* on p. 832). It is not necessary, though it may be convenient, to have a single word for this quantity.

Secondly, while I agree with Mr. Denton's use of "multiplicity" (*m*), it seems a pity to use both "double-wound" and "duplex" with exactly the same meaning. In practice Mr. Denton appears to use the latter expression, while the former is that favoured by Parshall and Hobart. My suggestion is that "double-wound" (or simply "double") be used for a winding with two sections (symbol 0 0:), and that "duplex" be used for one with two "plexes." (See col. 1 line 2 in table on p. 831). And similarly with triple (-wound) and triplex, &c.

Finally, in the rare cases of a combination of two or more windings with two or more plexes, the same words should still be used, and the "multiplicity" would be the product of the "plexity" and the "sectionality." *E.g.* the winding in col. 2, row 6, on p. 831, would be called a "double triplex," and its "multiplicity" is six. The alternative forms of nomenclature for this same armature give duplex trebly re-entrant (S.P.T.); doubly re-entrant sextuple (P. & H.); and sextuplex doubly re-entrant (Denton). Perhaps I may be allowed to refer to pp. 172-4 of my book, "C.C. Electrical Engineering," for a fuller explanation of some of these suggestions.

It would be interesting to hear the opinions of Mr. Denton and others on this subject. No doubt everyone would prefer to keep to the method with which he is familiar; but if some authoritative scheme were settled, say by the Institution, all writers would probably adopt it in future.

Incidentally, may I suggest that Mr. Denton's claim for multiple windings that they simplify the design of brush gear, is a mistaken one. Any winding may have as many brush sets as there are poles, and a multiple winding cannot have more; the advantage is in regard to the armature conductors.—I am, &c.,

Sunderland, April 19. W. TOLME MACCALL.

The Control of Large Amounts of Power.

The following is an account of a discussion which took place before the Scottish Local Section of the Institution of Electrical Engineers on Mr. E. B. Wedmore's Paper on the above subject. An abstract of the Paper appeared in THE ELECTRICIAN of March 8.

Mr. J. K. STOTHERT remarked that the very large power stations referred to in the Paper would become the very nerve centres of industry, and in a future war, which would probably be fought largely in the air, these large structures would be an easy mark for aerial bombs. In view of such a possibility, he thought they should have more than one power station for each area. He also favoured overhead lines as against underground cables for large power supply distribution.

Mr. W. W. LACKIE said they in Glasgow had an area sufficiently large to warrant the putting down of over 200,000 kw. on one site. He would have liked to hear more about the improvement of power factor. The author said that the first indication of a fault to earth was the occurrence of a dead short-circuit to earth. That was not according to their experience in Glasgow, where a cable on a 6,600-volt circuit was switched out before the lead on the earth side was damaged. While he agreed that the demand for switches of greater mechanical strength was not justified, he thought that the containing tanks for oil switches should be stronger. There were switches on the market capable of rupturing 750,000 kw., and switches were promised with double this capacity. They had been promised a reactance containing iron. This had a short-circuited secondary winding, which on load was released, and so increased the reactance of the primary. It was better to have one good oil switch than two inferior switches, and the arrangement necessitated some 600 insulators, whereas their practice only showed some 200. For Dalmarnock he had adopted the oil-immersed isolating switch, and the conductors from machine to consumer were enclosed in an insulating material protected by lead or iron, and the 'bus bars would be run up solid.

Mr. N. C. BRIDGES felt that in station design they were faced with two principal sets of conditions, one with large concentrated demand, and the other with remote centres of demand. In the former they would distribute at the generator voltage of 6,000 to 10,000 volts, and in the latter at 20,000 to 30,000 volts. In the one case generator reactance

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plus external coils in series, and in the other case inherent reactance plus transformer reactance between machine and 'bus bars would be used. He did not agree with the multiplication of sections, and regarded the ideal number as two only, with which there was no question as to the relative merits of star and ring arrangements of 'bus-bar reactance. He did not favour the third 'bus-bar system mentioned by the author.

Mr. R. B. MITCHELL said the development of selective protective devices had made the use of reactances on distribution systems unnecessary. Was it too much to hope that protective devices would be so perfected that the whole system would be bound up solidly, and so give them the full use of the copper? He inclined to the gradual elimination of the lower voltages on account of the economies thus to be effected. With regard to Fig. 8, if the switches on a board were all of one size, and apparatus provided for their ready removal, one complete spare switch would fulfil the purpose at a much smaller cost. He asked the author if a time limit relay had ever been evolved which would satisfactorily fulfil its purpose.

Mr. F. H. WHYSALL remarked that in certain circumstances it might be necessary to have reactances put in on the distribution system, where there was switchgear which might be liable to be subjected to serious strains.

Mr. MACLEOD did not see why the control should not be on the low-pressure side of the transformers. He agreed that, for large amounts of power, underground cables should be used as overhead cables were liable to be tampered with.

Mr. W. B. HIRD said that each section of the industry seemed to set out a language of its own, and in the Paper this made the argument difficult to follow for those who were not in this particular line. The author spoke of reactance as the percentage drop when the full load current was passing through.

Mr. J. R. COWIE, in a lengthy communication, said that 20,000 k.v.a. rupturing capacity was not permissible with large amounts of power. Too little attention was paid to the problem of switchgear, which was worthy of the most thorough investigation.

Mr. WEDMORE replied briefly.

15,000-volt Ironclad Cubicle Switchboard.

A 15,000-volt "Witton" ironclad cubicle switchboard is shown in the accompanying illustration. The whole of the apparatus, including isolating links, instrument transformers and so forth is included in the cubicle, and special care has been taken to give adequate clearances.

The oil switch has a capacity of 200 amperes, and is constructed of steel throughout, there being one tank per phase. By means of a simple

tank lifting device, any tank can be removed to inspect the switch or replace the oil. Despite the size of the switches, the design is such that they can be easily operated by hand. The doors at the back, which give access to the whole of the apparatus, are interlocked with the oil switches, giving the well-known "Witton" mistake-proof characteristics. This switchboard was constructed by the General Electric Co. (Ltd.), of Witton, Birmingham.

Legal Intelligence.

White and Others v. Mayor and Corporation of Dover.

On April 23 Mr. Justice Bray and a special jury concluded the hearing of an action in which damages were claimed by Mr. A. White, the lessee of two houses in Folkestone-street, Dover, and Messrs. Chadwick, Ward and Arthur R. Adams, the freeholders, against the Mayor and Corporation of Dover, for the alleged negligence of defendants' workmen in laying an electric cable into one of the houses. Defendants admitted having laid the cable supply into the house in accordance with plaintiffs' request, but denied that there had been any negligence in carrying out the work.

The case for plaintiffs was that Mr. White let one of the houses to a boot repairer who desired to use electric current for lighting and driving a boot repairing machine and he applied to the Corporation for an electric supply. As owners of the electric supply undertaking the Corporation undertook the work and sent men to carry it out. They laid the cable in the ordinary way, but plaintiffs alleged that the work was done negligently and that the brickwork of the foundation had been so disturbed as to cause a subsequent subsidence and a bulging of the walls.

Mr. J. JENNINGS, an architect, stated that upon examination of the premises he found that the brickwork had been disturbed and that was the cause of the trouble. In his opinion if proper care had been taken in putting in the cable the trouble would not have arisen. The cost of putting the matter right was £100.

For the defence, FRANCIS THOS. ASHFIELD, a ganger on the electric staff of the Corporation, said that the work was properly done and the brickwork was not disturbed. He had laid over 100 electric services in the town and had never before had any complaints. The brickwork of the house was very old and he had only to remove a brick with his hand in order to make the hole through which the pipe passed.

Mr. Wm. Beaston, architect, and Mr. S. E. Beaufoy, deputy mayor and builder, also gave evidence, and in the result

The jury found for defendants.

Alien Enemy Patent.

On the 25th ult. an application was made to the Patents Court by Mr. Ernest E. Greville, manufacturer of electro-medical apparatus, for a licence to take the patented spark gap of a German wireless apparatus to fit it into an instrument which he was making for treating shell shock by electricity.

Mr. H. A. GILL said the main features of the invention was a spark-gap having the electrodes placed very close together and the surfaces of high conductivity. The patentee defined them as being of material which conducted heat as well as or better than gold. That really meant copper and silver. The claim was for "an apparatus for producing but slightly damped electrical oscillations by the shock excitation method, and employing a very short spark-gap having parallel electrodes in which these electrodes are made of a material which conducts heat as well as or better than gold." The feature was the use of such a spark-gap, preferably in annular form—in the constructional forms it was essential that all sharp edges should be avoided—there was a central gap, and the edges were enclosed by a ring of mica, or something of that sort. The patentee, to secure his high conductivity, went on to make up his plates in sets or series with a series of water-cooling chambers between the spark-gaps. They were connected as cooling ribs with the electrodes. By the cooling means and several spark-gaps the patentee got longer range. A simple spark-gap soon reached its limit. The energy converted into oscillations was increased beyond that limit by a plurality of spark-gaps.

Mr. GREVILLE said he did nothing in the way of wireless telegraphy, but the same process he had good reason to believe could be useful for high frequency in treating shell shock and nervous cases electrically. For many nervous ailments high frequency apparatus was used. Silence was a great thing in treating shell-shock cases.

A question was raised by the Court of the suitability of such a wireless appliance for the purpose, but applicant said that he wanted a high-frequency current, and the appliance in question gave him just what he required, with a silent working, which was a necessity in treating cases of shell shock.

The Controller said the Court would certainly grant the licence, as it existed to assist all such useful adaptations for manufacture. The patent was No. 6424 of 1909.

Parliamentary Intelligence.

STATUTORY REQUIREMENTS OF TRAMWAY UNDERTAKINGS.

Last week, on the motion of Lord Edmund Talbot, the House of Commons agreed to appoint a Select Committee "to consider and report whether it is expedient that some provision should be made for the temporary modification of statutory requirements with regard to the charges for the conveyance of traffic on tramways and light railways constructed wholly or mainly on public roads, in the case of undertakings whose financial circumstances have been injuriously affected by causes arising out of the war; and, if so, on what terms and conditions, and whether by private Bill or by general legislation."

Shropshire, Worcestershire & Staffordshire Electric Power Bill.—Last week a House of Lords Committee adjusted the clauses of this Bill (including one relating to the supply of the Northern area and the district supplied by the Midland Electric Corpn. for Power Distribution), and ordered it to be reported for third reading.

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Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

18,411 SPERRY, E. A. Electrodes for searchlights. (22,12,15.) 102,971.

1917 SPECIFICATIONS.

2,741 MORRIS. D. K. Electrostatic generators. (24,2,17.) 114,174.
3,798 SOC. LORRAINE DES ANCIENS ETABLISSEMENTS DE DIETRICH ET CIE DE LUNEVILLE. Driving mechanism for magnetos. (3,4,16.) 106,471.
3,865 BATULANDER, G. A. Electrical selectors. (17,3,16.) 105,372.
4,162 WARD, J. H. & GOLDSTONE, M. H. Electric cables, flexible conductors and the like. (22,3,17.) 114,197.
4,948 BIHELLER, S. Electric pocket lamps. (5,4,17.) 114,215.
5,481 TURQUAND, F. J. Sparking plugs for internal combustion engines. (19,4,17.) 114,224.
9,383 B.T.-H. Co. (G.E. Co.) Electric motor control. (29,6,17.) 114,246.
9,919 WATSON, J. F., & CALLENDER'S CABLE & CONSTRUCTION CO. Supports for electric cables. (10,7,17.) 114,249.
12,127 SALLES, P. M. R. Incandescent lamp-holders. (23,8,17.) 114,259.
13,392 AUTOMATIC TELEPHONE MFG. CO. (Automatic Electric Co.) Telephone systems. (18,9,17.) 114,269.

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

March 21, 1918.

4,965 DRAKES. Electric switches.
4,970 CRESSALL MFG. CO. Electrical fire bars.
4,971 & 4,972 COWPER-COLES. Coating iron and steel for protective purposes.
4,990 HOPE. Electric lighting of machines driven by electric motors.
5,009 B.T.-H. Co. (G.E. Co.) Dynamo-electric machines.
5,010 AUTOMATIC TELEPHONE MFG. CO. Automatic telephone systems. (9,7,17, U.S.)
5,032 EVANS. Means of indicating condition of charge of secondary batteries.

March 22, 1918.

5,059 WESTWOOD. Gas and electric lamp fittings.
5,079 ESCOTT, HORTON & LEEMING. Electrical recording graph.
5,094 VANDERVELL & Co. Control of lamp circuits on motor-cycles, &c.
5,109 & 5,110 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Electric motor controllers.

March 23, 1918.

5,123 WOLSELEY MOTORS (LTD.) & REMINGTON. Couplings for magnetos of internal combustion engines, &c.
5,131 MOORE. Portable electric lamp.
5,173 SYKES INTERLOCKING SIGNAL CO. & TARRANT. Commutator brushes.

March 25, 1918.

5,202 HOBLEY. Telephone receivers, &c.
5,208 PARTRIDGE. Electric ignition device.
5,216 CLIFTON. Electromotors.
5,230 LA VALETTE. Electric couplings. (28,3,17, France.)
5,241 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. & THOMPSON. Electric transformers.
5,345 FORBES. Electric heating devices for hatching bacteriological, &c., apparatus.

March 26, 1918.

5,265 MANSON. Electrical switchboards.
5,286 HIGGS. Electric motors.
5,314 CROOKE & THOMSON. Systems of electrical distribution.
5,322 IGRANIC ELECTRIC CO. (Cutler Hammer Mfg. Co.) Circuit breakers.
5,323 DELANNE. Lamp-holders for incandescent electric lamps. (19,3,17, France.)
5,329 SORENSEN. Electrical heating apparatus.

March 27, 1918.

5,410 TANGE. Production of showers, &c., of electric sparks for advt. purposes.
5,342 HALL. Apparatus for electrically treating soil.
5,354 LEWIS. Electrical ladle.
5,381 AUTOMATIC TELEPHONE MFG. CO. (Automatic Electric Co.) Automatic telephone systems.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W.1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain for the Week.—Captain E. G. Fleming.

Next for Duty.—Captain W. Hynam.

Monday, May 6.—No. 3 Company, 6.30–8.30. Recruits' Drill, 6.30–8.30. Signalling Section, 6.30–8.30.

Tuesday, May 7.—Lecture on Demolitions at 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, May 8.—No. 1 Company, Drill, Knotting and Lashing, 6.30–8.30. Recruits' Drill, 6.30.

Thursday, May 9.—No. 2 Company, Drill, Knotting and Lashing, 6.0–8.0. Recruits' Drill, 6.30–8.30. Signalling Section, 6.30–8.30. Ambulance Section, 6.30–8.30.

Friday, May 10.—Musketry, 5.30–8.0.

Saturday, May 11.—Entrenchments, &c., for the whole Corps, 2.45–4.45. Recruits' Drill, 2.45–4.45.

Sunday, May 12.—Commandant's Parade at Waterloo Station, 8.45 a.m., for work at Esher. Marching Order. With Rifles. Midday and tea rations to be carried.

SPECIAL NOTICES.—All drills will take place at Headquarters unless otherwise stated.

The Medical Officer will attend for the examination of recruits on Thursday evening at 6.0.

Whitsuntide.—See special orders.

Summer Camp.—Arrangements are now being made for this Camp. to start August 3.

Commercial Topics.

The Patents Bill.

Some of the Chambers of Commerce have decided to make representations to the Board of Trade and members of Parliament with a view to having included in the new Patents Bill a provision to the effect that no machine or appliance, being the subject of a patent of the United Kingdom, shall be allowed to be sold within the United Kingdom at any higher equivalent price than in any other country in which it is also the subject of a patent.

* * * *

Industrial Reconstruction Council.

The report of the Industrial Reconstruction Council for the three months ended March 31 has been issued.

The total circulation of the pamphlet "Trade Parliaments" amounts to 15,000 copies, and the fourth edition is in the press. A verbatim report of the speech by Mr. G. H. Roberts (Minister of Labour), at the meeting of the Industrial Reconstruction Council in Manchester, and a "Handbook for Speakers," are to be published.

Particulars are given of the meetings of the Council which have been held, the assistance given to other organisations by supplying speakers for their meetings, and conferences at which the president (Sir Wilfred Stokes) and the chairman (Mr. Ernest J. P. Benn) have attended.

The Committee are anxious to increase the number of subscribing members of the Council, and the number of lecturers and speakers who are willing to explain the principles of the Whitley Report.

A list of members of sub committees is given, and, in conclusion, it is stated that the Council has so far fully justified the hopes of its founders, and that the principle of self-government for industry is beginning to be better understood.

* * * *

Post-War Commercial and Industrial Policy.

In our last issue we gave a brief abstract of the recommendations of Lord Balfour's Committee on Commercial and Industrial Policy after the War.

The Committee, in dealing with the trend of trade in 1914, finds that with the exception of the iron and steel industry, the older industries showed great vitality and power of expansion. Great progress towards removing the German control of business has been made during the war. The Committee recommends that the present prohibition of the importation of goods of enemy origin should be continued, subject to licence in exceptional cases, for at least 12 months after the war; also that the British Empire and the Allies should adopt a policy of joint control of the export of certain important materials which will be required for the restoration of their industries. The control of home and foreign trade imposed during the war should be kept within the narrowest limits, and, wherever practicable, the trades and industries themselves should be entrusted with this control, under Government authority. As to the supply of raw materials, the Committee considers that any attempt to make the Empire self-supporting would be neither practicable nor economically sound. Special inquiries should be instituted to deal with particular commodities, the general aim being to assure that the Empire in an emergency should be independent for its supply of any essential commodity of any single foreign country or possible combination of countries. A Special Industries Board should be established to frame schemes for the promotion and assistance of industries concerned with the production of essential commodities. The Committee recommends the reservation of certain occupations, such as pilot and patent agent, to British subjects. It suggests also the licensing of foreign commercial travellers: the registration of all titles to property, with a declaration as to the nationality of the owner or transferee; powers for the Board of Trade to investigate the ownership and control of any particular company; licences for foreign banks and insurance companies, and, in the case of the latter, the lodging of a money deposit.

The Committee is strongly in favour of closer combination among traders as a means of meeting increasing foreign competition. In all important British industries there should exist associations, which should be clearing-houses of information of common interest. In regard to production, the constructive action must come from the industries themselves. In the case of international combinations to which British firms are parties, compulsory registration is recommended.

The scheme for the establishment of an imperial bank of industry is not recommended. The Committee recommends investigation as regards taxation, currency and for the maintenance of foreign exchanges, such as is now being carried out by Committees of the Ministry of Reconstruction and H.M. Treasury.

The Committee recommends, as the bases of future economic policy, Government action to promote and safeguard "pivotal" industries, Government assistance to industries which are important for maintaining the kingdom's industrial position, efforts to meet the wishes of the Dominions and colonies and India for the development of their economical relations with the United Kingdom, efforts to develop trade with our Allies, and the refusal for a time at least of trading facilities to present enemy countries on the same unrestricted terms as before the war.

A majority of the Committee do not favour a tariff scheme covering the whole range of imports, and amongst their reasons are that a claim for protection cannot be regarded as valid unless the industry which makes it can show that, in spite of the adoption of the most efficient technical methods and business organisation, it cannot maintain itself against foreign competition; that there are large branches of production

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in which there is no demand for protection; that any State action towards maintenance of industries which do not contribute towards the national wealth would be economically unsound; that any State action likely to raise prices, even temporarily, for commodities of national importance should be confined to the closest possible limits; and that it is of paramount importance that our export trade should not be hampered by any policy which might unduly increase the cost of production in this country.

It is recommended that preferential treatment should be accorded to the oversea Dominions and possessions in any Customs duties, and that consideration should be given to the possibility of using for purposes of negotiation with our Allies and with present neutrals any duties which may be imposed.

The Committee recommends the establishment of a Board to examine all applications for State assistance, and to advise the Government upon them. The report also mentions the metric system and decimal coinage, neither of which the Committee recommend for adoption in this country.

* * * *

Australasian Zinc.

It is announced that the Imperial Government has contracted for the purchase of practically the whole output of Australian zinc concentrates for the period of the war and 10 years after.

* * * *

Reconstruction of Belgian Industry.

In view of the critical situation which will result for Belgium through the disasters caused by the depredations of the enemy, his removal of tools, raw materials, manufactured products, &c., the Comptoir National pour la Reprise de l'Activite Economique en Belgique (Société Co-opérative) has been formed (with the co-operation and under the control of the Belgian State) for the purpose of organising the economical reconstruction of Belgium.

It is claimed that this organisation, in helping industry and trade, by enabling manufacturers and others to purchase tools and necessary raw materials, will not only reconstruct the economical situation of Belgium, but will put an end to the sufferings of the working-classes by enabling them to start working the reconstructed shops. The new organisation will interest itself in metallurgy, materials for construction of buildings, farming implements, chemical products, wood-working machinery, electrical material, optical instruments, motor-cars, vans, wagons, oils and greases, &c. English manufacturers and merchants are asked to send catalogues and tariffs (in triplicate) to the Comptoir National, 110, Cannon-street, London, E.C. 4.

Electricity Supply.

General.

Armagh.—The Council is considering an application of the Armagh Gas Light Co. for permission to lay electric supply mains.

Brighton.—The Committee on Production decided as follows on the 12th inst. in the arbitration between the Corporation and the Electrical Power Engineers' Association:—

Men concerned aged 18 years and over shall receive as from the beginning of the first full pay following the date of the award 20s. per week over their pre-war wages, all previous war wages or war bonuses (exclusive of service increments, advances for individual merit, and the bonus of 12½ per cent.) which have been granted since the outbreak of war being merged in the said 20s. per week.

The amounts awarded are to be taken into account in the calculation of payment for overtime, or for work on Sundays or holidays, and are to be regarded as war wage advances.

Burnley.—Ald. J. M. Grey has resigned the chairmanship of the Electricity Committee, a position he has held for many years. The new chairman is Councillor Holden.

Electrical Power Engineers' Association.—The Midland Section will hold a smoking concert at the Imperial Hotel, Birmingham, on the 10th inst.

The chair will be taken at 7.30 p.m. by Mr. R. A. Chattock, M.I.E.E., the city electrical engineer. All engineers interested in the movement will be cordially welcomed.

Electrolytic Production of Ferro-Manganese.—It is announced that the Anaconda Copper Co. will construct a plant at Great Falls (Mont.) for the electrolytic production of ferro-manganese.

It is expected that the plant will be in operation within 5 months and will produce 90 tons daily. This amount will suffice for a daily shipment of 10,000 tons iron at the United States Steel plant, and will release 100,000 tons of shipping annually that is now used in carrying manganese ore between Cuban and South American ports and the United States.

Galway.—The Urban Council is considering the question of acquiring the Galway & Salthill Tramways Co., which recently decided to go into voluntary liquidation, and also the undertaking of the local electric light company.

Industrial Councils in Government Dockyards.—It is announced that the Admiralty has practically adopted the principles of the Whitley Report, and that Industrial Councils will be introduced in the Royal Dockyards.

Leeds.—The Electricity Committee propose to purchase 1,971 sq. yds. of land for £5,500 in order to extend the electricity works.

Manchester.—The Electricity Committee report that, owing to increased sales of electrical energy for power and to higher charges to consumers it has been able to provide £16,570 in aid of the rates in the past year, and also to devote £1,996 to capital expenditure for which borrowing powers are unobtainable, and to carry £6,469 to reserve.

For the current year the Committee will have to make a higher payment to the city fund—1 per cent. on capital outlays, equalling £33,400, instead of £16,570 in 1917-18.

Mersey Power Extensions.—The Parliamentary Secretary of the Ministry of Munitions (Sir L. Worthington Evans) has stated that the Mersey Power Co. is in negotiation for a site for an extension of their works, required for the supply of electric power to munitions factories.

The extensions do not constitute a super-power generating station, such as is contemplated in the scheme of the Coal Conservation Sub-Committee; but the Ministry of Munitions had obtained Treasury sanction to the making of a loan of £300,000 to the company on certain conditions, which have been embodied in an agreement. The loan was secured by a first debenture, and was repayable in 15 annual instalments, commencing in 1921. Interest at 6 per cent. is charged on the loan.

Nottingham.—This year the Electricity Committee will be unable to make any contribution towards relief of rates. Last year the contribution was £3,000, but war bonus, increased cost of coal, &c., preclude a contribution being made this year.

Ormskirk.—The Board of Trade has extended for one year from June 24, 1918, the time limited by the Ormskirk Gas and Electricity Act, 1915, for the compulsory purchase of lands.

Electric Traction.

Edgware and Hampstead Railway.—The Board of Trade has extended by one year the time limited for the completion of certain works, purchase of lands, &c., in connection with the construction of this railway.

Manchester.—The Tramways Committee has decided to abolish halfpenny stages and to abolish workpeople's fares on all routes, every class of passenger to be called upon to pay the ordinary fares. The ordinary fares and stages have been revised, and in future the average penny stage will be two instead of 2½ miles.

Metropolitan District Railway.—The Board of Trade has extended by one year the time limited for compulsory purchase of houses and lands, construction of foot bridge at Mansion House station, &c.

Salford.—The Tramways Committee has revised the scale of charges on all the tramway routes; workmen's tickets have been abolished and all stages shortened.

Tramway Economies.—The following additional announcements in regard to curtailment of traffic facilities have been issued:—

At Northampton in future there will be no tramcars on Sunday, and the service will be stopped half an hour earlier on week days.

At Plymouth the tramway service will cease at 10 o'clock on week days and 9.30 on Sundays.

Imperial Notes.

Canada.—An Order in Council of March 8 prohibits the exportation from Canada, except under licence from the Minister of Customs, of various articles, including machinery and electrodes.

It is announced that electrical energy from Niagara will be reserved for industries engaged in manufacturing munitions. Under an Order in Council, the Toronto Electric Light, the London Electric and other supply companies will resume the operation of their steam plants.

India.—"Indian Engineering" states that Mr. E. Batchelor, a member of the Indian Civil Service, has prepared a scheme for the utilisation of the water-power of the Pench and Kulbehra rivers.

The project embraces the problem of bringing the water of the Pench river into the Kulbehra river and of both to the top of the Silewani Ghat, and the equipment of hydro-electric works. Most of the future iron and steel industry of India will be concentrated in the Central Provinces, and the great value of electrically smelted steel is being more recognised daily. Although long-distance transmission would certainly be expensive at the present time, it is calculated that up to 100 miles the estimated cost is reckoned at not above 0·5 anna per unit, and at important centres over 100 miles distant it is believed that electric would cost less than steam power costs at the present day. The scheme provides for 11 reservoirs, with a total catchment area of 651 sq. miles, yielding 1,167 sq. mile-feet, and costing R.1,00,10,000. The amount of power generated would be 70,000 kw., and the cost per kilowatt R.143. Cost of reservoirs is put at R.1,00,10,000, canals R.96,33,000, pipe lines 63,07,000, generators, &c., R.65,23,740, land R3,20,000; total R.3,27,93,740. The capital

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cost will be R.470 per kilowatt. The estimated working expenses are R 6,80,000 and revenue R.77,00,000, leaving profit R.70,20,000, or 21·4 per cent. This project is merely academic, and not based on actual survey, but should lead to a preliminary survey and estimate.

Mr. G. Laird, representative of a British company, recently arrived in Palghat, Madras Presidency, in connection with an electrical scheme at the Aderpalli Waterfalls, 20 miles from Chalakudi railway station. It is intended to generate power to work the Shoranur-Ernaculam Railway, light the towns of Trichur and Ernaculam in Cochin and also to supply power to one or two mills.

Miscellaneous.

Enemy Firms Wound Up.—On Tuesday Mr. Justice Younger, on the petition of the Board of Trade, ordered the following companies to be wound up:—

Mechanical & General Inventions Co. (Ltd.), Radium (Ltd.) and H. & F. Bonten (Ltd.).

Scholarships.—On the results of the scholarship examinations held at Faraday House Electrical Engineering College (Southampton-row, London, W.C.) on the 10th, 11th and 12th of April, the following awards have been made by the Governors:—

To Horace Reg. Harbottle (King's School, Pontefract) a "Faraday" scholarship of 50 guineas per annum, tenable for three years; to James Scott Davidson (Penrith Grammar School) a "Maxwell" scholarship of 50 guineas per annum, tenable for two years; to Reg. H. Parkinson (Central Foundation Boys' School, Finsbury) an exhibition of 30 guineas, tenable for two years; and to Arthur Casswell Harrison (Cranleigh School) a special prize of 25 guineas.

Tenders Invited and Accepted.

Main Switches, &c.

The COMMISSIONERS OF H.M. WORKS, &c., invite tenders for the supply of main switches, &c. Forms of tender, conditions of contract, &c., from the Controller of Supplies, King Charles-street, Westminster, S.W.1, and tenders by 11 a.m. May 10 to the Secretary, H.M. Office of Works, &c., Storey's Gate, London, S.W.1. *See an advertisement.*

Turbo-Alternator, Cooling Tower, Switchgear, Boiler, &c.

REDDITCH Urban District Council invite tenders for a 2,000 kw. 3,000 k.v.a. three-phase turbo-alternator, with surface condensing plant, a cooling tower, additional h.t. switchgear, and a water-tube boiler and accessories. Copies of specifications, &c., from the consulting engineers, Messrs. Handcock, Dykes & Trotter, 11, Victoria-street, S.W 1. Tenders to clerk, Mr. J. W. Hobson, by noon May 13.

Turbo-alternators, Converter, &c.

ISLINGTON (London) Lighting Committee require tenders by noon May 24 for (*a*) 5,000 kw. steam turbine, alternator, exciter, condensing plant, switchgear, &c.; and (*b*) water-tube boilers, coal conveyor, telpher, steam piping, &c. Specifications from the Electrical Engineer, Eden-grove, Holloway, N. 7.

Electrical Stores, &c.

GLASGOW Corporation cleansing department require tenders by May 7 for six months' supply of electrical material, ironmongery, rubber and asbestos goods, paints, oils, &c. Specifications, &c., from Mr. W. Greig, 20, Trongate, Glasgow.

Metallic Filament Lamps.

HOYLAKE and WEST KIRBY Council require tenders by May 11 for 12 months' supply of metallic filament lamps, &c. Specifications, &c., from the Engineer and Surveyor, Town Hall, Hoylake.

MANCHESTER.—The Corporation has accepted the following tenders for the tramway stores and materials.

British Thomson-Houston Co., motor and controller parts, springs and worm brushes: Dick, Kerr & Co., motor and controller parts, commutator segments, armature and field coils, &c.: British Westinghouse Electric & Mfg. Co., motor and controller parts, coils, springs, lightning arresters, lamps, mica cones and gear, and pinion wheels, &c.; P. R. Jackson & Co., commutator segments and coils; Forest City Electric Services Supply Co., commutator segments; L. Andrew & Co., fullerboard and mica bushings and washings, dust rings, insulation, P.B. and Crown and white linen tape, soldering fluid, &c.; British Insulated & Helsby Cables & Engineering Supplies Co., controller fingers, &c.; Drake & Gorham & Edison Swan Electric Co., lamps; General Electric Co., lamps, switches, cells, carbons, &c.; Mason & Brown, bells,; Micanite & Insulators Co., Mica Mfg. Co., and G. Schultz & Co., mica goods; Britannia Lamp & Accessories Co. and Siemens Bros. Dynamo Works, insulation tape; Griffiths Bros. & Co., varnish, &c.; J. Eades, carbon brushes; Morgan Crucible Co., carbon brushes and crucibles; Fleming, Birkby & Goodall, trolley wheels, &c., Connolly Bros., power and lighting cable and bell wire; F. Smith & Co., copper cable, wire and strip and steel wire and cable; and R. Johnson & Nephew, steel wire rope and iron wire.

Government Contracts.—The following tenders were accepted by the British Government Departments during March:—

War Office.—H. W. Cox & Co. and A. Lyon & Wrench, X-ray apparatus; Bruce Peebles & Co., motor converters; H. T. Boothroyd (Ltd.), City Electrical Co. and Electric Construction Co., dynamos; Belliss & Morcom, Brotherhood, Lindley & Co., City Electrical Co. and Crossley Bros., generating sets; British Thomson-Houston Co., E. Brook (Ltd.), City Electrical Co., Electric Construction Co. and F. Parkinson & Co., motors, &c.; British Thomson-Houston Co., switchboards and spares; Foster Engineering Co., transformers.

India Office.—General Electric Co., armature; A. W. Penrose & Co., zinc plates.

Post Office.—Automatic Telephone Mfg. Co., British L. M. Ericsson Mfg. Co. and Western Electric Co., protective apparatus; British L. M. Ericsson Mfg. Co. and Tyer & Co., telegraph apparatus; British L. M. Ericsson Mfg. Co., Genf & Co., Peel-Conner Telephone Works and Western Electric Co., telephone apparatus; Bullers (Ltd.), c.i. brackets and stay swivels; A. Kenrick & Sons, c.i. brackets; Siemens Bros. & Co. and Telegraph Construction & Maintenance Co., submarine cable; Hackbridge Cable Co., New Gutta Percha Co., Siemens Bros. & Co. and Union Cable Co., telegraph cable; British Ever Ready Co., dry cells; British Insulated & Helsby Cables and London Electric Wire Co. & Smiths, cords for telephones; Edison Swan Electric Co., glow lamps; London Electric Wire Co. & Smiths, enamelled copper wire; British Insulated & Helsby Cables, soft copper wire.

Appointments Vacant.

Hammersmith (London) Borough Council require an engineer-in-charge. Salary £175, rising by annual increments of £12. 10s. to £200 per annum, plus war bonus 20s. weekly and 12½ per cent. on earnings. Applications to the Borough Electrical Engineer, 85, Fulham Palace-road, W.C., by Thursday, May 9. *See an advertisement.*

Greenock Corporation require a meter inspector and tester, junior draughtsman, fireman, switchboard and sub-station attendants for their electricity department. Applications to the chief engineer and manager, Mr. F. H. Whysall, Electricity Works, Dellingburn-street, Greenock. *See an advertisement.*

A meter test-room assistant is required with good experience. *See advertisement.*

A physicist is required for measurements in electro culture work during the current season. Applications to Dr. C. Chree, Kew Observatory, Richmond. *See advertisement.*

The Walthamstow Higher Education Committee of Essex County Council require teachers of engineering subjects (commencing salary £200-£220) and mathematics (master or mistress; commencing salary £180-£260) for the Walthamstow Technical Institute, Engineering and Trade School. Application forms (to be returned by May 10) from the Clerk to the Governors, 1, Selborne-road, Walthamstow, E.17.

A foreman is required to take charge of pump, coiling and ageing departments at a lamp works.

A chief assistant is required for electrical machine testing for large works in the Midlands.

An advertiser requires an electrical laboratory assistant for standardisation of instruments and materials and general research work.

Business Items.

Mr. J. Snow Huddleston has left Messrs. Siemens Bros. & Co., Ltd., of Woolwich, and has been appointed general manager of the Union Cable Co., Ltd., of Dagenham Dock.

Messrs. Walter L. Davies and Alfred Soames inform us that they have granted an exclusive license to the Equipment & Engineering Co., 2 and 3, Norfolk-street, Strand, London, W.C., for the use of the "Daysohms" magnetic clutch for electric arc welding machines.

All inquiries for welders fitted with this clutch should be addressed to the Equipment & Engineering Co., but inquiries for applications of the "Daysohms" to other than arc welding, should be addressed to Messrs. Davies & Soames, at Faraday House, 66, Southampton-row, W.C. 1.

Plant for Sale.—Oldham Corporation advertise for sale two Willans-Siemens 740 kw. sets. Particulars from Mr. F. L. Ogden, Joint Engineer and Manager, Electricity Works, Greenhill, Oldham.

Patent Development.—The proprietor's of Letters Patent No. 13,991/1910, relating to "Controlling Electrical Apparatus from a Distance," desires to dispose of the patent or grant licences with a view to the adequate working of the patent in this country. Inquiries to Messrs. Cruikshank & Fairweather (Ltd.), 65-66, Chancery-lane, London, W.C. 2.

Electric Fires and Cookers.—The attention of the Board of Trade having been called to the action of some householders who have given up electric and gas fires and cookers owing to the restriction of the recent lighting, heating and power order, the Board intimate that an order will shortly be issued restricting household supplies of coal, and that under this order regard will be given to electricity and gas consumed in fixing the allowance of coal.

Vandervell's Moon Charts.—We have received from Messrs. C. A. Vandervell & Co. copies of their chart showing the hours of moonlight during May.

Controllers.—The Electric Controller & Mfg. Co., Cleveland, Ohio, has issued recently new net price sheets of the various types of controllers and apparatus manufactured by the company.

Liquidations, &c.

A meeting to receive an account of the winding up of the Prentice Wireless Train Control (Ltd.) will be held on June 3 at the office of Messrs. H. S. Baker & Co., 5, Broad Street-place, London, E.C.2.

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Companies' Meetings and Reports.

Indo-European Telegraph Co. (Ltd.)

The 51st ordinary general meeting was held on Tuesday, Mr. J. H. TRITTON (the chairman) presiding.

The ACTING-SECRETARY (Mr. T. O. Stevens Perry) having read the notice convening the meeting.

The CHAIRMAN said: I beg to move "That a final dividend be and is hereby declared for the year ending Dec. 31, 1917, of £1 2s. 6d. per share, free of income-tax (making, with the interim dividend already paid, 7 per cent. for the year); and that a distribution from equalisation of dividends fund be made of £1 10s. per share, both payable on May 1, 1918, subject to the terms of the Trading with the Enemy Proclamations, to shareholders registered on April 18, 1918." Owing to the conditions prevailing it is not possible at present to place before you the directors' report and accounts, but this will be circulated among the shareholders so soon as the final figures are available. The arrangement come to with the Eastern Telegraph Co. and the Indo-European Telegraph Department of the Indian Government has applied to the whole of the financial year under review, whereas last year it covered only the last five months. Under that arrangement, those two telegraph administrations secure to this Company a sufficient revenue to cover all working expenses, and to pay a dividend of 7 per cent. upon the share capital of the Company. The Company's revenue from telegraph traffic is now comparatively small, and after adding to this the interest upon our investments, there still remains a considerable sum of money which has been found by the administrations just referred to, and the Company is deeply sensible of this generous treatment. The directors recommend that the total distribution for the year be brought up to the same level as in previous years by withdrawing £25,500 from the equalisation of dividends fund. I am unable to make any statement as to our wireless interest; the negotiations that were initiated last year are not yet concluded.

The Company's route remains interrupted between this country and Russia, and we are now having a good deal of trouble south of the Caucasus, owing to the unsettled state of the country lying between Tiflis and the Russo-Persian frontier. The Company completed 50 years of public service on April 8, and we fully hope and believe that once the war is over we shall be able to re-establish telegraphic communication, and that the Company will once more become a useful and active entity. I much regret to inform you that two of our staff gave their lives for their country since I last addressed you. I am sure that you will wish me to express your sympathy with the relatives in their loss. One member of the staff has been awarded the D.S.O.

Mr. CHARLES HOLLAND seconded the resolution, which was then put and carried.

Mr. Charles Holland and Mr. J. H. Tritton were re-elected directors, and Messrs. Kemp, Sons, Sendell & Co. were re-appointed auditors.

A vote of thanks to the chairman, directors and staff terminated the proceedings.

BRITISH ELECTRIC TRANSFORMER CO. (LTD.)—At the meeting on Tuesday the chairman, Mr. A. F. Berry, in moving the adoption of the report and accounts (abstracted in our last issue), said the increase of £9,000 in sundry creditors was due to the volume of work and the higher prices of raw materials. Stock of materials, &c., had also increased by about 50 per cent., due to the same causes. Gross profit had increased about £4,600 and net profit nearly £1,400. Net profit was enough to cover the preference dividend five times over. During the past three years £7,000 was retained in the business by reducing the ordinary dividend to 7½ per cent., and they were now able to pay the 10 per cent. dividend again. They started the current year with about 90 per cent. more work in hand in money value than they did the year 1917. While transformers had been delivered by hundreds of thousands of horse-power, the "Tricity" department had also been of the greatest value. At their 1912 meeting he said the electrical energy produced from 1 ton of coal did the same amount of cooking as 10 tons in the coal range, and that if all the then electric light users installed "Tricity" cookers there would be a saving of several millions of tons of coal in a year. Those words had an added value to-day, and he made no apologies for re-iterating his request that shareholders should take an increasing interest in that branch of their business. "Tricity" methods were being used more and more, but the pioneering work ahead of them was still to be measured by the vast apathy and ignorance regarding new ideas, rather than by what they had accomplished. Many of those in the engineering world were attending reconstruction and other committee meetings with a view to ensuring greater co-ordination of designing, manufacturing and other effort; and they would doubtless secure a full measure of co operation of manufacturing effort in the electrical industry.

The report and accounts were adopted, the dividends approved and Mr. A. F. Berry re elected a director.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.)—The profit available for the year 1917, including £89,735 brought forward, amounts to £177,859, out of which the following appropriations have been made: Special depreciation of plant, machinery, &c. (£48,000), additional reserve for employers' liability (£10,000), dividend on preference shares at 7½ per cent., less tax (£68,625), leaving to be carried forward £51,234. During the year Mr. Philip A. Lang resigned his seat on the board. His great experience will, however, remain at the disposal of the board in the capacity of technical adviser. Mr. Lincoln Chandler (one of the managing directors of the Metropolitan Carriage, Wagon & Finance Co., Ltd.) has been appointed managing director to fill the vacancy. Mr. W. W. Blunt, who has also resigned his seat on the board, will for the future give the whole of his time and attention to the supervision of the commercial department. The directors during the year have also appointed Sir E. V. Hiley, K.B.E. (a director of the Metropolitan Carriage, Wagon & Finance Co.), and Sir F. H. Barker, Kt. (a director of Vickers Limited), to fill the vacancies on the board.

DIRECT UNITED STATES CABLE CO. (LTD.)—The report of the directors for the year ended March 31 last states that the reserve fund account shows a balance of £528,626. 10s. 4d., compared with £502,511. 13s. 10d in 1917. Three quarterly interim dividends of 2s. each per share (less tax), amounting to £27,319. 10s., have been paid, and a final dividend of 2s. per share (less tax) was paid on the 30th ult., making a total distribution of 4 per cent. for the year.

JOHNSON & PHILLIPS (LTD.)—Mr. W. Claude Johnson, who presided over the meeting last week, referred in feeling terms to the death of Mr. R. W. Blackwell, who had been chairman since the formation of their enterprise into a public Company. The accounts showed a considerable improvement over those of the preceding year. After making provision for bad and doubtful debts, and after charging to revenue upwards of £10,000 for maintenance of plant and buildings, &c., the trading profit was £70,000 odd, against £56,000 in 1916. With £9,900 brought forward the total was £80,000, which it was proposed to deal with as set out in the report, including payment of a dividend at rate of 7 per cent. per annum on the ordinary shares, leaving £13,564 to be carried forward. The business was in a thoroughly sound position. A further sum of £11,000 was expended during the year on additional buildings and plant in order to meet the growing demand for war material. Their output for the past 12 months was a "record" by a very large amount, and the turnover for the current year so far exceeded that of the corresponding period of 1917. The works were as full as they could well be of orders. A great many difficulties had had to be overcome in carrying out the vast amount of work entrusted to them, but he believed that the Company had undertaken their full share of national responsibilities. It was impossible to foretell what might happen in the next 12 months, but so far as the board could see there was little doubt that the output would be maintained, and that they would get their share of any business going.

LONDON UNITED TRAMWAYS (LTD.)—The gross receipts for 1917 were £354,473, an increase of £18,138 compared with 1916, but owing to continuous advances in cost of material and labour, the expenses have further increased by £23,595. After deducting the adverse balance of £2,583 brought forward and all expenses incurred during the year, the balance is £60,028, which is required for carrying out repairs and renewals as and when it becomes practicable to carry out such work. The charges for interest on the first mortgage debenture stock and loans amount to £71,627. Since the appointment of Mr. F. S. Price (Price, Waterhouse & Co.) as receiver in June last, negotiations have been carried on by the directors, with a committee appointed by the 4 per cent. first mortgage debenture stockholders, with a view to the reconstruction of the Company's capital and the rehabilitation of the tramways undertaking. These negotiations have resulted in a provisional arrangement under the terms of which, subject to the Bill now before Parliament passing into law, both the loan and share capital will be substantially reduced and funds will be provided for the reconstruction and renewal of the tramways.

METROPOLITAN ELECTRIC TRAMWAYS (LTD.)—The revenue for the year 1917 was £594,085. 10s. After adding balance brought forward and deducting all expenses (including a provision of £22,687. 10s. 5d. for future reconstruction and renewals), there remains £22,910. The directors recommend that £9,874 be placed to reserve and that a dividend on the preference shares at the rate of 2 per cent. for the year be declared, leaving £3,035. 11s. 2d. to be carried forward. The traffic receipts, after adjustment of accounts with the London County Council in regard to through running services, amounted to £542,531, and show an increase of £38,192. 17s. 8d. compared with 1916. Early last year the directors decided, in view of the increased cost of working, to raise the fares on the whole of the system, but the revised scale of charges did not become fully operative until the beginning of October. The increase of fares has undoubtedly had the effect of bringing in additional gross revenue, but it is manifest that the fares will have to be raised to a higher scale if the company is to be in a position to meet the continual increase in the working expenses due to the higher cost both of materials and labour. The number of units sold by the North Metropolitan Electric Power Supply Co. during 1917 represented an increase of approximately 18 per cent. compared with 1916. The increase in the output is mainly due to the larger supply given to power users. The gross profits of the power company for the year show an increase of £4,759 over 1916.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY (LTD.)—The revenue for 1917 amounts to £42,706 and the expenditure (including £1,408 for debenture interest) to £26,889, leaving a net profit of £15,817, which, added to £2,783 brought forward, makes an available balance of £18,600. The directors propose to place £10,000 to reserve, pay a dividend at rate of 5 per cent. for the year on the cumulative preference shares (£2,500), and a dividend on the ordinary shares at rate of 6 per cent. for the year (in respect of which an interim dividend for six months at rate of 5 per cent. per annum has been paid), absorbing £3,000, leaving £3,100 to be carried forward. The local authorities are entitled to purchase the tramways in their respective districts within six months after the expiration of 21 years from the date of the company's Act, and on Jan. 28 last Hyde Corporation gave notice of intention to exercise their statutory powers to purchase that portion of the tramways (about

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1 mile 5 furlongs) within their area, and negotiations are proceeding as to the price to be paid and other matters. The other local authorities in whose areas the remainder of the track (about 6 miles 2 furlongs) is situated availed themselves of the provisions of the Special Acts (Extension of Time Act), 1915, and the Board of Trade granted an extension of time until Feb. 6, 1919, for giving notice of purchase. The local authorities concerned have since passed the necessary statutory resolutions and have applied to the Board for their approval to a proposed service of notices requiring the company to sell its tramways and undertaking. Mr. J. E. Spagnoletti has been appointed a director of the company.

SOUTH METROPOLITAN ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—The total revenue for 1917 was £86,139 against £68,794 in 1916. With balance brought forward and deducting all expenses (after setting aside £6,000 to renewals fund) the surplus is £20,152. The directors recommend a dividend at rate of 6 per cent. per annum on the preference shares for the year ended Dec. 31, 1916, and at the rate of 3 per cent. on account of preference dividend for 1917, to place to reserve £4,000 and to carry forward £891. Gross receipts from tramways and light railways were £62,578 (increase £14,140) and net receipts from motor omnibuses £1,589. Gross receipts from electricity supply £21,232, against £17,468. Total number of units sold (including 230,692 supplied to tramways) was 1,540,281, against 1,267,631. Number of units sold for lighting and power 1,309,589, increase 256,167 units.

URBAN ELECTRIC SUPPLY CO. (LTD.)—The gross profits for 1917 amount to £67,732, compared with £64,983 in 1916, and after deducting expenses the balance is £64,521. The amounts required for interest, debenture stock redemption and income tax absorb £45,547, leaving, together with £1,774 brought forward, £20,748. The directors recommend that £10,000 be placed to reserve for depreciation, and that a dividend of 2½ per cent. for the year be paid on the preference shares, and that the balance (£4,497 18s. 5d.) be carried forward. Various establishments in the Twickenham Co.'s area engaged on war work require a large additional supply of power, involving a very considerable addition to the plant and mains at an estimated cost of £75,000. This sum the Government are arranging to advance to the Urban Co. at 6 per cent. interest on the security of a floating charge ranking behind the existing debenture stock, the repayment being spread over 15 years. To enable the Company to accept the loan it is necessary for the shareholders to sanction an increase of the Company's borrowing powers. The directors have arranged to renew the agreement with Edmundsons, which expired on March 31 last, for a further period of five years on practically the same conditions as before, except that the annual sum payable for management and administration is increased to £3,000. At the end of the year the load of the Company's various undertakings was 36,902 kw., against 33,886 kw. in 1916.

VICKERS (LTD.)—Mr. Douglas Vickers, who presided over the meeting last week, said the board had discussed the most varied plans for utilising for peace purposes as much as possible of their war plant. A very great portion of it would be quite unusable. At one of their large works in the south they proposed to manufacture on a large scale certain semi-electrical devices for motor-cars for which they thought there would be a large demand, and also another speed-controlling apparatus, which they originally developed mainly for war purposes, and which they thought would find a large application in other directions. At the same place they hoped to make two or three types of machine-tools of the class that had hitherto been mainly imported into this country. In connection with electrical work they had long intended to increase their rather too modest department in Sheffield and had proposed to build new works on a large scale, probably outside Sheffield. Recently an offer was made to them, which they accepted, to be associated with the Metropolitan Carriage, Wagon & Finance Co. in the control of the British Westinghouse Co. They thought that presented much better prospects than building new works, which would have taken a very long time to get into working order. They did not propose to discontinue manufacturing electrical material in Sheffield. They had also acquired the Bosch magneto works, and were going to manufacture on a large scale in Birmingham, and there also they were developing a most interesting manufacture, that of the new light alloy now known under the Company's trade mark as "Duralumin." In Sheffield they had a fairly ambitious programme, mainly intended to develop some of their older trades. Some had been rather pushed out by the growing armament trade, and the board hoped to push them back to the front.

At an extraordinary meeting which followed it was agreed to alter the memorandum of association to permit of the peace developments foreshadowed by the chairman.

New Companies, Mortgages and Charges, &c.

New Companies.

BASFORD ENGINEERING CO. (LTD.) (150,176.)—Private company. Reg. April 17, capital £3 000 in £1 shares mechanical and electrical engineers, boiler makers, &c.

EASTERN GENERAL WELDING & BRAZING WORKS (LTD.) (150,231.)—Private company. Reg. April 22, capital £3,000 in £1 shares, to carry on the business of welders of metals and alloys by oxy-acetylene, oxy-hydrogen, oxy-coal gas or other processes, also to carry on the business of electrical and general engineers, &c. Reg. office: 75A, East-road, Portway, West Ham, E.13.

ELECTRICAL COMPONENTS (LTD.) (150,218).—Private company. Reg. April 20, capital £5,000 in £1 shares. Manufacturers of and dealers in electrical accessories, &c. First directors are W. T. Bower (manager and secretary) and R. W. Bill. Reg. office: 36, Cannon-street, Birmingham.

JACOB & PARTNERS (PORT TALBOT) (LTD.) (150,220).—Private company. Reg. April 29, capital £40,000 in £1 shares. Ironfounders, mechanical and electrical engineers, tool makers, metal workers, &c.

Mortgages and Charges.

BRITISH ELECTROLYTIC ZINC CO. (ISHERWOOD PROCESS) (LTD.)—Charge dated Feb. 21, 1918, to secure £2,000 and further advances not exceeding £5,000, charged on Company's undertaking and property present and future. Holder: C. E. Heath, 3-4, Royal Exchange Buildings, E.C. 4.

EGHAM & STAINES ELECTRICITY CO. (LTD.)—Agreement dated Dec. 12, 1917, extending time for payment of and increasing rate of interest on £12,000 debentures outstanding of a series authorised Sept. 28, 1912.

City Notes.

BRUNNER, MOND & CO. (LTD.)—Sir John Brunner has resigned the chairmanship of this Company and he is succeeded by Mr. Roscoe Brunner. Sir John retains a seat on the board.

CITY OF BUENOS AYRES CO. (1904) (LTD.)—A dividend of 1s. 3d. per share (at rate of 5 per cent. per annum), less tax, has been declared for the quarter ended March 31.

CLARKE, CHAPMAN & CO.—It is proposed to divide each of the ordinary £10 shares into 10 shares of £1 each, and to increase the dividend on the preference shares from 6 to 7 per cent.

LONDON ELECTRIC SUPPLY CORPN. (LTD.)—Mr. W. H. Wilson has been appointed secretary of this Company in succession to Mr. H. C. Carter, who has retired owing to ill-health. Mr. Wilson has been connected with the Company since the early part of 1906.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The directors will recommend to the shareholders at the approaching meeting payment of the following final dividends and bonus for the year 1917: 6s. per share on the first and second preference shares, and 6d. per share dividend and 3d. per share bonus on the ordinary shares(tax free).

The Round Table.

By "kVA."

A Round Table reader kindly sends me the following letter, which is distinctly amusing. Evidently 50 new cycles were something to snap up at once:—

DEAR kV.A.: My firm recently advertised in the "Machinery Market" as follows:—

"Three-phase Oil-immersed Auto-Starter, 150 H.P., 500 volts, 50 cycles, new."

In response to this we received the following letter from an institution describing itself as a Motor Works and Official Repairer to R.A.C., O.A.G.C. and A.A.:—

"DEAR SIR: I see by the "Machinery Market" you have 50 cycles for sale. If they are still unsold, will you wire me the price, &c. I enclose 9d. in stamps for wire. I shall be in Manchester on Wednesday on business, and if unsold would call and see the cycles.—Yours faithfully."

We explained the position to our inquirer, and left him to decide whether he was sold or not, but we DID return the stamps.

Shortly afterwards we were visited by a female representative of a firm describing themselves as "Automobile Engineers," also intent on the purchase of the cycles. The position was duly explained, and the inanimate form conveyed from the premises.

We have also had several keen inquiries for the starter, but so far nobody has offered to purchase the volts or even the horse-power.

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, April 30, 1881.]

THE PARENTAGE OF THE TELEPHONE.—The little city of Brantford, Ontario, claims the honour of being the place where Prof. Bell carried on his first experiments which led to the discovery of the telephone.

IS IT POSSIBLE?—The Colonies and India says that 800 sheep have been killed by a flash of lightning at Coolah. We can only suppose that they were all congregated under or near one tree, or grove of trees, otherwise this statement seems almost incredible.

THE ELECTRIC LIGHT AT THE CENTRAL TELEGRAPH STATION.—The experiments with the Brockie lamp in this building are being persevered with, and seem to promise well. A 10 H.P. engine, made by Marshall & Gainsboro', is employed to feed the five lamps, to which number the experiment is limited at present.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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CONTENTS.

NOTES	21
Arrangements for the Week	23
A British Electrical Proving House. By C. Turnbull	24
Artificial Line for High Voltages	25
Trade Parliaments and Their Work. By E. J. P. Benn	26
Large Batteries for Power Purposes	27
Hints on Rectifying Faults in Motor Control Gear	27
THE UNORTHODOX CRITIC OF EDUCATION	28
REVIEWS	28
CORRESPONDENCE	29
LEGAL INTELLIGENCE	29
Volunteer Notices	29
Commercial Topics	30
Electricity Supply	30
Tenders Invited	31
Companies' Meetings and Reports	32

Notes.

The Maintenance of Essential Industries.

AN interim report has been issued by the Committee on Commercial and Industrial Policy, of which LORD BALFOUR OF BURLEIGH is chairman, dealing with the maintenance of certain "key" industries after the war. As to the definition of a key industry some difficulty may, perhaps, be felt. In many cases, such as the magneto industry, there can be no such difficulty, for our automobile industry undoubtedly depends upon the manufacture of this accessory and so do our air forces. If, however, preferential treatment is introduced, there will no doubt be a tendency on the part of many industries to describe themselves as key industries if possible, so as to benefit by such arrangements. But for the moment we need not trouble about cases of this kind. The present report does not deal with our great staple trades, such as the iron and steel industry, engineering, shipbuilding and the electrical trades, but deals with the smaller industries upon which others depend. Of these, the supply of tungsten is of direct interest to the electrical industry. Before the war this was largely controlled by Germany, even when the ore was found within the British Empire, and attempts to establish the industry in this country were met by organised price cutting from Germany. The present report recommends that tungsten should in future be manufactured within the Empire on such a scale as to supply our domestic requirements and to afford a margin for export. For this purpose it is necessary for British manufacturers to have the first claim upon the supplies of ore available within the British Empire, and to meet this point it is proposed by the Engineering Industries Committee that such ore shall not be exported without paying a duty of £25 per ton, unless there are no buyers in the Empire market, or the Government of the country in which the material is offered for sale refuses to purchase within a certain time. In other words, there is to be no duty on exporting the ore from the Empire if it is not required within the Empire. In order to help the British firms in the tungsten industry to meet German competition after the war, it has been suggested that they should receive special consideration as regards excess profits tax in relation to the amount of money which they have invested in ore dressing plant, &c. The Treasury, however, is not in favour of this method, and the Committee agree that any financial assistance by the State should take the form of a subsidy or a loan. Another industry in which electrical engineers are directly interested is the manufacture of magnetos. In regard to this industry the Committee see no reason why it should not establish itself firmly in this country in due course, but they consider that it will require some special assistance during the first few years after the war. To this end a number of proposals have been made by the British Ignition Apparatus Association, such as the voidance of all enemy patents relating to magnetos, the prohibition of imports for at least five years, after which certain import duties would be levied, the specifying of British-made magnetos by Government departments, &c. The Committee are largely in favour of such restrictions. In regard to the subject generally, it is considered that industries of this nature will require special and separate consideration and that no general measure will be sufficient to meet their varying requirements. The recommendation is therefore made to establish a special Industries Board, which would make recommendations from time to time and would consider such cases as might arise. The maintenance of efficient and adequate production at reasonable prices is laid down as a condition of the continued receipt by an industry of special State assistance. In addition to considering the protection of any new industry that might arise, it would be the function of the Board to consider complaints that such protection had been improperly used, or had for any reason ceased to be in the public interest.

Restriction of Exports.

AN interim report has also been issued by the same Committee on the treatment of exports from the British Empire and on the conservation of the resources of the Empire. This report is concerned with certain resolutions adopted at the Economic Conference held at Paris, whereby the Allies declared their determination to secure the restoration of raw materials to the devastated countries and to conserve for the Allied countries their natural resources during the period of reconstruction. This is undoubtedly a difficult subject. As is pointed out in the report, the simple prohibition of exports to present enemy countries would be insufficient to effect its object, and, unless it be proposed to consider the rationing of neutral countries, such a policy would merely have the effect of appearing to do something while in reality achieving no useful result. It is highly desirable that the Empire and the Allies should assure themselves of priority for their own requirements. On the other hand, rationing of neutral countries is, in the opinion of the Committee, impracticable and inexpedient. Nevertheless, the Paris resolution can be carried into effect if a policy of joint control of certain important commodities can be agreed upon between the British Empire and the Allies for the transition period. It is, therefore, proposed that in the United Kingdom the Government should be empowered to prohibit the export, except under licence, of such articles as may be deemed expedient, and that the regime should be administered with the help of strong committees on which the trades concerned would be fully represented. For this purpose it would be necessary

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to establish a joint organisation with the Allies. These steps appear to be highly desirable. There are but few people who would favour the policy of permitting our enemies to have materials at the expense of ourselves during the period of reconstruction. Our policy should at least aim at giving ourselves the advantage.

Chemical Obstruction.

WE are surprised to note that certain Power Bills now before Parliament have been opposed by the Association of British Chemical Manufacturers. The proposed Bills ask for powers, in addition to those for the generation of electricity, to manufacture gas and to work up chemical by-products obtained in the manufacture of gas. We take it that the promoters have in mind the possibility of low temperature carbonisation and desire to have powers to work up chemical by-products in the event of such methods being adopted at some future time. It appears to us that this opposition on the part of the chemical industry is very short-sighted and cannot be for the national good. There has been much discussion recently about the desirability of removing valuable constituents instead of allowing them to be lost by using raw coal for steam raising, but this cannot be done unless the necessary powers are given. If, for example, power companies are not permitted to recover ammonium sulphate, any idea of carbonisation goes by the board. The net result of the present position has been the withdrawal of at least one Power Bill and a compromise in the case of others.

Electrical Equipment of Ships.—An informal discussion upon the "Proposed Regulations for the Electrical Equipment of Ships," under the auspices of the Institution of Electrical Engineers, took place at a meeting held in the Mining Institute, Newcastle, on Monday, May 6. Members of the North-East Coast Institution of Engineers and Shipbuilders also participated in the discussion.

A Council on Eyesight.—Following a meeting of ophthalmic surgeons, recently held at the house of the Royal Society of Medicine, it has been decided to set up a standing advisory council on all matters relating to eyesight. The acting and past presidents of the Ophthalmological Society and of the Section of Ophthalmology of the Royal Society of Medicine, will be permanent members, and the Council will have power to co-opt others interested in various aspects of the problem.

Faraday Society.—Last Tuesday the Faraday Society held a discussion on the co-ordination of scientific publications. This was of an informal character, and was opened by the president, Sir Robert Hadfield, Bart., F.R.S. A large number of speakers contributed to the discussion, and there was evidently a feeling that there should be greater co-operation between societies on a number of matters. Reference was made to the overlapping of societies, the difficulty experienced in keeping in touch with what was published in the various transactions, the need for indexing and joint abstracting, and the desirability of combining to have a common building and library.

Institution of Civil Engineers.—At the annual general meeting of the Institution of Civil Engineers, held on Tuesday, April 23, the result of the ballot for the election of officers for the year 1918-19 was declared as follows :—

President: Sir John A. F. Aspinall. *Vice-presidents:* Sir John P. Griffith, Mr. John A. Brodie, Mr. W. B. Worthington, Dr. W. H. Maw. *Other Members of Council:* Dr. Charles C. Carpenter, Sir Dugald Clerk, K.B.E., D.Sc., F.R.S., Col. R. E. B. Crompton, C.B., Mr. Maurice Deacon, Sir Archibald Denny, Bart., Mr. G. H. Duggan, Sir William H. Ellis, C.B.E., Sir Robert R. Gales, Mr. W. W. Grierson, C.B.E., Sir Robert A. Hadfield, Bart., F.R.S., Brigadier-General Brodie H. Henderson, C.M.G., Mr. R. W. Holmes, Mr. G. W. Humphreys, Mr. Summers Hunter, C.B.E., Mr. M. E. Kernot, Lieut.-Col. Charles L. Morgan, C.B.E., Mr. Basil Mott, Engr. Vice-Admiral Sir Henry J. Oram, K.C.B., F.R.S., Mr. Frederick Palmer, C.I.E., Mr. J. W. Restler, Captain H. Riall Sankey, C.B., R.E., Sir John F. C. Snell, Mr. E. F. C. Trench, Mr. T. R. J. Ward, C.I.E., M.V.O., Mr. E. J. Way, Sir Alfred F. Yarrow, Bart.

Physics in Relation to National Life.—A lecture on the above subject was delivered at the Polytechnic, Regent-street, by Sir Richard Glazebrook, on April 25, Sir Alfred Keogh being in the chair. A variety of illustrations of the benefits to mankind following the greater knowledge of scientific laws was given. In the present war, unfortunately, the same knowledge has been the cause of great suffering. An account was given of the steps leading up to the development of electric power, special reference being made to the proposals of the Coal Conservation Committee of the Reconstruction Committee, through which it was possible that in the future 55 million tons of coal at present used for manufacturing processes might be saved. In conclusion, the lecturer referred to the need for laboratories devoted to industrial research, and to the work being done by the National Physical Laboratory as a source of information on technical subjects, and a central institution correlating the work of many others.

Royal Institution.—The annual meeting of the members of the Royal Institution was held on Wednesday, May 1, Sir Jas. Crichton-Browne, M.D., F.R.S., treasurer, in the chair. The annual report of the Committee of Visitors for the year 1917, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The report of the Davy Faraday Research Laboratory Committee was read. The following were unanimously elected as officers for the ensuing year :—

President—The Duke of Northumberland. *Treasurer*—Sir James Crichton-Browne. *Secretary*—Col. E. H. Hills. *Managers*—Henry E. Armstrong, Sir Wm. Phipson Beale, Bart., Sir James Mackenzie Davidson, John A. Fleming, Percy F. Frankland, J. Dundas Grant, Donald W. C. Hood, H. R. Kempe, the Right Hon. Lord Kinnaird, Sir Charles Nicholson, Bart., the Hon. R. C. Parsons, Edward B. Poulton, J. Emerson Reynolds, the Right Hon. Lord Rothschild, the Right Hon. Lord Wrenbury. *Visitors*—K. A. Wolfe Barry, Sir William H. Bennett, John G. Bristow, John F. Deacon, Edward Dent, Sir James J. Dobbie, John A. W. Dollar, W. B. Gibbs, William J. Gow, W. A. T. Hallowes, Sir Alexander Pedler, Hugh Munro Ross, Joseph Shaw, John Strain, Sir Henry J. Wood.

Electric Welding.—The "Electrical Review and Western Electrician" describes an interesting series of patents relating to electric welding issued on Jan. 1 to Mr. Thomas E. Murray, Junr., of New York. According to one of these a cavity is formed on the surface of one of the metal pieces opposite a part of the proposed joint, so that the molten metal flows into this cavity. In another, pipe ends are welded to plates by using a ring-shaped electrode sliding over the pipe and of greater electrical conductivity than the pipe. For welding plates or bars without leaving protrusions or excessively thick spots, two rollers are used as electrodes and one of these is rotated so as to compress the metal while softened by the heating. To countersink a punched hole, the perforated plate is treated electrically and a suitably shaped tool is forced into the opening. For cutting metal discs, an electrode is used, arranged like the cutter of a rotary metal shear ; this and an adjacent second electrode are moved in a circle over the metal while supplying them with current. Finally, as an ingenious substitute for riveting or spot-welding, Mr. Murray perforates one metal plate, lays the other over this, and forces a projecting part of the latter into the perforation by means of a punch, which acts as one electrode in both softening the metal so that it can thus be forced, and in welding the resulting projection to the perforation into which it is forced.

Experiments on the Production of Diamond.—In his Bakerian Lecture before the Royal Society on the 25th ult. Sir Charles Parsons alluded to some of the results of experiments described in his Papers to the Royal Society in 1888 and 1907, more particularly to those on the decomposition by heat of carbon compounds under high pressure, and on the effect of applying pressure to iron during rapid cooling. A description was given of experiments designed to melt carbon under pressures up to 15,000 atmospheres by resistance heating and by the sudden compression of acetylene oxygen flame ; also by the firing of high velocity steel bullets through incandescent carbon into a cavity in a block of steel. Allusion was made to experiments on chemical reactions under high pressure and

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their results. The pressures occurring in rapidly cooled ingots of iron, and experiments bearing upon this question were discussed, and experiments at atmospheric pressure and experiments *in vacuo* were described. The main conclusions arrived at were: That graphite cannot be converted into diamond by heat and pressure alone, within the limits reached in the experiments; that there is no distinct evidence that any of the chemical reactions under pressure have yielded diamond; that the only undoubted source of diamond is from iron previously heated to high temperature and then cooled; and that diamond is not produced by bulk pressure as previously supposed, but by the action of the gases occluded in the metal and condensed into the centre on quick cooling.

Iron and Steel Institute.—At the annual meeting of the Iron and Steel Institute on May 2–3, a variety of instructive Papers were presented, a specially interesting event being the address of the new president, Mr. Eugene Schneider, of the famous Creusot Iron Works in France. In opening his address Mr. Schneider emphasised the value of research in the iron industry, but remarked on the difficulty of defining clearly the connection between two groups of men, scientists and industrialists, whose relations hitherto have not been sufficiently intimate. Liberty of thought must not, however, be paralysed by undue organisation. Industrial and scientific invention is, almost in every case, the product of the creative power of an individual—conspicuous examples being the work of Henry Bessemer and Nasmyth (in England) and Bourdon (at Le Creusot) in France. Yet engineers must guard against too ready acceptance of ready-made doctrines, and must study the "human material" at their disposal. Mr. Schneider's address was illustrated by various facts illustrating the expenditure of iron and steel in the present war. Instead of 20,000 gun-shots which Napoleon fired at the battle of Wagram, or the 1,500,000 shells which the siege of Sebastopol cost the Allies, we must fire to-day several million shells to drive the enemy a few miles back on a very narrow front. The expenditure is due largely to the difficulty of securing an accurate range from guns, although artillery engineers have made great progress in this respect. Mr. Schneider presents a diagram showing the increased weight of shells necessary to destroy an infantry shelter of specified size, in the years 1870, 1904 and 1916. Of great interest were the particulars given of the efforts France has made to meet the difficulties imposed by foreign invasion. The enemy's incursion enabled him to occupy more than 70 per cent. of French iron and steel works. Yet in spite of this, by building new blast furnaces and 60-ton open-hearth furnaces the armies have been kept supplied. The Caen furnaces produce, per unit, 450 tons of steel per day, where, before the war, out of 123 such furnaces in France, few could turn out more than 250 tons. Liberal use is being made of hydraulic power in France, an output of 4,500,000 H.P. in the near future, as compared with 700,000–800,000 at present, being anticipated. Transmission at 60,000 volts are already used, and one of 120,000 volts will be in operation very shortly.

Obituary.

J. W. GARSIDE.—The death is announced of Mr. James W. Garside, electrical engineer to Hebden Bridge Borough Council since 1903.

J. W. ROOK.—We regret to announce the death of Mr. J. W. Rook, manager of the Sloan Electrical Co. (Ltd.). Mr. Rook, who was 61 years of age, was manager of the company from its incorporation in 1899, previous to which he was with Messrs. Crompton & Co.

ARNOLD VON SIEMENS.—It is reported that the death of Herr Arnold von Siemens, chairman of Siemens & Halske, occurred on the 29th ult.

SECOND-LIEUT. M. P. MCLACHLAN.—Second-Lieut. Malcolm P. McLachlan, aged 22, who lost his life in a canoe accident at Bedford on Saturday last, was formerly apprenticed to a Bootle firm of electrical engineers. He had served for some months in the R.E. Wireless Signal Corps.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service are reported:—

We regret to record the death of Major A. G. Parsons (R.F.A.), who was killed on April 26. He was a director of C. A. Parsons & Co. (Ltd.), and the only son of the Hon. Sir Charles A. Parsons. The deceased was born in 1886, received his first commission in 1906, and, after serving three years, retired to enter the engineering profession. He rejoined the R.F.A. on the outbreak of war.

Capt. Henry Middleton (R.E.), who was killed on April 23, was an engineer by profession. He served his apprenticeship with Vickers Limited, and later was engaged with John Willey & Sons (Ltd.).

Capt. G. Trevor Williams (R.F.A.), whose death occurred on April 19 as the result of an accident, was for some time a pupil at Armstrong College, and took the degrees of M.Sc. (Durham) and B.Sc. (London) in engineering. After two years' experience in the works of Messrs. C. A. Parsons & Co., he proceeded to Trinity College, Cambridge, for research work. Subsequently he held an important post with Messrs. Chance Bros., Birmingham. He saw active service in France, Egypt, and Mesopotamia, and was invalided to India. He died in hospital at Rawal Pindi at the age of 30 years.

Lieut. B. C. Peach (Prince of Wales' Own Yorks. Regt.), who was killed by a sniper on April 10, was formerly engaged with Messrs. Brook, Hirst & Co., switchgear makers.

Lieut. George Proctor (Lancs Fusiliers), who has died in action, was formerly in the service of Rushworth Bros., electric crane makers.

Pte. R. Standish (L.N. Lancs.), formerly engaged at the Bolton electricity works, has died in action.

After being missing since July last, Pte. Jas. Smith (Cheshire Regt.), a former employee of Dick, Kerr & Co., is now presumed to have died in action.

Personal.

Sir Arthur Duckham, K.C.B., has been appointed superintendent of Aircraft Production, in succession to Sir William Weir.

Mr. A. Hugh Seabrook, lately manager of the Marylebone (London) electric supply department, is now with the General Electric Co., and is engaged in the organisation of the new General Electric combine, which includes the undertakings of Fraser & Chalmers (Ltd.) and Chamberlain & Hookham (Ltd.). Mr. Seabrook's present address is Witton Works, Birmingham.

WAR CASUALTIES.—The following casualties are reported:—

Signaller Thos. Melia, formerly a Burnley tramway employee, has been wounded.

Cpl. W. H. Barker (London Regt.), formerly in the general office of the India Rubber Co., has been wounded in France.

L.-Cpl. Wm. Bain (M.G.C.), who was in the proofing department of the India Rubber Co., is now a prisoner in Germany. He joined the Army in 1914 and went to France, but upon discovering that he was only 16 years of age the authorities sent him home. On attaining the age of 18 he rejoined.

Arrangements for the Week.

FRIDAY, May 10th (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Papers to be read: "On the Times of Sudden Commencement of Magnetic Storms," by Dr. S. Chapman; "The Entropy of a Metal," by Dr. H. S. Allen, M.A.; and "On Tracing Rays Through an Optical System," by Mr. T. Smith, B.A.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, Westminster, London, S.W. Lecturette on "The Preparation of Drawings for Reproduction," by Mr. W. H. Godfrey.

SATURDAY, May 11th.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

6 p.m. At Cannon-street Hotel, London, E.C. Sixty-fifth Anniversary Festival.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. At the Swan Hotel, New-street, Birmingham. Paper on "Electric Lifts," by Mr. C. G. A. Macdonald.

MONDAY, May 13th.

INSTITUTION OF ELECTRICAL ENGINEERS, NEWCASTLE LOCAL SECTION.

6.45 p.m. At the Mining Institute, Newcastle. Paper on "A British Electrical Proving House," by Mr. C. Turnbull. Annual General Meeting.

TUESDAY, May 14th.

ILLUMINATING ENGINEERING SOCIETY.

6.30 p.m. At the House of the Royal Society of Arts, John-street Adelphi, London, W.C. Discussion on "The Lighting, Heating and Power Order (1918) and the Best Methods of Making Economies."

JUNIOR INSTITUTION OF ENGINEERS, NORTH-EASTERN SECTION.

7.15 p.m. At the Mining Institute, Neville-street, Newcastle-on-Tyne. Paper on "Stores Organisation," by Mr. E. F. Oakford

WEDNESDAY, May 15th.

INSTITUTION OF ELECTRICAL ENGINEERS, STUDENTS' SECTION.

7 p.m. At Finsbury Technical College, Leonard-street, E.C. 2. Paper and discussion on "Electric Railway Traction," by Mr. G. H. Fletcher, A.C.G.I. Annual General meeting.

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A British Electrical Proving House.*

By C. TURNBULL.

In this country the Engineering Standards Committee have produced a number of excellent specifications which have prepared the way for work of a more advanced nature. One may also mention the very useful work done by the Cable Makers' Association. The C.M.A. specifications were immediately accepted by the industry, and their use has caused a great saving to both buyers and manufacturers. The Institution wiring rules have resulted in a further simplification in wiring work. But probably all engineers who supervise and otherwise deal with wiring work have felt that it is not enough merely to print rules relating to installation work; a difficulty also arises in specifying materials for installations. It is common practice when drawing up specifications for consultants to specify the actual makers of the apparatus and materials to be used, and from many points of view the plan has merit. It puts all tenderers on the same basis, and on the completion of the work it enables the consultant to satisfy himself that the installation will be adequate; but the plan has its disadvantages. The accepted tenderers may desire to use their own standard materials.

The best solution of the difficulty would be for the electrical industry to found and maintain a Proving House to test samples of standard apparatus and materials, and to give certificates where the same had passed the tests imposed. This would be fair to all parties, and it would put the industry on a scientific basis. Consultants would merely specify the class to which materials should conform, and it would no longer be necessary to mention the manufacturers' names. The use of various classes would meet the requirement that cheaper materials would be suitable on straightforward installations on dry premises than, say, on installations where there was much dampness, or where the circumstances were difficult for other reasons. This would result in economy in many instances. The use of various classes would further encourage inventors to bring out new kinds of materials specially suitable for varying conditions; indeed, it might eventually be found that much cheaper materials would be satisfactory for the ordinary installation than are now considered desirable. We have had an example of this in the case of the higher densities now allowed for small sizes of rubber-covered wires, the increased carrying capacities having been discovered as soon as scientific methods were brought to bear on the problem. The saving in the cost of wiring, brought about by the National Physical Laboratory investigations on this subject, must by now be very great. We may reasonably expect that similar savings will accrue in other directions as soon as we develop research in departments now controlled by rule of thumb.

The Proving House would be of great value to wiring contractors as well as to consultants. It would enable them to buy their materials on the best terms, with the certainty that there would be no difficulty in getting them accepted by buyers. They would also be relieved from competition of jerry wiremen, whose influence in the past has been so baneful. Manufacturers would also be able to guarantee their goods, as they would know exactly what tests would be enforced, while they would be relieved from the expense of providing a host of patterns to meet cheap competitive types of doubtful value.

Once the Proving House has been established we may expect that buyers will soon become accustomed to demand that only certified goods must be supplied to them in all cases. Such a step would mark a great advance in our methods, and it would tend to eliminate unsatisfactory apparatus and materials of every kind.

Organisation of the Proving House.

It is suggested that the Proving House should be organised on commercial lines, its aim being to assist British trade. Its certificates would give a hall-mark to those British firms who were able to satisfy its requirements, and this would create a prestige for British manufacturers which would be useful not only at home but in foreign markets. The value of such prestige is incalculable; indeed, it is not too much to say that an enormous amount of business comes from foreign markets to firms who have been able to create the feeling that their goods are the real thing, and once this feeling has been created it is difficult for competitors to get in at all.

The Board of Control might consist of representatives drawn from all interests concerned, including Government departments, consulting engineers, manufacturers, electric supply undertakings, insurance companies and users of electrical goods. The laboratory work would be carried out by a highly trained staff provided with the necessary equipment. The Control Committee would keep the Proving House in touch with modern ideas and see that it did not get out of date.

Duties.—The author suggests that the duties of the Proving House might be on the following lines:—

1. It would assist the Engineering Standards Committee in the preparation of specifications for electrical accessories and apparatus, with details of tests which they were to undergo.
2. In conjunction with the appropriate committee, it would assist in drawing up new and improved rules from time to time.
3. It would test samples from manufacturers and certify those which were satisfactory.
4. It would test actual samples taken from installations and decide whether the same came up to specification or not.
5. It would keep in touch with breakdowns and failure of materials and accessories, with a view to the elimination of those which were defective.
6. It would publish results obtained in a form useful to the manufacturer and user of electrical apparatus.

It is suggested that the Proving House should begin its work by taking up the testing of selected electrical accessories, such as rubber-covered cables as used for ordinary installations, switches, fuses, plugs, starters and similar things, other items being added as found desirable.

Rubber-covered Cables.

The testing of rubber-covered cables is admittedly a difficult subject, and there appears to be some doubt as to whether it is possible at all to find out by tests if such cables will or will not have a satisfactory life. Even if a method has not yet been evolved by which their probable life may be discovered with a relatively short test, from past experience we may be certain that efficient methods will be discovered when expert investigators tackle the problem with the aid of a properly equipped laboratory. It has been stated in the Press that American research laboratories are already busy on the subject. If in the near future they are able to advertise that their cables are made in a manner which their experimenters have shown will ensure long life they will achieve a prestige in the markets which will be very damaging to our manufacturers—that is, provided that we are not in a similar position. It does not follow that the best cables will necessarily be the most expensive to make. It may happen that processes may be discovered by which the best results may be obtained from cables which are relatively cheap to manufacture. If this should be realised, the advantage of the Proving House certificates to the inventors of such new types of cables will be so much the greater.

A further point in the favour of the Proving House is that it is impossible to frame rules which debar inferior cables, unless recognised tests are introduced by which the bad may be discriminated. Before the war very large quantities of cheap German cable were introduced into this country, and much of this was known to have a short life. The certificate of the Proving House would be invaluable both in home and in foreign markets, as buyers would soon get into the way of dealing only with makers whose goods were certified.

The chief defects from which rubber-covered cables suffer are well known. Some dielectrics become soft, with the consistency of treacle, while others become hard and develop cracks when bent. Some types suffer severely in the presence of damp, and others deteriorate where surroundings are unduly hot.

It should not be impossible to discover liability to the grosser defects, while, with time, means should also be found whereby more subtle deficiencies can be tracked down in the laboratory.

Some of the flexible wire now sold is of unsatisfactory quality, and means should be taken to remove it from the market. Good flexible cable is procurable, but inferior material is cheaper, and there is no means at present for preventing its use.

New Types.—From time to time makers introduce new types of cable, some of which are of great value, while others are not. The question arises: How can Wiring Rules Committees deal with such new types? Take, for instance, cables protected with tough rubber compound. These are permitted, without casing or conduit, by clause 65 of the Institution wiring rules, subject to their conforming to certain conditions, yet it would doubtless be possible to make a cable, of which a new sample would fill all requirements of the wiring rules, although such cable might not be reliable over a long period of time. The tests undertaken by the Proving House would ultimately ensure that only suitable materials came on to the market.

* Abstract of a Paper read before the Institution of Electrical Engineers.

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LAMPHOLDERS AND LAMPS.

Many inferior lamp-holders have been imported into this country, and have had a ready sale owing to their low prices. The metal of which they are made is too thin, the shade rings are often a bad fit, and generally they are quite unfitted to carry heavy shades. Terminal screws often have little or no grip, and the cord grip does not grip the flexible cable, so that the weight of the holder and shade is taken by the terminal screws. It is highly desirable in the interests of public safety that the sale of such defective holders should be speedily prevented.

Many details in the manufacture of lamps have given trouble, although on the whole British lamps are satisfactory. Caps sometimes come loose owing to defective cement, and the leading-in wires occasionally short-circuit. One may also call attention to the lamp tops now adopted by makers for half-watt lamps. Those taking 150 and 200 watts have Edison screw caps, while lamps of 300 watts and over have Goliath caps. At 220 volts the current of the 150-watt lamps is about ¾ ampere, and for the 200-watt lamp it is still under an ampere. Lamps at these currents have run satisfactorily from ordinary bayonet-cap lamp-holders for many years past, and it seems to be an unnecessary inconvenience to make them with the Edison cap now, which means that holders must be changed when one wishes to use the new type of lamp. If, however, it is necessary to use Edison screws, might these not take the 300-watt lamp also?

The use of efficient reflectors instead of dense shades has made a marked improvement in illumination during recent years, yet the old vicious type of shade is still used far more than it ought to be.

SWITCHES AND OTHER ACCESSORIES.

It is notorious that many tumbler switches listed for 5 and 10 amperes at 240 volts are unable to deal with anything like the full load. Some patterns should be rated at 1½ amperes, and a few patterns at a little more. There is a similar diversity between the rates and actual capacity of other types of switches. Many double-pole switches in cast-iron cases are quite unsuitable for breaking their rated loads frequently, particularly if the circuit be at all inductive. The general design is often defective.

There is much need of experimental work to determine which types of insulation are reliable. Slate is still used for switchboards, but it is liable to faulty insulation. Many of the artificial insulators are also defective. Some of them have low insulation properties and others are weak mechanically. Insulation for radiators and ovens particularly requires investigation, both as to the actual properties of the materials and as to the design. Where radiators are used in bathrooms special care should be taken to obviate the possibility of leakage. The whole subject of insulation in all its branches would give profitable employment to a large department of the Proving House.

Many of the fuses in use are far from satisfactory. A favourite design for house distribution boxes has the fuse on the top of the bridge. This exposes an unwary operator to the danger of severe burns should the fuse blow when it is being replaced. Fuses should be arranged so that they will be reasonably safe if they are inserted on a short-circuit. Many fuse bridges are weak and are liable to fracture every time a fuse blows on a heavy overload. Clips also often break off after they have been in use for some years..

The Proving House could do useful work in ensuring that plugs conformed to the design of the Engineering Standards Committee. The present needless diversity in designs is a perpetual source of irritation, and the introduction of the standard design should mark a great advance. Useful work could be done in connection with all the above accessories.

FINANCE.

The question will be asked How is the cost of the Proving House to be met? Our Allies in the United States have a ready answer to this. They pay the expenses out of the profits which accrue from research work, and have something over besides. Not only does research work prevent waste and save money by concentrating the attention of manufacturers on the work of proved utility, but it adds to the prestige of the firms who support the laboratories, as British firms may learn from their travellers abroad. There should be no difficulty in arranging a levy on an equitable basis, while in addition there would be revenue from fees for testing apparatus. The U.S.A. laboratories obtain hundreds of thousands per annum for research work, and one may expect that British firms would be no less enterprising once they had come to understand the benefits of the work. Quite small firms regularly spend £5,000 per annum and over on advertising, and find it pay. Sums much less than this from a fair proportion of the firms engaged in the electrical industry would give us a good Proving House, equipped in a manner worthy of the traditions of the nation.

LEGISLATION.

It is evident that some legislation is required to put the wiring and accessories business in a proper position. For instance, it ought to be an indictable offence for anyone to fix a heavy shade in the roof of a public building suspended on a weak lamp-holder by a piece of thin, inferior flexible cable, with no proper means of taking the weight. It ought also to be an offence for anyone to wire houses with cable the insulation of which may be expected to perish in a short time. But it is evident that Parliament cannot pass the legislation required until a recognised authority is constituted which can be relied upon to give correct verdicts on matters submitted to it. Lloyd's Register, for instance, receives recognition by the authorities because it has proved itself capable, and the British Electrical Proving House would also receive similar recognition when it had become the accepted authority of the industry. The Proving House would thus automatically solve a number of problems relating to the enforcing of wiring rules, problems which otherwise are insoluble. No one can doubt the need for an improvement in the present conditions of the wiring business, and if the Proving House did nothing further than provide a method for dealing with this part of the problem it would be well worth the expense of its establishment.

At present one hears complaints from consumers that manufacturers will not listen to suggestions for improvements in detail. The Proving House would act as a bridge between the two parties, for it would record and classify complaints, and would test apparatus to locate defects, and when its experts declared that apparatus was not fulfilling its functions properly, the manufacturer would not be slow to make the required changes.

Artificial Line for High Voltages.

In our issue of February 1st we referred to an artificial high-tension line which had been constructed by Prof. L. Lombardi, of Naples. Since that date Prof. Lombardi has been good enough to send us the following particulars:—

The line is actually built up with three coils of 240 turns, 36 cm. diameter and 170 cm. long, of brass wire 3 mm. diameter, having a total resistance of 8 ohms and a self-induction of 0·012 henry. The capacity is given by 36 Moscicki condensers of 0·002 mfd., uniformly distributed at every 20th turn. The frequency of resonance is about 9,000, and the natural wave-length of the complete line is 33 km. Two coils, excited at the mid-point, can be employed as a symmetrical antenna, having a fundamental wave of 11 km. and responding to every odd harmonic wave, of length 3,600, 2,200. . . metres. The essential feature of the line is its adaptability to experiments with very high voltages, the condensers having been tested at 30,000 volts, and the necessary provisions made for the connection of every two in series, so as to give to the coils a potential of 60,000 volts. A number of condensers have already been purchased for doubling the capacity of the line.

The first experiments performed on the line were with the object of demonstrating the surging waves produced by suddenly connecting or short-circuiting the line when fed at one end by a transformer, the other end being open or connected to appropriate coils so as to give resonance for the surging waves. It was easy in this way to excite surges of 50–100 thousand volts at the open end, starting at the other end with 5–10 thousand volts, and to measure the steepness of the waves along the line by sphere gaps. Analogous experiments could be performed by connecting to the charged line a battery of condensers, so as to obtain a sudden discharge, the danger of which is practically increased by the inversion of the charge, as explained by Sarfert.

A second set of experiments was performed on modern protective devices, and was sufficient to demonstrate the action and to compare the efficacy of resistances, reactance coils, capacities and different combinations thereof.

All the experiments were repeated at a lecture before the Electrotechnical Association, and will be fully described in a Paper to be published in the Italian "Electrical Review."

Prof. Lombardi proposes to extend his experiments by the use of high-frequency oscillations, for which purpose an arc generator will be used.

Book Received.

[Copy of the undermentioned work can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"Transactions of the American Electrochemical Society." Vol. XXXI. (Pennsylvania: The American Electrochemical Society.) Pp. viii.+437.

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Trade Parliaments and Their Work.

By E. J. P. BENN.

III.—The Rationing of Materials.

One of the best examples of the sort of work that is waiting for the creation of Trade Parliaments is connected with the rationing of materials and priority arrangements. There is hardly a raw material of any importance which is not at the present moment either entirely owned by the Government or entirely controlled by the bureaucracy; whether it be wood, steel, wool, cotton, leather or paper, the position is the same. Not one ton or sheet can be secured without some sort of permission from some sort of Government Department. It is the fashion to rail at all these arrangements, and to hold up to ridicule the methods of the bureaucrats. This is not always fair, because it must be confessed that, having regard to the almost total absence of adequate organisation in the various trades, the war-time machinery which has been devised to undertake the necessary controls has worked as well as could be expected of any amateur contrivance. When the time arrives that these materials are no longer required for war-like purposes, fresh arrangements will have to be made to cover the transition period, and to bring back our markets and our supplies by a gradual process to a normal condition. It is commonly assumed that on the conclusion of peace the repeal of the Defence of the Realm Act will follow as a matter of course, and that all the controls, restrictions, licences, permits, exemptions and certificates with which we now have to comply will automatically disappear. The business man is, as a rule, so fully conversant with the details of the weaknesses of the present system that he does not bother to go deeply into the problem, and contents himself with the happy idea that it will all come to an end some day. Nothing could be farther from the truth. The fact is that all these restrictions will have to be removed by degrees, and it is also certain that the bureaucracy will do everything that they can to maintain for as long as possible their grip over affairs. We have already had an illustration of this in the two Acts of Parliament which have recently been passed at the instance of the Board of Trade; the one giving to that office powers to continue after the war their present control of imports and exports, and the other giving to them very wide scope in connection with the non-ferrous metal trades. It may be that these two measures are really in the public interest, and there is no intention here to dispute that point; but, even supposing them to be directly against the public interest, measures presented in the way that they were by a Government charged with the conduct of the war are bound, in present circumstances, to receive the assent of Parliament. If, therefore, any controller of anything cares to go to Parliament to-day for a lease of life extending well into the peace period, the chances are heavily in favour of his getting what he wants. There is an urgent need for Trade Parliaments, authoritative bodies speaking with the voice of whole trades, backed by both Capital and Labour, at this very moment, in order simply to express the views of the trades on the need for a continuation of all these arrangements. It does not, of course, follow that in granting to the Board of Trade a continuation of its powers Parliament is acting foolishly; the only point that it is desired to make here is that it is acting without the possibility of knowing the views of those most vitally affected by what it does. Neither does it follow that if, say, the wool trade could express its opinions with one voice, those opinions would be in favour of a total and immediate abolition of the wool control immediately hostilities cease. After four or five or six years of artificial arrangements, the industry might be ruined if markets were suddenly allowed to take care of themselves. It may well be found upon examination that a modified control for a time is essential. It will certainly be found that the present shortage of materials will continue for periods varying from months to years after the war. The most casual examination of the shipping figures places this point beyond argument. If, therefore, the supply of raw wool is likely to be half the demand, there would seem to be a *prima facie* case for the continuation of some system of rations. The offer of the Government, expressed by three of its Ministers, is to transfer the duty of rationing from Whitehall to the Whitley Councils. Surely nothing could be better, and no offer could be more worth accepting. Any trade which has real concern for its future interests should be able to overcome any minor difficulties that may be in the way of the formation of an Industrial Council, if only for the purpose of making sure that sane arrangements shall prevail for the supply of its requirements in raw materials. The machinery which controls raw material for war purposes is obviously not suitable for the control of those materials in times of peace. In the one case one buyer is supreme, in the other all buyers will have to be put on level terms. The machinery required for the rationing of materials in the transition period is of two kinds. There must, first of all, be a central control in touch with shipping facilities which will decide the total tonnage that can be allocated to a particular material, and further decide how that total tonnage shall be distributed as between trades. For example, if a million shipping tons of timber can be imported, the central control will have to allocate it between the builders, the furniture men, the railway works and the shipping yards. Then the respective Trade Parliaments of the building, furniture, railway and the shipbuilding industries, having secured the total tonnage for their industry, will arrange for the equitable distribution between their own members. Such a plan is quite obviously infinitely preferable to the present cumbersome process of priority certificates issued from a central office in Whitehall. To begin with, the traders themselves will be able to deal with their own requirements in far less time than any Government Office can hope to do, and when we are back on peace work time will be a very vital factor. This in brief is the case for the Whitley Council so far as raw materials are concerned. There are some trade associations which have, so far, failed to see the need for an Industrial Council in this connection. Their attitude is briefly that they are the representatives of the trade, and that if any rationing is necessary they are well fitted to undertake it. They claim that the supply of raw material is an employers' matter, and that Labour is not entitled to be consulted in this connection. The most superficial thought shows how utterly wrong this view is. The supply of wood or steel to the building trade is of much more importance to Labour than to Capital. To the former it means the difference between work or unemployment, whereas to the latter it can only mean the difference between the completion of a contract sooner or later. In allocating materials as between trades the Government, if it is a good Government, will certainly take into account the amount of labour which the material will keep going; thus, if a given quantity of wood will employ a thousand hands in one trade and only five hundred in another, there will be a very strong case for preferential treatment of the former. There can be no doubt that the Government in this work of rationing must have very careful regard to the claims of Labour—must, in fact, consult both employers and employed on the matter. For this reason rationing cannot be left to be settled by employers' associations only, and rationing is one of the most urgent reasons why joint councils should be brought into being. The subject of rationing is by no means exhausted when we have considered imported raw materials, although that is, of course, the largest question involved. Priority will have to be arranged in many forms of manufactured articles. The best examples of this sort of problem is in connection with the textile industries. It is understood that these trades are woefully short of machinery, while it will be admitted that at the end of the war one of the first jobs to be done will be to get the great textile industries working at full pressure. Here, then, arises the need for seeing that some of the first machinery which we can produce is placed at the disposal of the textile trade.

We shall see in a subsequent article how closely related this sort of problem is to the question of demobilisation. The trade which may be able to absorb large numbers of soldiers and war workers must obviously be supplied with the necessary facilities in the way of machinery and materials before some industry which does not offer the same advantages. Trade Parliaments in dealing with rationing and priority will also have to take into account the relative demands of the home and foreign market. It is understood that foreign buyers, especially neutrals, are prepared to pay high prices for early deliveries of machinery. Matters must quite obviously be so arranged that the German should not be able through neutral agents, and by paying some small premium, to secure machinery to re-start his industries while those same industries at home are held up for the want of it. There are many other matters to be considered in connection with this subject of rationing, but enough has probably been said to show that it will not be possible, or wise, to terminate suddenly existing arrangements, and to show the need for the creation of proper organisations in each trade to look after these matters on behalf of their trades. The only alternative would seem to be the continuation of the present centralised bureaucratic control, and the consequent serious handicapping of our industries.

Daylight Saving in the United States.—This year the United States will have its first experience of daylight saving, the altered time having come into operation on March 31. Opinion generally now seems quite resigned to the change, especially in view of experiences in Europe. It is anticipated that it will lead to a saving of about 300,000 tons of coal this year, and possibly will diminish the bills of electric light consumers by about 7½ million dollars. For most central stations the reduction in income will, however, be relatively small, and the load factor may be appreciably improved.

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Large Batteries for Power Purposes.

The following is an account of a discussion which took place before the Manchester Section of the Institution of Electrical Engineers on Mr. E. C. McKinnon's Paper on the above subject. An abstract of the Paper appeared in THE ELECTRICIAN of April 26th and May 3rd.

Mr. S. L. PEARCE, in opening the discussion, said he had some little difficulty in giving further data beyond what had been published with regard to the degree of success that had been obtained in Manchester. The Dickinson-street battery was put in in 1910, and the particulars relating to performance had been very fully published. That battery was followed some three years later by a battery put in by the author's firm, which was used exclusively on traction service. On a modified scale, this had been as successful as the battery in Dickinson-street, which latter was now used exclusively for lighting and power, and chiefly lighting. He saw no reason to change his opinion that a peak load battery, taken even at the one-hour rate, effected a saving in capital charges in comparison with steam plant, and was also capable of fulfilling to a very large degree the functions of a purely emergency battery. That was the way in which the Dickinson-street battery was operated to-day. In the winter it dealt with about 30 per cent. of the average daily peak; on occasions in the summer, during storm loads, it had been called upon to deal with an increased demand of something like 70 per cent. Obviously, with that class of violently fluctuating load, nothing else than a battery was really equal to the demand and could so readily and economically deal with it. The author raised possibly some new points in connection with the very debateable question of booster control versus cell regulation. The author suggested that if engineers were able to start de novo some might be inclined to reverse their original decision regarding methods of control. He (the speaker) agreed and confessed that he was one of them. Under the actual operating conditions in Manchester to-day, which differed somewhat materially from the arrangements which were originally proposed and for which the battery was originally designed, he believed that end-cell regulation would show better results than booster control. The power which was required for the booster plant in order to maintain the 'bus-bar voltage represented a very considerable percentage of the battery discharge, and it must be remembered that the maximum output of the battery was generally required at the time of maximum 'bus-bar voltage. He could give some figures in connection with their own battery to substantiate that statement. Taking the one-hour rate of discharge—namely, 8,400 amperes—of that total 1,100 amperes might be deemed to be absorbed by the booster plant, leaving a net battery discharge of 7,300; those were the figures at the commencement of the hour. At the end of the hour they were 1,900 and 6,500 respectively, showing a variation over the hour from 13 to 24 per cent.—that is to say, out of a total of 8,400 amperes, 13 per cent. was required by the booster plant at the beginning and it rose to 24 per cent., the booster voltage having risen from 53 to 93. Obviously, at the higher rate of discharge, this percentage of the power required by the booster plant increased very rapidly. Hence it seemed to him that these very high rates were only possible with low boosts, or perhaps with the battery on the bars without the use of boosters at all. He therefore thought that, working as they did at Dickinson-street, the advantage would rest with the end-cell arrangement. The total losses in the booster plant and in the batteries were covered some three or four times over by the saving in coal; but that was not the point in question. He wholly disagreed that engineers in this country would employ batteries for purely stand-by or emergency puposes, and he asked the author to tell them what was really the underlying reason for this practice in the States. From the economic aspect of the question, a purely stand-by battery could effect no saving in running expenses; therefore it seemed a wrong policy. A battery which was large enough to act as a substitute for a peak load plant on the one-hour basis ought to give that economy in working and have all the emergency qualities which made it a sound commercial investment. On the five-minute rating the Manchester battery price worked out at £3. 15s. per kilowatt. Mr. Taylor stated that the Birmingham battery, on the three-minute rating, worked out at £2. 10s. per kilowatt. According to the author, an Exide stand-by battery in the States, on the six-minute rating, worked out at £3 per kilowatt. The difference in cost per kilowatt did not seem so very material. He could not see where the gain really came in.

Mr. S. J. WATSON thought that the best form of flooring was not a flat tile, but one which had serrations across it, so that one walked on comparatively dry surfaces. The drainage should be carried to more than one position in the battery room. A battery room of any size, which necessitated the flowing of liquid from one end to the other, would be in an exceedingly sloppy and uncomfortable condition when any work was going on such as the removal or the washing down of the plates. The disposal of acid was really an important matter. When you came to entirely renew or overhaul a battery necessitating a complete change of acid it was rather a problem how to dispose of the large quantity which had to be got rid of. He did not think at the present time there was very much hope of standardisation in batteries. The conditions being such as they were in regard to methods of construction and formation, he was doubtful whether any standardisation was desirable at the present time. You might, no doubt, attempt to standardise the design of boxes or the methods of carrying the boxes, but he was afraid very little if anything could be done in regard to the standardisation of the plates. One of the most important points in connection with battery agreements the author had not dealt with—namely, the provision, when a battery had to be entirely replaced, of a clause which would automatically adjust the amount to be paid, based upon the price of lead at the time. Most of them would appreciate that point. In equity provision should be made for a variation in the amount paid when a considerable amount of replacement had to be done. Although batteries for tramways were not now so necessary, a large battery was undoubtedly a source of great security. With regard to booster or regulator control, the first battery he had to deal with was used solely for lighting purposes, and had multiple-contact regulating switches with charge and discharge bars. When a very much larger battery was put in they decided to adopt booster control, and on the whole they had been very successful. It was far more difficult to obtain satisfactory auto-regulation in connection with a lighting and power system than in connection with a tramway system, where the demands vary considerably from moment to moment. Hand-regulated battery boosters for lighting and power purposes were the only kind used to any extent in this country. The author remarked that regulating switches were being used to a large extent in the States, but such switches for very heavy currents presented difficulties.

Mr. W. A. BARNES (L. & Y. Railway) referred to the author's list of "obstructing factors" to the progress in developing large batteries, and considered that many of these factors should really be under the general heading of "inadequate training of engineers." The speaker considered the want of a standard maintenance agreement was badly felt, and the author's suggestion on this matter should be acted upon.

Mr. PURVIS criticised the author's specification. With regard to sunlight in battery rooms, the greatest effects were due to the atmosphere causing evaporation, and if impurities were present their activity for mischief was much increased with high temperature. Evaporation was also increased by the use of wood separators, especially where such were supported by wooden dowels projecting above the level of the acid. Moisture rose to the top of the dowels and evaporated. The trouble of taking specific gravity readings was largely due to the very bad divisions on the hydrometer. With better divisions, much more accurate readings could be taken and much more readily. At present all readings were taken on the surface of the electrolyte, and the meniscus tended to prevent a true reading. A hydrometer reading about 1½ in. or 2 in. above the level of the acid by means of a float was on the market, and had made the reading of specific gravity very much easier.

Mr. EUSTACE THOMAS expressed interest in switchgear. With the cell switches there was easy control. It was possible to have batteries entirely controlled by automatic switches.

Mr. L. BROEKMAN referred to the prejudice against batteries, which was the result of experience in the early days. Maintenance agreements introduced many difficult points and responsibilities.

Mr. D. S. PAXTON dealt with temperature variations and the space that should be allowed for the collection of sediment at the bottom of a cell.

Mr. H. C. SABINE dealt with a number of details, and then referred to maintenance agreements. He thought the grievances were more imaginary than real. In the ordinary way the battery maker carried out his obligations in a large number of cases. If the battery was under maintenance, he found that the manufacturers automatically put the repairs in hand, sometimes without any correspondence and often before the engineer appreciated there was anything wrong.

Mr. G. S. WALLACE referred to the difficulty of handling carboys.

Mr. MCKINNON, in reply, said that stand-by batteries in America were to some extent a question of convenience. The companies were tied down to give continuity of supply, and there were engineers who would do anything rather than lose continuity of service. On the other hand, we had cases in this country where the users were the last to receive consideration. The Eagle-street battery owed much of its success to the fact that the positive plates were of antimonial lead, and therefore able to hold up their own weight. They found that with soft lead plates, much shorter in depth, there was a risk, especially if the plates were very wide, that they would sag. The speakers who referred to the question of floors all had the impression that the battery floor was a sloppy mess. As a matter of fact, floors only became sloppy when they had to be damped down to remove any dust; if dust were kept out of the room there would very seldom be any occasion for that. As regards standardisation, he felt he was a prophet crying in the desert. The theory of Mr. Watson that some adjustment should be made in accordance with the price of lead had been taken up and agreed upon by the battery makers.

Hints on Rectifying Faults in Motor Control Gear.

A booklet on the above subject, by Geo. Ellison, insists on the desirability of purchasing control gear only from makers of repute. Alternating and continuous-current gear are dealt with separately, and a good deal of useful advice is given. In the alternating section, the use of overload releases, the furnishing of full particulars of slip-ring rotors, precautions in starting up and effects of temperature, the examination and renewal of contacts and worn-out insulation are among the points dealt with. The section concludes with the sound advice: "Keep everything clean, bearings well lubricated, all connections tight, brushes well bedded, watch the air-gap, and pay special attention to the instructions issued by the motor makers."

Continuous-current motors and control gear are dealt with in a similar manner, but more briefly. The booklet is concluded by a series of illustrations of the firm's specialities, including circuit-breakers of various types, controllers, disconnector plugs and oil-immersed rotor starters.

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The Unorthodox Critic of Education.

During the last year or two we have heard so much about our present system of education, about its defects and remedies, that many of us have become a little tired of the subject notwithstanding its importance. In many respects, therefore, it is refreshing to find a critic who is entirely unorthodox. The critic we have in mind is Mr. HERBERT G. TAYLOR, who is the author of a small book entitled "The Education of Engineers."* We do not know that we should pay so much attention to this little volume were it not for the fact that Mr. TAYLOR is lecturer in civil and mechanical engineering at King's College, London, and is, therefore, in a position to speak on the question with some knowledge.

It is impossible for us to refer to all of the criticisms made by Mr. TAYLOR. Briefly, the corner stone on which he builds his criticism is the dictum that engineering is purely and simply an art, and not a branch of science. Engineering was firmly established many years before the development of mathematics or the sciences. Ships sailed on the water long before ARCHIMEDES had his celebrated bath. Battering rams were used before NEWTON was born and were, therefore, effective before the enunciation of the laws of motion. Thus it follows that many of the accomplishments of engineering were effected without the aid of science, and hence we have the view that engineering is simply an art.

The author goes rather on the principle that the engineer, like the poet, is born and not made. Therefore he should start work with his hands and develop the engineering instinct without appealing to the aids of science. He should be in the works, in the midst of engineering; there should be practice first and theory second, only as a later aid to further practice. If the boy engineer merely follows the education of the ordinary school-boy and then goes into the engineering department of a university he is, in the words of the author, "simply trying to learn, after he is 21, what he ought to have learnt when he was quite a boy."

We agree that in engineering the ladder is somewhat difficult, and it may often be that, when the ladder is found, it is full of rotten staves; but it is remarkable that a teacher of engineering should make the statement that "for an engineer who is to make his way in life the worst thing he could possibly do is to become educated; this is the rottenest stave of all." Towards the end of the book the author goes still further, and suggests that science would do well to take a trip on the next passing comet; after this voyage, and not till then, will he "believe that RONTGEN and the CURIES were not afflicted with a particularly crooked mentality." After reading this page we confess we are inclined to doubt whether the mentality of the author himself is strictly rectilinear, and we begin to wonder whether he has some personal grievance against modern education.

Even so, there is generally some ground for criticism when criticism is made, and it may be as well to consider whether something more might not be done from the point of view that engineering is an art. From this aspect it would certainly be better if all engineers could be educated more on the lines of engineers for the navy; in other words, if closer touch could be kept with the life's work from the earliest days. There is, however, great difficulty in doing so except in an amateurish way, nor is it altogether desirable. It would, in our opinion, be a great mistake to restrict our would-be engineers mainly to engineering topics from the age of, say, 14. Education should be broad, and it is often something of a reproach to our engineers at the present day that their education is so narrow. Let not the mere humanities and general education be neglected. On the other hand, we think there is a great deal to be said in favour of the school which runs a good workshop, from the point of view of keeping these boys with mechanical tastes interested in engineering matters. It appears to us, however, to be quite impracticable to follow the idea of the navy; and similarly it is impossible to follow the idea of the hospital in providing medical training for doctors, however excellent and admittedly desirable this may be. The great distinction between an engineering works and the navy, or a hospital or an art school, is that none of the three latter are run for profit.

It is quite true, as Mr. TAYLOR remarks, that a university engineering department is largely divorced from practical engineering. The ideal arrangement would, no doubt, be to have the engineering school as an off-shoot of two or three large engineering works, half the time being spent in the school and half the time in the works. Unfortunately, however, it is necessary for a works to be run on a commercial basis and on one that shows a profit; consequently it cannot be made subordinate to educational establishments. Moreover, this would not meet the requirements of so-called civil engineering. We quite admit that engineering education is not all that it might be. At the same time to suggest that education is a bad thing for an engineer is quite absurd. How would an engineer build a Forth Bridge, however heaven-born he might be, unless he were able to calculate the stresses involved in the construction he proposes to use? The engineering art is sufficient up to a point, but the more any specific branch develops the more necessary does it come to depend upon scientific data and scientific work if the best results are to be attained. It appears to us that the only way to obtain really satisfactory engineering education is for manufacturers and educationalists to combine in order to make the best compromise (for a compromise it must be), and this is largely what is taking place at the present time.

* G. Bell and Sons, 2s. net.

Reviews.

Continuous-Current Motors and Control Apparatus. By W. PERREN MAYCOCK. (London: Whittaker & Co.) Pp. xvi.+331. 6s. net.

This book is elementary in character, but appears to be well adapted to the needs of those who have continuous-current motors installed on their premises, or of electricians with continuous-current installations in their care. It will also be of some use to the student for its description of modern apparatus.

A large portion of the book deals with all kinds of starters, speed-regulators and controllers, including contactor gear, and with different methods of control. The descriptions are very full and clear, and contain many diagrams and photographs. The explanation of the action of the continuous-current motor is rather short, but contains sufficient information for the class of reader mentioned above. One chapter

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deals with torque and the uses and characteristics of shunt, compound and series motors, and another with efficiency and testing. In the last chapter extracts are given from the I.E.E. rules and other regulations regarding the installation of motors, and one section is devoted to troubles and their remedies. A series of questions appear after each chapter, which should be very useful in getting a clear understanding of the subject, although in some cases these questions require more knowledge than could be obtained from the text. In one appendix, methods of determining the resistance steps for starters are given, and, since logarithms are used in the calculations, a further appendix is added to describe how to use them.

A somewhat misleading statement is made on page 5. The author states that a given machine when totally enclosed must be worked with less current than when open. We can quite imagine that an electrician, on the strength of this statement, might fit covers on a motor, run it on the same voltage at a lower output, and then be surprised that it heated up. However, such statements are by no means general. The author has introduced his own "hand-rule" for determining the direction of flow of a current, but it is really an adaptation of Fleming's well-known rule, and has lost somewhat in the adapting.

On page 125, a maker's diagram of a multiple-switch starter is reproduced, and the author points out two mistakes in it. Surely when a firm has been good enough to supply the diagram, it would have been more courteous either to point out the errors to the firm and ask them to correct the diagram, or else to omit the maker's name. However, it is not of great importance in this particular case, because one of the so-called errors is not an error, and the other is probably due to a mistake in preparing the block. R. G. J.

Industrial Engineering: Present Position and Post-war Outlook. By F. W. LANCHESTER, M.Inst.C.E. (London: Constable & Co., Ltd.) Pp. 61. 1s. net.

Readers will recall the stimulating Presidential Address delivered by Mr. Lanchester before the Junior Institution of Engineers in December, 1916, which was dealt with in these columns at the time. This is now published in volume form. Mr. Lanchester has combined with an analysis of technical engineering problems some consideration of the economic aspects, and his remarks on the relations between Capital and Labour provide food for thought. While sympathising with the natural desire of the craftsman or engineer to better his position, he is opposed to any "conspiracy of persons to hold up industry for their own personal gain and benefit." Co-partnership and profit-sharing are discussed, the author remarking that the whole psychology of the working man is against allowing him to shoulder any of the gamble of industry. An increase in remuneration therefore should take the form of an increase in pay on the piece-work or bonus system, rather than profit-sharing. In particular Mr. Lanchester emphasises the need for closer relations between engineering and industry, and the wide field open to the "industrial engineer."

Correspondence.

ELEMENTARY PRINCIPLES OF C.C. ARMATURE WINDING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I appreciate Mr. MacCall's comments in your issue of May 3.

The suggestion that the meaning of terms used in describing armature windings should be standardised is good. Possibly the International Electro-Technical Commission might do something in the matter. But if new terms are to be coined and standardised I hope they will be carefully chosen. It is to be hoped, for instance, that they may be words whose formation may follow the conventions of good etymology (if indeed there are any such conventions!) and not be freaks like "oscillograph" or "deceleration."

I did not know that I had claimed "for multiple windings that they simplify the design of brush gear," but such is, I think, quite a reasonable claim. We have, for instance, in the laboratories of the Northampton Institute a 600 ampere 100 volt 4 pole C.C. generator, which has a singly re-entrant duplex wave winding, and requires, therefore, only two sets of brushes. None but a multiplex winding would have made possible such a simple design of brush gear.—I am, &c.,

London, May 4. F. M. DENTON.

COMMERCIAL DEVELOPMENT OF ENGINEERING IN CHINA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The two articles by Mr. S. W. B. McGregor, recently appearing in your columns, have naturally been read with keen interest in China. His account of conditions in this country are, in the main, correct, and such errors as do creep in are scarcely surprising in view of his short stay here. Our present object in writing is to call attention to a serious misstatement in the latter part of his second article. He states (his own italics): "To-day there exists only *one British merchant firm in the whole of China* that has the necessary ramifications throughout the country and still maintains an engineering department." Later he says that this one firm is "the official purchasing agent for certain Government railways." This statement should be qualified. For example, although we are not official purchasers for any railway, we, as another British merchant firm, most emphatically do possess the necessary ramifications throughout China, and we do maintain an active, even an aggressive, engineering department. We already hold some British engineering agencies of the first importance, and we believe that we have been able to satisfy our principals. Our organisation is capable of handling a few more branches that would not compete with our present agencies. The difficulty at present is, however, to persuade British manufacturers that now is the time to build up an organisation for "after-the-war" trade, and to convince them of the folly of being as unprepared for peace as the nation was, alas, unprepared for war.—We are, &c.,

Per pro. ARNHOLD BROS. & Co., LTD.
J. S. S. COOPER.

Legal Intelligence.

Mr. Ferranti's Spinning Invention.

Mr. Justice Sargant has granted the petition of Mr. S. Z. de Ferranti for the extension of his spinning patent for seven years from Aug. 20, 1917, the new patent to be subject to the existing arrangement with Messrs. Coats, and the company has also agreed that the position of the inventor should be improved.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.
Headquarters: Balderton-street, Grosvenor-square, W.1.
Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.
Orders for the Week.

Captain of the Week.—Captain W. Hynam.
Next for Duty.—Captain W. D. Bentley.
Monday, May 13.—No. 3 Company, 6.30–8.30. Recruits' Drill, 6.30–8.30. Signalling Section, 6.30–8.30.
Tuesday, May 14.—Lecture on Demolitions, 6.30. Physical Drill and Bayonet Fighting, 7.30.
Wednesday, May 15.—No. 1 Company, Entrenchments, Revetments, &c., 6.30–8.30. Recruits' Drill, 6.30.
Thursday, May 16.—No. 2 Company, Entrenchments, Revetments, &c., 6.0–8.0. Recruits' Drill, 6.30. Signalling Section, 6.30–8.30. Ambulance Section, 6.30–8.30. Band Practice, 7.0.
Friday, May 17.—Musketry for the whole Corps, 2.45–4.45.
Saturday, May 18.—Knotting, Lashing, &c., for the whole Corps, 2.45–4.45. Musketry, 2.45–4.45.
Sunday, May 19, and Monday, May 20.—Commandant's Parades at Waterloo Station, 8.45 a.m., for work at Esher. Dress: Marching Order, with Rifles. Midday and tea rations to be carried.

SPECIAL NOTICES.—All drills will take place at headquarters unless otherwise stated.

The M.O. will attend for the examination of recruits on Thursday evening at 6.0.

Summer Camp.—Arrangements are now being made for this Camp to start August 3rd.

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Commercial Topics.

Glass Control.

The Minister of Munitions has issued an Order extending the provisions relating to electric lamp glass in the Glass Control (Consolidated) Order, 1917, to vitrite and other glass used or intended for use in electric lamp caps for insulating purposes.

The Order of 1917 prohibited the manufacture or delivery of electric lamp glass except for Government contracts or under the approval of the Controller of Glassware Supply. Applications in reference to the new Order should be made to the Controller of Glassware Supply, Ministry of Munitions, 22-23, Hertford-street, London, W.1.

* * * *

Power-driven Tools.

Power-driven machine tools or woodworking machines and treadle lathes for woodworking or metal (3 in. centres and over) come under Regulation 30A of the Defence of the Realm Regulations.

Intending purchasers must make application for permission to purchase the machines they require to the Executive Officer of the Area Clearing House Board in their district. Firms (including auctioneers) must obtain permission to sell machines from the Controller of Machine Tools, Charing Cross Buildings, Embankment, London, W.C. 2.

* * * *

Electric Power Development.

In the course of his reply to the recent discussion upon Mr. Churchill's statement in the House of Commons regarding the work of the Ministry of Munitions, Sir W. Evans pointed out that without power there would be no production. They had had, therefore, to revise the gas and electric power of the country; and, indeed, it was a curious fact that electric power supply had been doubled, or nearly doubled, since the beginning of the war. That had not been done without financing; they had had to lend money to a private company here and a manufacturing company there, or, in a case where the power was municipalised, to the Corporation, for, it might be, new power plant.

* * * *

Development of Essential Industries.

In a further interim report of Lord Balfour of Burleigh's Committee on Commercial and Industrial Policy, certain essential industries are dealt with.

The staple industries such as coal, mining, iron and steel, engineering, shipbuilding, &c., are not touched upon, but there are, however, certain special commodities which are essential to national safety as being absolutely indispensable to important British industries and were supplied before the war entirely or mainly from present enemy sources or from sources under present enemy control. These include synthetic dyes, spelter, tungsten, magnetos, optical and chemical glass, &c. The Committee states that it seems to be certain that in the future industries of the nature dealt with in the report will always require special and separate consideration, and that no general measure will be sufficient to meet their varying requirements. Therefore, the Committee recommends the establishment of a permanent Board—which might be called the Special Industries Board—charged with the duty of watching the course of industrial development, and of framing from time to time, when necessary, either on its own initiative or on the application of interested departments or persons, detailed schemes for the promotion and assistance of industries concerned with the production of commodities of the special character indicated. This organisation should take the form of a Board of commercial and industrial experts, associated with whatever Department of State is entrusted with the care of the commercial and manufacturing interests of the country and represented in Parliament by the political head of that Department. It should be a statutory condition that, except upon its recommendation, no State assistance by way of grant or subsidy should be given to any industry, and where financial assistance is given it should be a condition that the firms or companies in receipt of grants should be entirely British.

In a memorandum to the report Mr. Arthur F. Pease states: "If the suggestion that the State should, in normal times, give money grants towards the establishment or carrying on of 'essential' industries, or otherwise place certain trades or firms in a specially privileged position, were given effect to, it would form a dangerous precedent, and there is a fear that as time goes on more and more trades will endeavour to establish a claim to grants as 'essential' or 'key' industries.

Electricity Supply.

Extensions.

Belfast.—It was reported to the Council last week that the difficulties in regard to the acquisition of the site for the new generating station had been overcome.

Sanction is to be sought for expenditure of £311,000 on the new station. A contract has been provisionally arranged with Messrs. Workman, Clark & Co., to supply 1,500 kw. at their north yard, and 500 kw. at their south yard, and an arrangement has also been entered into with Messrs. Harland & Wolff for the Corporation to supply them with 1,500 kw three-phase current as soon as the new turbine is available, and 1,000 kw. of direct current as soon as it can be safely supplied. Messrs. Harland & Wolff would want a further supply in 1919 when their total demand on the Corporation would rise to 4,250 kw. The revenue from the supply of current to the shipbuilding yards would amount to about £70,000 a year up to the end of the first year of peace, and negotiations are going on in regard to the conditions of supply for a subsequent period of 10 years, so as to safeguard the interests of the city. The estimates show that after the scheme has been completed there would be a substantially higher surplus available than at present. By the new plant the coal consumed per unit generated would be under 3 lb. instead of 4½ lb. at present, or a saving of some 20,000 tons of coal each year. Application has been made to the L.G. Board for sanction to a loan and to the Ministry of Munitions for licenses.

Councillor Stirling said he foresaw very large developments ahead for their electric undertaking, and these would be dealt with on a gradually increasing scale. They would put in one 6,000 kw. generator, then another after that of 12,000 kw., and then if development went on, as they believed it would, a 25,000 kw. machine.

London County Council.—On Tuesday it was decided to sanction loans of £10,734 to St. Pancras Borough Council and of £3,838 to Woolwich Borough Council for electricity supply purposes.

General.

Electrical Power Engineers' Association.—This association has recently had a large influx of engineers engaged with electrical manufacturers throughout England, and last week the East London Manufacturing Section of the E.P.E.A. was inaugurated.

There was a good attendance of members of the technical staffs of electrical engineering firms in the district. Mr. G. F. Dewynter was elected chairman and Mr. E. Barnard honorary secretary, with a committee of four. This section will be represented on the Divisional Council by their honorary secretary. Similar sections in other areas are in prospect, and one will shortly be formed at Hayes. Membership is now open to all qualified engineers engaged on power plants or with electrical manufacturing and contracting firms.

Limavady.—The Urban Council has decided to close down the gas-works, owing to war-time conditions, and it is probable that public electric lighting will be introduced.

National Electricity Supply.—A conference of representatives of north-east coast municipalities owning electric supply plants was held at Newcastle recently.

The Lord Mayor (Sir Geo. Lunn) presided, and, in addition to Newcastle Corporation, the following municipalities were represented: Darlington, Stockton, West Hartlepool, Middlesbrough, South Shields, Tynemouth, Sunderland and Berwick.

The conference was held in private, but the Press were informed at the close that the conference had agreed that the generation of electrical energy for public utility purposes should be under public control. The following resolution was also agreed to: "That this conference, whilst recognising that the unification, production and distribution of electrical energy over areas sufficiently large and carefully defined is desirable, does not endorse the recommendations in the report of the Coal Conserving Sub-committee, and agrees to appoint a committee to consider that report and prepare a reasoned statement in relation thereto."

Scottish Provisional Orders.—Applications for Provisional Orders are being made by the Clyde Valley Electrical Power Co. (for additional powers) and by Edinburgh Corporation (Tramways, &c.).

Electric Traction.

Bradford.—The Tramways Committee recommend the Council to increase each fare stage on the tramways by ½d. on and after June 1, but children under 16 will not be affected.

Doncaster.—The Council has authorised the Tramways Committee to revise and increase the tramway fares.

Edinburgh.—The Council will shortly appoint a tramway manager at a salary of about £1,000 a year.

L.C.C. Tramways.—On Tuesday the Highways Committee presented a report to the L.C.C. recommending extensive alterations of the tramway service.

The alterations include the reduction of the average length of the 1d. stage from 2 to 1·8 miles. Stages will be divided into three sections—length of the 2d. stage to be six of such sections and of the 3d. stage nine sections, the maximum fare for a continuous journey to be 4d. The 1½d. and 2½d. fares, ordinary transfer and children's reduced fares are to be abolished. Workmen's single tickets to be 1d. for four consecutive sections, and 2d. for any distance on one car. Return workmen's tickets to be 2d. for a journey in each direction over four consecutive sections on one car. Return tickets to be issued at 3d. for any distance on one car, with transfers as now given for 2d. return. Passengers now paying 2d. on the Woolwich route to pay 3d., and those paying 4d. to pay 6d. Average distance for a workman's penny to be 2·4 miles or 4·8 miles for 2d. return. The alterations are made as the estimated revenue for the coming year will be insufficient to meet expenses, &c.—£205,290, a figure which includes £113,000 for increased war wages. It is calculated, in addition, that renewals will cost £125,000.

After discussion, the recommendations of the Highways Committee were adopted.

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Manchester.—The City Council has approved an agreement with Mr. J. M. M'Elroy, by which he will remain manager of the tramways for a further five years at £1,500 per annum.

It has been decided to abolish workmen's fares and halfpenny stages and the penny stage has been also reduced from 2½ miles to 2 miles.

Salford.—Last week the Council authorised an increase of the tramway fares.

The chairman of the Tramways Committee (Ald. Linsley) stated that during the last three years expenditure had increased by £115,000, owing to the war bonuses, increased wages, higher cost of materials, &c. The tracks were also badly in need of repair, and after the war a considerable sum would be needed to meet this expense. The last advance in fares brought in some £25,000, but that had all been swallowed up by the recent award of the Committee on Production to motormen and conductors. The workers were now asking for a still further advance.

Sunderland.—The Sunday tramcar service has been discontinued.

Tramway Fares.—At the recent meeting of the Board of Trade Tramway Advisory Committee at Bristol, it was decided to apply to the Government for power to raise the statutory limit of maximum fares by 100 per cent. throughout the south and south-west areas in view of the increased expenditure of wages and materials.

Miscellaneous.

Application for Extension of Patent.—Prof. J. A. Fleming, D.Sc., has given notice of intention to apply for an extension of the term of letters patent No. 24,850/1904.

Electrical Trades Benevolent Institution.—The annual general meeting was held on April 29, Mr. C. E. Hunter presiding.

The CHAIRMAN, in moving that the report and accounts be adopted, said the total contributions for 1917 were £781. 14s. 6d., compared with £608. 12s. in 1916. The total, although better than that of the previous year, was very small; but the fact that the annual festival had not been held was largely the cause. He suggested that, as long as festivals could not be held, chairmen of the annual general meetings should make appeals in the same way as if they had been chairmen of the festivals. The subscriptions were £251 (against £270. 3s. 6d.), the falling off being largely due to the war, as many members were on active service. The total dividends, together with income tax, which had been deducted (but which was recoverable), amounted to £382. 14s. 8d., against £327. 6s. 3d. The cost of working the Institution was £158. 18s. 4d., against £183. 15s. As the first object of the Institution was to build up a fund out of dividends on which pensions could be paid to members, the fact that £995. 10s. 10d. had been carried to credit of balance-sheet was very satisfactory. The secondary object was to give temporary relief to qualified destitute persons; but the present condition of the labour market was such that only in one case during the year had it been necessary to give assistance, and in that case the total amount was £10. The Institution now held £2,000 5 per cent. War Stock, and the total invested at cost price was £9,606. 3s. 1d. Mr. Campbell Swinton, chairman of the meeting in 1917, gave a donation of £100, in the hope that by setting that example the invested funds would reach £10,000 in 1917. The Committee regretted that that stepping-stone had not been reached. He (Mr. Hunter) was willing to follow that example, and would give 100 guineas to the Institution in the hope that his example might be followed by others, and thus bring the invested funds, not to £10,000, but to £20,000. The Committee are extremely desirous of increasing the numbers of persons collecting, and ask for every possible publicity to be given to this matter in order that the heads and members of the staffs of firms shall appoint collectors. Concerts organised by Mr. Hobbs, of Cardiff, and by Mr. Fifield, of Bristol, had good results.

In seconding the resolution, Mr. RAWLINGS agreed with the chairman's suggestion that an appeal should be sent out this year, and he hoped that Mr. Hunter would suggest something that would enable the Institution to reach the rank and file.

The report and accounts were then unanimously adopted. The following were re-elected members of the Committee of Management: H. H. Berry, H. Bevis, E. J. Clarke, Lord Vaux of Harrowden, R. J. Wallis-Jones, S. D. White. Messrs. F. W. Fifield, W. E. Hobbs and G. C. Law were elected members of the Committee. Messrs. Price, Waterhouse & Co. were re-elected auditors, and Messrs. Sugden & Hextall, honorary solicitors. Votes of thanks were passed to the B.E.A.M.A. (for granting the use of their council chamber for the meeting), and to the chairman for presiding. Mr. Eck, who proposed the vote of thanks to the chairman, referred to the good work of the secretary (Mr. F. B. O. Howes), and stated that he anticipated the formation of local committees would be a source of great strength to the Institution.

"Printers' Pie, 1918."—We are glad to hear that that ever-welcome annual, "Printers' Pie," will be published on the 13th inst.

Judging by the list of eminent authors and artists who have contributed to its pages, it will undoubtedly come as a cheery gleam to those on active service, in hospitals and camps, or at home. "Printers' Pie" is published at 6, Great New-street, London, E.C., and is obtainable at all booksellers' and bookstalls, 1s. 6d. net.

"Trade Parliaments and Their Work."—Mr. Benn's articles on "Trade Parliaments and Their Work" will shortly be published in volume form by Messrs. Nisbet & Co. (Ltd.), price 2s. net, and may be ordered of any bookseller or newsagent.

Tenders Invited.

Water-Tube Boilers, Superheaters, Stokers, &c.

SUNDERLAND Corporation invite tenders for the supply and erection of two water-tube boilers with integral superheaters, mechanical stokers, vertical cast-iron tube economisers, steel plate chimneys, &c. Specification and form of tender from the general manager, Mr. Alfred S. Blackman, Electricity Offices, Dunning-street, Sunderland, and tenders to the town clerk, Mr. H. Craven, Town Hall, Sunderland, by first post May 29. *See advertisement.*

Turbo-Alternator, Condensing Plant, Switchgear, Boiler, &c.

REDDITCH Urban District Council invite tenders for a 2,000 kw. 3,000 k.v.a. three-phase turbo-alternator, with surface condensing plant, a cooling tower, additional h.t. switchgear, and a water-tube boiler and accessories. Copies of specifications, &c., from the consulting engineers, Messrs. Handcock, Dykes & Trotter, 11, Victoria-street, S.W.1. Tenders to clerk, Mr. J. W. Hobson, by noon May 13.

ISLINGTON (London) Lighting Committee require tenders by noon May 24 for (*a*) 5,000 kw. steam turbine, alternator, exciter, condensing plant, switchgear, &c.; and (*b*) water-tube boilers, coal conveyor, telpher, steam piping, &c. Specifications from the Electrical Engineer, Eden-grove, Holloway, N. 7.

Electric Torches.

Tenders are invited for the supply of electric hand torches, &c., to the N.Z. EXPEDITIONARY FORCE. Patterns and specification can be seen at the N.Z. Ordnance, 29, Bloomsbury-square, London, W.C. 1. Tenders by May 16 to the Chairman, N.Z. Contracts Board, 31, Bloomsbury-square, London, W.C. 1.

Appointments Vacant.

Greenock Corporation require a meter inspector and tester, installation inspector, junior draughtsman, fireman, switchboard and sub-station attendants for their electricity department. Applications to the chief engineer and manager, Mr. F. H. Whysall, Electricity Works, Dellingburn-street, Greenock. *See an advertisement.*

A staff assistant is required for electrical office work in a Government department at Portsmouth. Salary £250 per annum. *See advertisement.*

A professor of physical chemistry is required for the University of Cape Town, South Africa. Salary £800 per annum. Applications to the High Commissioner for the Union of South Africa, 32, Victoria-street, London, S.W.1.

An assistant district electrical engineer (£4 to £4. 10s. per week), a mechanist (£3 to £3. 10s.), and a foreman electrician (£3. 5s. to £3. 10s.) are required for the Engineer Services of the Northern Command. Applications to the District Electrical and Mechanical Engineer, Northern Command, 54, Swinburne-road, Darlington.

Business Items.

The address of the wholesale department and warehouse of Messrs. Drake & Gorham is now Felix House, 67, Long-acre, London, W.C.2. Telephones: Regent 3338 (2 lines); Telegrams: "Dragorlite, Rand, London."

Alfred S. E. Eckermann and Robt. L. Matthews (trading as the Linolite Co.), 25, Victoria-street, London, S.W.1, have dissolved partnership.

Mr. H. Cobden Turner, of the British Westinghouse Co., has been appointed manager of Salford Electrical Instruments (Ltd.).

Plant for Sale.—Oldham Corporation advertise for sale two Willans-Siemens 740 kw. sets. Particulars from Mr. F. L. Ogden, Joint Engineer and Manager, Electricity Works, Greenhill, Oldham.

Patent Development.—The proprietor's of Letters Patent No. 13,991/1910, relating to "Controlling Electrical Apparatus from a Distance," desires to dispose of the patent or grant licences with a view to the adequate working of the patent in this country. Inquiries to Messrs. Cruikshank & Fairweather (Ltd.), 65-66, Chancery-lane, London, W.C. 2.

Hints to Electric Light Consumers.—The British Thomson-Houston Co., Mazda House, 77, Upper Thames-street, E.C. 4, has prepared a folder entitled "Hints to Electric Light Consumers," which gives a short and lucid explanation of what consumers must do in order to comply with the recent Light Restrictions Order. Quantities over-printed with contractors' name and address can be supplied on application.

Induction Motors.—The British Thomson-Houston Co. have recently issued descriptive list No. 2,142B, which gives illustrated particulars of the two and three-phase induction motors manufactured by them. The list, which contains tables of ratings, dimensions and shipping specifications of various types of motors, supersedes the company's list No. 2,142A.

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Companies' Meetings and Reports.

Cuba Submarine Telegraph Co. (Ltd.)

The 88th ordinary general meeting was held on the 1st inst., Mr. CHAS. W. PARISH, the Chairman of the Company, presiding.

The SECRETARY (Mr. A. C. Austin) having read the notice convening the meeting, and the report of the auditors,

The CHAIRMAN said: Gentlemen, generally speaking, the volume of telegraphic business has increased, partly because it has not been permissible to use codes to the same extent as before the war, and also, I think, because of the delays and difficulties of sending letters by post to certain countries, thus forcing the public to cable business transactions. It is a great satisfaction to your Board that we are able to show such excellent results for 1917; we have earned £65,203 by our traffic, which is a record figure; last year it was £46,814, and that compared very favourably with the previous five years, but we must go back to 1896 for the previous record, which was £59,499. Every month shows an increase on the corresponding month of last year. We also derived some extra traffic from interruptions on competing lines. We have received £7,328 as interest on our investments, &c., and adding £7,637 brought forward, we arrive at a total of £80,168. The ordinary working expenses were £19,292, cable repairs £6,567 and income tax £2,701. A sum of £10,000 has been transferred to general reserve account, and £2,500 to pension fund, leaving £39,108 to be dealt with. We have already paid interim dividends at the rate of 10 per cent. per annum on the preference shares (less tax) and 5 per cent. per annum on the ordinary shares, free of tax, and we now propose to pay final dividends at the same rates, and a bonus of 2 per cent. on the ordinary shares, free of tax, thus making for the year 5 per cent. dividend and bonus of 2 per cent. for the ordinary shares. Working expenses are higher than last year, and we must be prepared for a further increase. A sum of £6,567 has been expended on cable repairs.

Up to almost the end of the year the cables continued in good working order, but in September we had to repair one of our Batabano-Cienfuegos cables, and in November our main cable between Cape Cruz and Santiago gave way, followed by interruptions to three of the shorter coast cables. Fortunately we were able to hire the West India company's vessel for the repair of the main cable, the coast cables being repaired by one of the local steamers. The Batabano-Cienfuegos 1891 cable, which broke down in the beginning of last month, was repaired on the 16th, the cost of which will appear in the current year's accounts. Happily none of these interruptions affected the traffic. Our general reserve fund has again reached £100,000, and it should be further increased, for we must remember that we will need some fresh cable as soon as we can procure any, the expense of which is now at least double what it was before the war. These excellent results for 1917 bring us under the Excess Profits Tax, as we have considerably exceeded the standard allowance, based on pre-war results. The valuation of £128,220 of our investments now represents their market value, and it has not been necessary to make any further adjustment. Our company has done well in the past, and I see no reason to expect that it will not keep up its reputation. I had hoped that our colleague, Mr. Nosworthy, would have been with us to-day. You will remember that when we last met he was in Cuba, looking after the affairs of our company, but he was kept there longer than was expected, and afterwards he was delayed at New York, and then again in Brazil, where he represented the Amazon Telegraph Co.; but I hope he is now on his way home, and may be here any day. He was well satisfied with our business in Cuba. I now move the adoption of the report and accounts.

Mr. ALEX. G. LOW seconded the motion, which wa scarried unanimously. The final dividends and bonus for the year as recommended were declared; Mr. Alex. G. Low was then re-elected a director, and Messrs. Gane, Jackson, Jeffreys & Freeman were re-appointed auditors.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The report of the directors for the year ended March 31, 1918, states that three quarterly interim dividends of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, have been paid, absorbing £157,500, and on Feb. 1 last the directors paid the final dividend for the year ended Dec. 31, 1917, amounting to £1 10s. per cent. on the ordinary stock, £1 10s. per cent. on the preferred stock, and £1 10s. per cent. on the deferred stock. These payments absorbed £262,500, being the rent paid by the Western Union Telegraph Co. for the year, equal to 3¾ per cent. on the ordinary stock. 6 per cent, on the preferred, and 1½ per cent. on the deferred stock. The balance (£71,428) includes £5,803 interest received, and £65,625 is available for payment of dividends for the quarter to March 31, 1918.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.)—Mr. J. Annan Bryce, M.P., presided over the annual meeting on Monday, and said that the available profit for the year was £194,403, compared with £311,199 in 1916, a falling off of £116,796, while the net profit was £88,124, against £199,346. That result was due in part to the conditions in Russia, which had made it necessary to provide a considerable sum in respect of outstandings in that country. Moreover, it had been thought prudent to provide considerable sums for development and research work. In no industry were changes more rapid and more numerous than in theirs, and every day developments requiring the expenditure of large funds in research and experiments were taking place. The labour position had become steadily worse, and there had been continual and increasing difficulties in obtaning raw materials even at the greatly enhanced prices which had been ruling. Owing to those adverse factors, completion of orders had been suspended and deliveries postponed, with the result that in many cases the estimates of cost had proved to be inadequate. Another cause adversely affecting profits had been the fact that a considerable part of their business had been Government work, in which margins were cut very fine. After the war there would be an immense field for expansion, for not only would a great part of the world require reconstruction, but the experience and necessities of the war had shown that in this country one of the main elements of economy in its resources would be the development of electric power from large central stations. For such work the Company was well laid out. Until shipping restrictions began to impede their business they were building up a good Continental and export business, and though it was suffering at present, it was to be hoped that it might recover and extend after the war. The operations of the works committee had produced a more harmonious feeling between the workers and the management, and in view of the increased spirit of trust and mutual respect the management looked forward with confidence to the assistance of the committee in the handling of the difficult problems likely to be presented by demobilisation. Much good research work had been accomplished during the year. The scope of the department had been considerably increased and the equipment and personnel strengthened. There was now under consideration a comprehensive scheme in connection with research and development.

Sir E. V. HELEY, K.B.E., who seconded the resolution for the adoption of the report, said that when the representatives of the Metropolitan Carriage, Wagon & Finance Co. and Messrs. Vickers took their seats on the Board the results of the year's trading to that date were found to be very unpromising, although there had been a welcome improvement in recent returns, and particularly those for January and February. In the past it had been the practice to rely largely on America for designs and improvements in apparatus, but in the national interest they could not afford to do so any longer. The Company was now British owned, and it must stand on its own feet. They intended to build up that business until it could take its place among the foremost industries of the world, for electrical enterprise had been too long in the hands of other nations. To cope with the keen competition they would undoubtedly have from the Germans after the war they must be thoroughly up-to-date, and to that end the directors had decided to develop a department for research and scientific study. Last year the shareholders were warned that there must soon be further expenditure on capital account. When the capital of the foreign companies was increased it was necessary that the Company should take up its proper proportion, as otherwise they would lose their voting control. The sums required would be large, and he was inclined to believe that they could only be obtained from one source—the ordinary shareholders. The capital was very badly balanced, and he had no hesitation in saying that it wanted redistributing. It was doubtful if a 15 per cent. dividend would ever be paid on the preference shares. The majority of the preference shareholders would agree to a curtailment of their privileges in the interests of the Company.

City Notes.

BRITISH COLUMBIA ELECTRIC RAILWAY CO.—The Parliament of British Columbia has granted powers to the City of Vancouver to eliminate the jitney (motor-car) competition in the City of Vancouver and between that city and New Westminster.

EDISON SWAN ELECTRIC CO. (LIMITED & REDUCED.)—A petition has presented to the High Court to confirm a resolution for reducing the capital from £888,071 to £698,307. A list of creditors (other than debenture holders) on April 20 last has been prepared, and creditors whose names do not appear in the list must send particulars by June 17 to the company's solicitors (Messrs. King, Adams, Cotton, Voysey & Macnien), 15, Dowgate-hill, E.C. 4.

SIEMENS BROS. & CO. (LTD.)—Various reports have appeared in the Press as to the future of Messrs. Siemens Bros., but we understand the actual position is that certain shares in the company which before the war were held in Germany were vested in the Public Trustee, and these only have been sold. As already announced, these shares were recently transferred to a British syndicate, headed by Messrs. C. Birch Crisp & Co., of London. Mr. C. B. Crisp is chairman of the British Bank for Foreign Trade. The syndicate undertook to alter the articles of association in conformity with the requirements of the Board of Trade, and that has been done. The directors are now Sir Wm. Bull, M.P., Mr. G. Chauvin, Sir Clifford J. Cory, M.P. (chairman of Cory Bros. & Co. and director of the Barry Railway Co.), Lord Queenborough (director of the British Bank for Foreign Trade), Mr. G. Mure Ritchie (chairman of Palmer's Shipbuilding Yard), and Mr. J. H. Thomas. Mr. W. Wheeler is secretary.

In regard to the statement that "care has been taken in the sale of the shares that no one should be allowed to purchase who could bring about amalgamation with any other electrical concern," this is, we believe, incorrect, the tendency being rather to build up big combinations than to make it impossible for small firms to come together. In the case of the Union Cable Co. there was a proviso that they should not enter into any electrical trust or combine, but recently those conditions have been dropped.

SUBMARINE CABLES' TRUST.—Notice is given that 49 certificates of this Trust were drawn on the 1st instant for payment, out of surplus income, on and after that day at Messrs. Glyn, Mills & Co., 67, Lombard-street, E.C. The numbers of the certificates are given in an advertisement.

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CONTENTS.

NOTES	3
Arrangements for the Week	35
Flickering of Electric Lamps. By K. Simons. Illustrated	36
An Electrolytic Metering Can. Illustrated	38
Some Notes on Loop Tests for Fault Localisation. By G. W. Stubbings. Illustrated	40
A British Electrical Proving House	41
U.S.A. Production and Distribution Costs	43
AN ELECTRICAL PROVING HOUSE	44
REVIEWS	44
CORRESPONDENCE	46
Trade Parliaments and Their Work. By E. J. P. Benn	46
Provincial Electric Supply Committee	47
The Static Machine of the Medical Supply Association. Illus.	47
PARLIAMENTARY INTELLIGENCE	47
LEGAL INTELLIGENCE	48
Volunteer Notices	48
Patent Record	48
Commercial Topics	49
Electricity Supply	49
Tenders Invited and Accepted	52
Companies' Meetings and Reports	53

Notes.

The Education Bill.

AN important point in education has been raised by an amendment to Clause 10 of the Education Bill now being considered in Committee. Clause 10, Sub-Clause 3, reads as follows :—

"The obligation to attend continuation schools under this Act should not apply to any young person :—

"(ii) Who is shown to the satisfaction of the Local Education Authority to be under suitable and efficient part-time instruction in some manner for a number of hours in the year (being hours during which, if not exempt, he might be required to attend a continuation school) equal to the number of hours during which a young person is required under this Act to attend a continuation school."

Into this Clause Mr. J. H. WHITEHOUSE has introcdued the following amendment in the form of an addition :—

"Provided always that no young person shall be required by his employers or by a Local Education Authority to attend any school or classes held at or in connection with the place of his employment as a discharge of the obligation imposed upon him under this Section."

If this amendment is carried it will have the effect of destroying all efforts by engineering and other firms to provide instruction for their apprentices. We cannot think that Mr. WHITEHOUSE is in touch with what is being done at the present time in this direction. There is no question that instruction in the factory is of an extremely useful character, because it is provided by the employer to meet the requirements of the apprentices, and the employer, of all people, knows just what is likely to prove useful to the apprentice. We do not say that all such courses are necessarily efficient, but the Bill already provides that these courses must be recognised as being efficient by the Local Education Authority before they can be accepted. We think it would be a great misfortune if schools of instruction, like that established by the British Westinghouse Co., were rendered impossible. It is also doubtful whether the Government dockyard schools would be permissible under the conditions sought by Mr. WHITEHOUSE. Considering that the Local Education Authority is to decide on the question of efficiency, which should certainly be a sufficient safeguard, we trust that a strong effort will be made to throw out what we can only regard as a very mischievous amendment.

A Tribute to Oliver Heaviside.

OUR readers will be glad to learn that the work of OLIVER HEAVISIDE has been recognised by the American Institute of Electrical Engineers, and that he has been elected an honorary member of that body. The corresponding honour was conferred by our Institution of Electrical Engineers in 1908, just 10 years ago. The case of HEAVISIDE is remarkable as an instance of slow recognition of the value of work of the first importance. As early as 1887 he demonstrated theoretically the advantage of inductances in telephone circuits, urging that practical experiments should be made in this direction, but the value of the suggestion was not appreciated by our own Post Office officials, nor was his work appreciated to any considerable extent by scientific men at that time. We need scarcely remind our readers that quite a considerable amount of HEAVISIDE'S work was published in the columns of THE ELECTRICIAN. In Volume I. of his "Electromagnetic Theory," published in 1893, he suggested the "insertion of inductance coils at intervals in the main circuit," and he pointed out that "this means using coils of low resistance and the largest possible time constants." A good many years have elapsed since then, but the Pupin cable has been the result, and we need scarcely say that this is now being largely used in the United States. We need not refer particularly to other work of OLIVER HEAVISIDE. It is well, however, to point out that here we have a remarkable case showing the great value of mathematical science of the highest kind when used as it should be used. Unfortunately, there are but few men capable of applying mathematics in this way, but it is well to bear in mind that when we are seeking for finger posts to further advances, mathematical science can probably show us the way with more certainty than any other branch. It is well, then, that the work of OLIVER HEAVISIDE should be recognised, and at the present time, of all times, when the United States and Great Britain are working together in a common cause, the compliment will be appreciated by British engineers and men of science.

Interim Industrial Reconstruction Committees.

ALTHOUGH there are many industries sufficiently organised to appoint Joint Standing Industrial Councils, as recommended by the Whitley Report, there are, nevertheless, many industries which are not so well organised as to permit of a step of this kind. To meet these cases it is proposed by the Minister of Reconstruction that Interim Industrial Reconstruction Committees should be formed consisting of an equal number of representatives of employers' organisations and trade unions. Where there is lack of organisation it is only natural that the programme laid down for such committees should be somewhat indefinite. The functions of the committee must depend somewhat on the special circumstances. It may be difficult to say off-hand what questions should be handled by such bodies or what problems should be delegated to existing organisations. But we can at least say that there

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is a great deal of work for such committees to take in hand, including many specific inquiries by Government Departments. For example, there is the promotion of industrial organisations and questions of employment and the supply of raw materials. Provision in these directions must be made for the transition period. There must be co-operation in restoring, and increasing, the productive capacity of the country and in assisting the progressive development of each industry concerned. Further, there are such important questions as the arrangements for demobilisation, war pledges affecting industry, schemes to meet possible unemployment, and the training and employment of disabled men. In order to assist the formation of such committees, the Ministry of Reconstruction has drawn up a draft constitution which should prove useful, at least as a basis of discussion. Although an Interim Industrial Reconstruction Committee cannot be thoroughly representative of its particular industry, it should certainly prove a useful stepping stone to the Joint Industrial Council by which it would in due course be superseded.

Modern Languages in our Education.

THE war has shown the vital importance to this country of a knowledge, not only of the languages of other nations, but of their customs, methods of business and habits of thought. To the scientific and technical worker, especially, some knowledge of foreign languages is very necessary. We are, therefore, glad to note that the Report just issued by the Committee on the Position of Modern Languages in the Educational System of Great Britain, strongly emphasises the importance of this subject. From the historical data presented we gather that the study of modern languages at our schools and colleges is of quite recent growth. At Cambridge, for example, a test of pronunciation and spoken language was not introduced until 1894, and even then was optional. In schools, even on the recently organised modern sides, insufficient encouragement was given to the study of languages, and especially foreign history, and the conditions are not such as to attract capable teachers. Business firms generally attached too little value to foreign languages and were often content to rely upon foreign clerks for such work, though it is at least satisfactory to observe that 93 firms encourage their employees to study modern languages by payment of fees, &c. Stress is also laid on the importance of modern languages to many Government Departments, especially the Foreign Office, the Board of Education, and the Board of Trade. In the Army and Navy facilities for instruction have been insufficient. Lord CROMER points out the special value of a knowledge of foreign languages to officers in the Navy, who visit ports in all parts of the world, and are often involved in diplomatic negotiations. The recommendations in the Report cover very wide ground, and although there are dissentients on minor points, the Committee are unanimous on the main lines of procedure. Their suggestions for fostering the study of foreign languages in schools and universities and in specially created institutions for the purpose, and their endorsement of the vital importance of the subject to science and industry, and to Government officials, will, we hope, receive serious consideration.

Commercial and Industrial Policy.—We have received from Mr. J. S. Hecht a number of interesting communications in regard to the recent report of Lord Balfour of Burleigh's Committee. These communications deal with the principles of free trade, wages, prices and kindred subjects. With many of Mr. Hecht's views we agree, though not with all. Unfortunately, owing to the severe restrictions on our space in these days, we feel that we must limit our comments to technical matters rather than to topics of a very controversial character.

Committees on Signalling Apparatus in the United States.—We observe that the Associated Manufacturers of Electrical Supplies in the United States have formed a Signalling Apparatus Section. Committees of the section have also been formed to deal in detail with various accessories coming under the head of signalling, including bells and buzzers, contact devices, fire alarm apparatus, signal gongs, telephone apparatus, and telegraph instruments. The work of these committees will doubtless be directed towards determining the most efficient forms of apparatus with a view to standardisation.

Demand for Small Motors in India.—According to the "Indian Textile Journal" there is a very promising field for electric motors for miscellaneous industrial purposes, including small cotton and grist mills, printing presses, elevators, and brass and wood-working machinery in India. Local producers of electrical energy would be interested and glad to co-operate with such a project, if promoted on the ground. Motors of medium grade and cost would probably be best suited to the market. The war has changed conditions materially and previous British sources of supply have been largely cut off, but in the future this market will deserve cultivation and should not be lost sight of even now.

The Heavy Steel Industry in India.—Among the Papers read at the recent annual meeting of the Iron and Steel Institute was one by Mr. Andrew McWilliam, Metallurgical Inspector to the Indian Munitions Board, on the heavy steel industry in India. Some historical notes on the industry, which appears to have been started by Mr. J. M. Heath on the Madras Coast in 1830, are given. Since the outbreak of war, considerable progress in making shell steel has been made, while the manufacture of rails, fish-plates and structural steels is now firmly established. It is interesting to note that three of the laboratory workers are Indians, and have proved to be skilful and reliable. One of these, Mr. Aloke Nath Bose, was formerly at the University of Birmingham.

Agricultural Machinery.—A useful Paper on the above subject was read by Mr. F. S. Courtney before the Royal Society of Arts on April 17. A variety of machinery, including ploughs, harrows, seed drills, potato planters, reapers, hay-making and threshing machinery, &c., was described, most of the appliances, however, being mechanically driven, although several examples of operations for which electrical driving is specially suitable were mentioned. Among the latter are grist mills and pumps for irrigation. The chief difficulties attending the wider use of electricity are, no doubt, lack of facilities for electrical distribution and high first cost. In this country most of the farms are small and the average farmer is not a capitalist and cannot afford expensive apparatus. It is probable, however, that in the future the trend towards fuller use of agricultural machinery will be stimulated by shortage of labour.

The Chinese Wood-Oil Industry.—The "Journal" of the Royal Society of Arts, quoting from a recent United States Consular Report, refers to an interesting industry developed in China, the distillation of oil from several varieties of spurge wood. The oil is collected from the fruit, which resembles hickory nuts in size but is more like Brazil nuts in appearance. The yield is about 40 per cent. of the weight of the kernels. The oil is widely used in China for outside work and is said to excel linseed oil for many purposes. It is largely used for painting and as a preservative, and, in conjunction with various minerals, for varnishes and waterproof coatings. The output has increased by 45 per cent. during the years 1912-1915, and the demand in foreign countries, particularly the United States, is steadily growing. The possibility of growing the tree in other countries is receiving attention, and investigations appear to show that it could be cultivated with success in some of the southern states of America.

Electric Motors for Sheep Shearing.—The "Electrical Review and Western Electrician" describes an interesting installation in Public Service Company's system, at Stockdale, Ill., U.S.A. It consists of six motors, of 53 H.P., at a feeding

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and sheep-shearing station situated on the Rock Island railroad. In addition to pumping water, elevating grain and grinding feed by motor power, a 5-H.P. motor is connected by a line shaft to 10 shearing stalls, and in each stall a shearing machine is operated by a flexible shaft, the latter being connected by gearing to the line shaft. The shearing capacity of this outfit is 1,300 head of sheep per day. Sheep are brought to this place from the western ranges. Here they are rested, fed and sheared before sending them to the mutton market. Sheep-shearing by electricity, it is stated, is not new at many of the big sheep ranches of the West, but the installation is interesting as showing the many different applications now being developed for electricity in pastoral and agricultural work.

Blast Furnace Practice.—Several communications made at the annual meeting of the Iron and Steel Institute related to practice with blast-furnaces. The report of the committee on this subject summarises the replies to a series of inquiries addressed to all owners of blast-furnaces in this country. Mr. T. C. Hutchinson describes some modifications in practice and design that led to considerable fuel-economies—in one case a reduction of coke-consumption by 2 cwts. per ton, and an increased make of 33·7 per cent. of iron. The saving in fuel was attributed entirely to the better distribution in the furnace by the increased size of the bell, and the life of the furnace-lining was also considerably improved. A Paper by Dr. E. E. Stead on "Blast Furnace Bears" makes interesting reading. "Bears," it should be explained, are the masses of metal which are found below the hearth level of a blast furance after the furnace has been blown out. The author analysed a number of bears and with some curious results. Quite a surprising variety of compounds and crystalline metallic formations were found to occur, among the substances noted being nitrocyanide of titanium, large idiomorphic crystals of double carbide of manganese and iron, and carbonless iron masses, rich in phosphorus. In many bears the lower central axes have a columnar structure closely resembling the basaltic formation of Staffa and the Giant's Causeway. "One authority," one learns, "claims that he had found diamonds in a German bear, but they have not, so far as is known, been discovered in English bears!"

Institution of Electrical Engineers.—At the meeting on Thursday, May 9, the President, before calling upon Mr. Turnbull to read his Paper, said it had been arranged to set up a committee of the Institution and other interested parties, including the B.E.A.M.A., to consider a detailed scheme for the formation of an association such as that outlined at the end of Mr. Gillott's Paper on "Electrical Cooking." Similar action had been taken by the Council in connection with Mr. Andrew's Paper on "Overseas Engineering Trade." It was proposed to call a conference of those interested, including the B.E.A.M.A., Cable Makers' Association, Association of Chambers of Commerce, Federation of British Industries and British Engineers' Association, with a view to ascertaining whether in their judgment any action could be usefully taken by the Institution towards promoting a body to formulate a scheme for furthering British trade. Arising out of Mr. McKinnon's Paper, the Council had also decided to give effect to the suggestion he (the President) had made that a committee should be appointed to draw up a model maintenance agreement for secondary batteries, and the Council were writing to the Engineering Standards Committee suggesting the desirability of their undertaking the standardisation of details in connection with secondary batteries.

The Council had also decided to take steps to set up an Electrical Appointments Board. It would have to be a body separate from the Institution in order to comply with the requirements of the law, although it would be worked by the Institution.

The President then gave an account of the Council's attitude on the subject of a British Electrical Proving House, which was dealt with in the Paper to be read by Mr. Turnbull that evening. This portion of the President's statement appears in another column as part of the discussion on the Paper.

Obituary.

J. G. BENNETT.—The death of Mr. James Gordon Bennett, proprietor of the "New York Herald," took place at Nice on Tuesday. In 1883 Mr. Bennett, in association with Mr. James W. Mackay, founded the Commercial Cable Co., at first known as the Mackay-Bennett cable.

CHARLES S. GARNETT.—We regret to record the death, which took place on Sunday, of Mr. Charles S. Garnett, manager of Darwen Corporation electricity works, from pneumonia. Mr. Garnett, who was 40 years of age, was appointed chief engineer of the electricity works in April, 1901, when he was only 23, on the resignation of Mr. Stanley Clegg, to whom he had been assistant.

CHAS. C. HOWARD.—The death is announced of Mr. Charles C. Howard, tramways manager to Bolton Corporation until 1906, when he retired.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service are reported:—

Capt. Geo. Leonard Andrews (R.G.A.), aged 43, who was killed in action on May 3, was born in Calcutta and was educated in Sheffield. He qualified as an electrical engineer, and held positions in connection with the tramway undertakings at Kidderminster, Hull, Sunderland, Madrid and Lisbon, and was manager of the undertakings of the Para Electric Railways & Lighting Co. and the Pernambuco Tramways & Power Co. He was a member of the Institution of Civil, Mechanical and Electrical Engineers, and was a B.Eng. of Sheffield and B.Sc. of London University. When war broke out he gave up his appointment in Pernambuco to join the Army.

Major Richard Raymond-Barker (R.A.F.), M.C., who was killed on active service on April 20, in his 24th year, was a son of Mr. Edward Raymond-Barker. He assisted in laying from the "Silvertown" the Sydney-Auckland telegraph cable, and was also engaged in other cable-laying work.

Sec.-Lieut. Hubert Pumphrey (Cheshire Regt.), who has been killed in action, was formerly a student at the Durham College of Science, and an articled pupil of Messrs. W. P. Thompson & Co., patent agents, and afterwards resident partner of the firm at Bradford.

Sergt. H. J. Browning (South African Rifles), who has died on active service in South Africa, was formerly a Post Office employee, and served as a military wireless telegraphist during the Boer war. He was employed as a telegraphist in South Africa, when he volunteered for service in the present war.

Acting-Sergt. Wm. Geipel (R.A.F.), nephew of Mr. Wm. Guy-Pell, died as the result of a flying accident on May 4. He was developing into a brilliant pilot and had been recommended for a commission. He was formerly a student at Armstrong College, Newcastle, and was apprenticed as an electrical engineer at Messrs. Richardsons' Westgarth's works.

Wireless Operator Ernest D. Morris, who has lost his life at sea through enemy action, obtained a first-class certificate in wireless telegraphy at 15½ years of age.

Pte. Wm. Scowcroft (L.N. Lancaster Regt. and Pte. Fred Fellows, of the same regiment, employees of the Bolton tramway and electric supply departments, respectively, have been killed in action

Pte. H. W. Allan (R.W.F.), formerly engaged with Messrs. Dick, Kerr & Co., has died in action.

Pte. W. Mareden, formerly a Darwen tramway employee, has also died in action.

Personal.

MILITARY HONOURS.—Mr. L. Byng (Grenadier Guards) a director of the General Electric Company, Ltd., has been awarded the Military Cross for distinguished service in the recent battles on the Western Front.

Pte. W. Smith (L. N. Lancs.), and Pte. Richard Marshall (R.F.A.) formerly tramwaymen of Bolton and Burnley respectively, have been awarded the Military Medal.

Pte. F. W. Langford Harris (K. O. R. Lancs. Regt.), formerly employed on the St. Annes and Lytham tramways, and who was wounded on April 9, has been specially mentioned in despatches by Sir Douglas Haig

Pte. Geo. Macdonald, a former Burnley tramwayman, and of the "Royal Edward," which was sunk in August, 1915, has been awarded the Military Medal.

Arrangements for the Week.

THURSDAY, May 23rd.

INSTITUTION OF ELECTRICAL ENGINEERS.

5.30 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "Some Transient Phenomena in Electrical Supply Systems," by Prof. E. W. Marchant.

FRIDAY, May 24th.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "The Heating of Industrial Buildings," by Mr. M. H. Jones.

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Flickering of Electric Lamps.*

By K. SIMONS.

Flickering of electric lamps is often present both on direct-current and alternating-current systems. It may be caused by irregularities in the running of engines, peculiarities in the generators or reaction of loads on the network. Great trouble was experienced by the author at La Plata on a single-phase 42 cycle system with generators driven by Diesel engines. This caused him to conduct tests to determine what conditions favour flickering with a periodically varying source of light, the lowest frequency permissible with modern metal-filament lamps, the greatest voltage variation permissible on direct-current systems or on alternating-current systems of a frequency too high to produce flickering, the best method of measuring the frequency of flickering, and to examine the mechanical reasons that give rise to variations of engine speed and thus cause flickering.

Experimental results are already available on some of these points. It is known that the frequency at which flickering begins grows nearly proportionally to the logarithm of the intensity of illumination on the surface under view; this law does not hold at very low or very high intensities of illumination. The magnitude of the total flux of light and the angle at which the illuminated surface is viewed also have an influence on the appearance of flickering. The sensitiveness of the eye to flickering depends on the ratio of the amplitude of the flickering to the average illumination, and so in making tests the superposition of illumination from sources other than the one under test must be avoided.

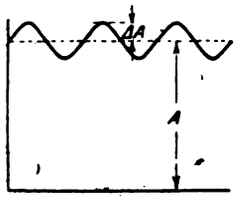

FIG. 1.

If a variable illumination with amplitude ΔA is superposed on a steady illumination A (*see* Fig. 1), the ratio ΔA/A determines the strength of the flickering that is produced.

The arrangement adopted in the present tests consisted in examining a ground glass screen of diameter 20 cm. illuminated from the back, the observer being at a distance of 75 cm. Flickering could be produced by cutting off the light from a Nernst or arc lamp by an interposed rotating sector. The distance between the lamp and the sector was found to have an influence on the flickering, and after some unsuccessful attempts to remove this variable factor it was decided to place the sector as near as possible to the lamp at a fixed distance of 5 to 6 cm.

The ground glass screen and observing tube were mounted on a photometer bench of 3 m. length, so that candle-power measurements could be made. The surface illumination could also be calculated from the candle-power of the lamp, its distance from the screen and the dispersion coefficient of the ground glass by using Lamber's formula. This gives for the radiation per sq. cm.

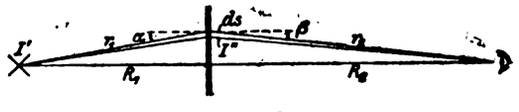

FIG. 2.

$$I''=\frac{cI'\cos\alpha\cos\beta}{r_1^2}$$

where I' is the candle-power in the direction r_1 (Fig. 2) and c is a constant. If α and β are small we have $I''=cI'/R_1^2$.

Ground glass obeys this law up to an angle of 20 deg., but only on the assumption that all the light is absorbed and radiated again by its particles. If the glass is so thin that the light that issues is composed partly of diffused light and partly of weakened transmitted light, then the illumination at the retina is

$$E_{\text{Retina}}=\Sigma\frac{cI'\cos\alpha\cos\beta}{r_1^2r_2^2}+\frac{c'I'}{(R_1+R_2)^2}.$$

In this case the illumination of the screen is no longer uniform. The uniformity was tested by photometric tests on selected portions of the screen, and different varieties of glass were tested viewed directly and at an angle of 11 deg. It was found to be important to keep the eye at rest. When viewing indirectly a slow frequency was superposed on the rapid flicker. This was traced to the fact that the sector was not mounted quite concentrically. The slow frequency flicker was also removed by replacing the belt drive by a direct drive and mounting a small fly-wheel on the motor shaft. This shaft ran at 1,600 revs. per min. and the sector had four openings. It would have been preferable to use a motor running at a speed of 4,800 revs per min. with a sector of 180 deg.

The observed results are shown in Fig. 3, in which the critical frequency n, at which flickering is just perceptible, is plotted as

The flickering produced in glow lamps by alternating currents depends on the wave-shape of the E.M.F., being imperceptible with quite flat rectangular wave-form and becoming more noticeable as the wave becomes more peaky. Tests were made with an alternator giving a voltage following an approximate sine wave. It was incidentally observed that variations of the light were sometimes present on account of mechanical vibrations of the lamp filaments produced either by the vibrations set up by the motor or by forces a function of the illumination in HK per cm². The horizontal scale is broken into four parts and the continuous and dotted curves correspond to direct and indirect observation respectively. Fig. 4 is the logarithmic curve from which it will be seen that the frequency at which the flickering vanishes is over wide limits proportional to the log of the intensity of illumination. The greatest sensitiveness

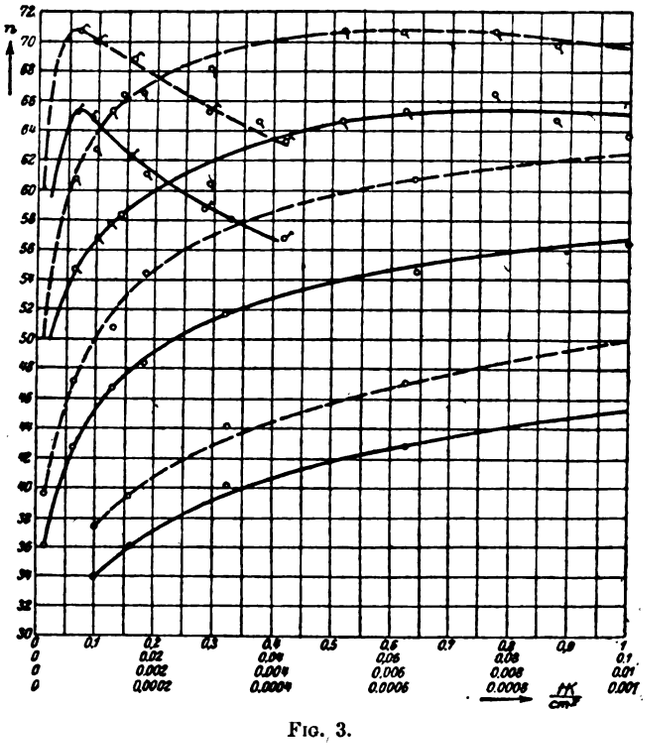

FIG. 3.

under the conditions of the measurement was obtained at an intensity of illumination between 0·05 and 0·1 HK/cm².

residing in the filaments themselves. Lamps showing this defect were avoided. The test results are given in the table:—

Type of Lamp.	Volts.	HK. Hefner candle-power	Critical Frequency. Direct Observation.	Critical Frequency. Indirect Observation.
Carbon filament....	220	32	24·5	27·0
Tantalum	220	32	29·5	32·0
Wotan	110	32	28·5	31·0
Wotan	220	32	29·5	32·5
Half-watt	225	1,000	27·3	29·5

As expected, the thick filament of a 110 volt metal-filament lamp does not cool to the same extent during the passage of the current through its zero value as the thinner filament of a 220 volt lamp, and both of these cool much more than the carbon filament. The 1,000 c.p. half-watt lamp lies between the carbon-filament and low candle-power metal-filament lamp.

The tests described show that the troublesome flickering that led to these experiments did not arise from the frequency of the supply (42 cycles a second), but must have been caused by voltage variations of the generators. The effect of such variations was, therefore, investigated. A preliminary calculation shows that mechanical oscillations of the generator about a mean position give rise to fluctuations of the fundamental frequency with two superposed frequencies, the first producing variations in amplitude and the second mainly variations in phase. Measures were taken to re-

* Abstract of an article in the "Elektrotechnische Zeitschrift," Nos. 37, 38 and 39, 1917.

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produce such variations and to measure them. In one method an alternating current was superposed on a direct current, and in another a resistance that could be periodically varied by mechanical means was inserted in the lamp circuit. The first method was discarded, as the alternator, connected in series with the battery giving the steady supply, produced flickering on account of its remanent magnetisation. The second method was, therefore, adopted. The variable slider-resistance was actuated from a small motor through a connecting rod and eccentric. The measurements were carried out by two observers, one of whom varied the frequency of the fluctuations produced by the motor-driven variable resistance, and the other noted the moments when the fluctuations of the light just began or left off. Using a metal-filament lamp of 32 c.p. at 220 volts, it was found that the critical frequency was the same when the fluctuations were superposed on a continuous current or on an alternating current, and that the variation of voltage necessary to produce flickering was greatly dependent on the frequency. Fig. 5 shows that the lamp was most sensitive to changes of voltage as regards the production of flickering when the superposed fluctuations had a frequency of about 6 cycles a second. Fluctuations above 60 cycles a second were not perceptible to the eye.

As a result of these investigations it may be concluded that if it is desired to avoid flickering on a network supplied by a single machine, it is not sufficient to demand that the engine should have a certain cyclic irregularity, but it is more important to have regard to the number of impulses that it gives. For instance, if a high-speed compound engine runs at 200 revs. per min. with a frequency of

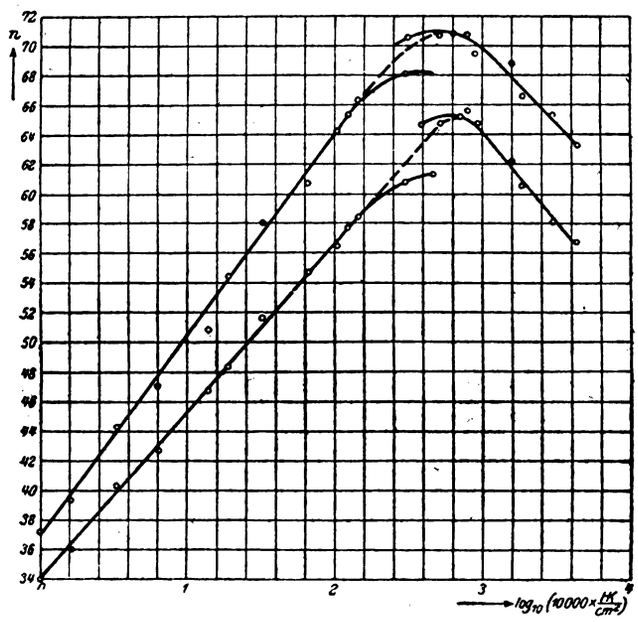

FIG. 4.

$200\times4/60=13{\cdot}3$ cycles per second, the greatest voltage variation would be about 2 volts according to the curve (Fig. 5), and, if the mean voltage were 220 volts, the limiting cyclic irregularity would be $\delta=2/220=1/110$. If, on the other hand, the drive is obtained from a three-cylinder Diesel motor running at 250 revs. per min., the impulse frequency would be $(250\times3)/(2\times60)=6{\cdot}17$ cycles a second. For this frequency flickering would be already perceptible at 1·1 volts and the limiting cyclic irregularity would be $1{\cdot}1/220=1/200$. If the type of excitation and the armature reaction increases the fluctuations in the voltage, then the cyclic irregularity of the engine would have to be still smaller.

Another feature that sets a limit to the permissible fluctuations of voltage is the flexibility of the shaft. In the case of large Diesel motors that have on their shaft the pole system of the generator besides a flywheel, two mechanical oscillations are always set up. In such units the condition must be avoided that the slower oscillation lies in the region of 10 cycles a second, as in this case the fluctuation of voltage might easily cause flickering even with the machine lightly loaded. If the oscillation in question lies above 20 cycles a second flickering will certainly be absent. Oscillations of the governor are usually too slow to cause flickering.

Further measurements were made to develop a method for determining the frequency of flickering of a source of light. Preliminary attempts at a comparison of two flickering sources, one of known frequency, in an ordinary photometer, showed that the two illuminated fields that are to be compared must have the same mean intensity of illumination and that the amplitudes of the two variations must be the same. Even with these conditions fulfilled, the accuracy of the measurement was not within ±15 per cent.

The apparatus in its final form is shown in Fig. 6. A is a small metal-filament lamp for 3·5 volt, 0·2 amp., such as is used in pocket flash lamps. This lamp illuminates one-half of a ground glass screen, and is connected in series with a carbon-filament lamp K in the circuit producing the flickering the frequency of which is to be measured.

The negative temperature coefficient of the lamp K, which was chosen so as to have about 98 per cent. of the total resistance of the circuit, causes the flickering effect to be greatly enhanced in the lamp A.

The other half of the ground glass screen was illuminated by the two lamps B that could be switched off singly. These lamps were identical and the lamps were all mounted so that their distances from the screen were easily adjustable. In front of the lamp B_2 was placed a rotating sector S driven by the motor M and also a

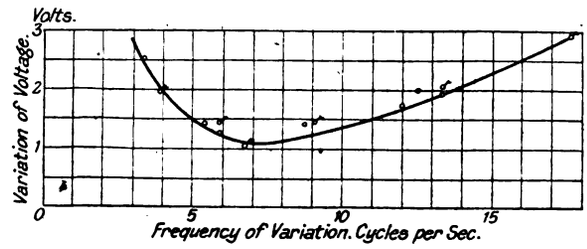

FIG. 5.

disc D with a number of diaphragms by which the intensity of the illumination from the lamp B_2 could be varied. By comparison of the lamp B_2 and A it was possible to determine the frequency of flickering of the lamp A with an accuracy of ±2 per cent.

If the flickering to be measured consists of two fluctuations superposed, the measurement becomes difficult. Three cases should be distinguished: (1) The amplitudes of the two fluctuations are very different; (2) they are nearly equal; and (3) they differ by a small amount.

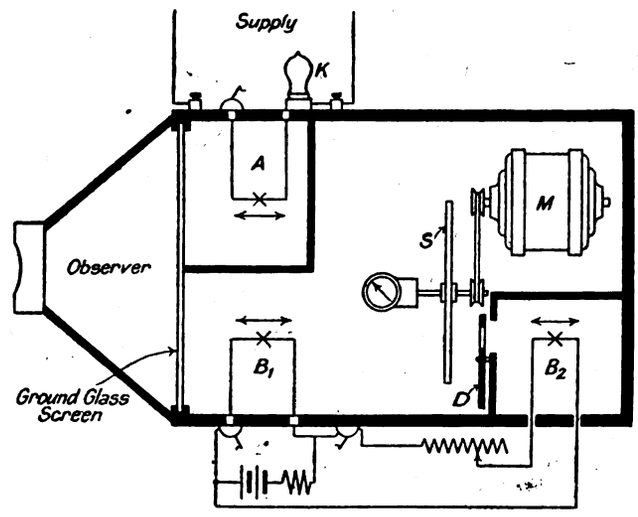

FIG. 6.

If the fluctuations follow the sine law they may be represented by the expression $A\sin mt+B\sin nt$. For the second case $A=B$ and we get for the fluctuation the expression

$$2A\sin\frac{m+n}{2}t\,.\,\cos\frac{m-n}{2}t.$$

Thus if m and n are not too small it is probable that the eye will only perceive the fluctuation of frequency $(m-n)/2$. In the third case the fluctuation is given by $(A-B)\sin mt+2B\sin\frac{m+n}{2}t\,.\,\cos\frac{m-n}{2}t$, so that there are three superposed fluctuations and it is doubtful which one will be apparent to the eye. Thus the predominant fluctuation will be most easily measured under the conditions of the first case.

The third instalment of the article refers to the mechanical oscillations of the shafts of Diesel motors. These are reproduced by an experimental arrangement in which two rigid shafts are coupled together with two flywheels mounted on the combination, the frequencies of the oscillations produced being adjusted at values low enough to be followed by the eye. The mode of oscillation of this system is investigated both by calculation and by experiment.

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An Electrolytic Metering Can.

The electrolytic metering can is designed to take the place of the direct-current watt-hour meter for small customers, with the object of eliminating the expense of reading the meter and calculating the bill at monthly intervals.

The automatic electrolytic meter is regarded as distinct from any other electrolytic meter so far proposed. There are no deposits to be weighed, no delicate balances to be maintained, and no moving mechanical parts to be adjusted. The electrolytic action upon which its operation is based is far more sensitive and accurate than that of meters hitherto employed, because of the design of the electrolytic elements and partly because the regulating resistance units are so designed as to minimise the effect of resistance variations in the electrolytic cell.

The device is designed to automatically open the circuit and terminate the supply of electric service to the consumer as soon as he has completely used a specified amount of electric current for which he has paid. The measurement of current depends upon the electrolytic action of a small shunt current acting on the anode, a small copper cylinder of known weight, which is gradually consumed by this action during such time as current is being used but is unaffected during the time when no current is being used. The ratio between the shunt current and the weight of the copper anode is such that the latter is completely consumed when the specified amount of current has been used. The final disappearance of the anode opens the main circuit, and terminates the service.

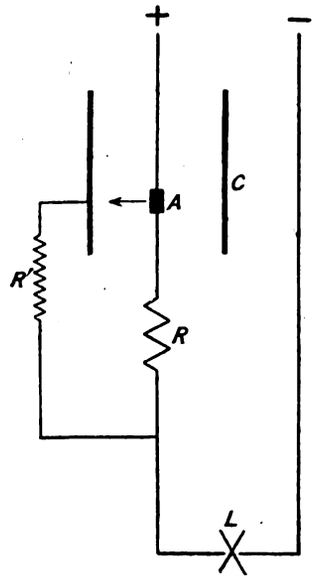

FIG. 1.—DIAGRAM OF CONNECTIONS.

A. Copper Anode.
C. Walls of the cell which serve as cathode or negative electrode, in shunt circuit.
L. Variable load of the customer's service.
R. Series resistance = 0·3 ohm.
R'. Shunt resistance = 280 ohms.

Electrical Operation.—A diagram of the electrical connections is shown in Fig. 1.

The polarity of the terminals is indicated. The shunt current flows from the anode as indicated by the arrow through the copper sulphate solution (not shown) to the walls of the cell *C*, which also acts as the containing vessel for the solution. The weight of copper dissolved from the anode by electrolytic action is directly proportional to the value of the shunt current, depending upon a definitely known relationship. The total resistance of the shunt circuit is about 300 ohms, the sum of 280 ohms constant resistance at *R'* and about 20 ohms resistance in the solution and at points of contact between solution and electrodes (anode and cell walls). Since the resistance at *R* is 0·3 ohm the shunt current will always be one-thousandth part of whatever current may be flowing through the main circuit, subject to certain variations which will be mentioned a little later. The weight of copper dissolved from the anode thus bears a definite relationship to the ampere-hours used in the main circuit. The predetermined weight of the anode will therefore govern the number of ampere-hours which may be used by the consumer before his service is automatically cut off by the dissolution of the anode.

The construction of the cell in cross-section is shown in Fig. 2.

As soon as the main circuit is broken by the complete dissolution of the anode the main or load current crosses the gap through the solution which now forms the only connection between the ends of the copper leads which formerly made contact with the anode. The upper or positive end is rapidly eaten away and copper is deposited on the lower end. At the same time there is a considerable voltage drop between the ends, since the resistance of the solution is relatively high, and a rapid generation of heat takes place. As soon as the temperature becomes sufficiently high the 60 deg. solder melts, releasing the copper cylinder *P*, which, no longer supported by the anode below, drops, and completely opens the circuit at a point above the level of the solution.

This cycle of operations has a characteristic effect on the customer's lamps or other current-consuming equipment. At the moment when the metallic circuit is broken the current is shut off completely for a moment, extinguishing the lights. Then, as current begins to flow through the solution, the lamps will light up with a flickering, uncertain light, which varies in brilliancy according to the total wattage of the lamps in service. One or two 60-watt lamps will give a fairly serviceable although unsteady illumination. This continues until the permanent cut-out occurs, and the service is completely interrupted. The period of time between the initial warning and the final cut-out may be regulated to some extent in

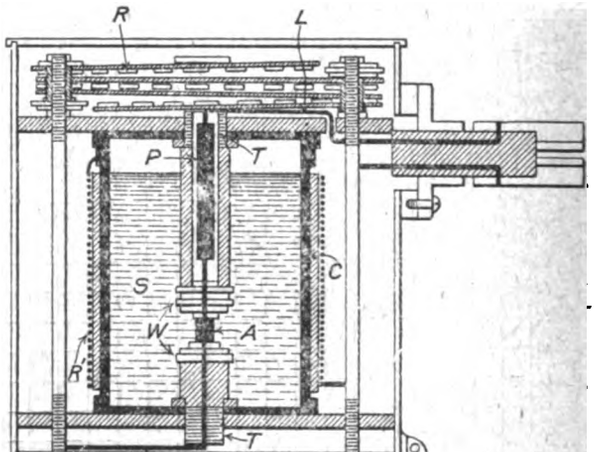

FIG. 2.—CROSS-SECTION OF ASSEMBLED METERING CAN.

A. Copper anode.
C. Copper cylinder which forms the container, and also acts as the negative element of the electrolytic cell.
S. Copper sulphate solution.
T T. Protecting tubes of hard rubber or similar material.
L L. Copper leads which form part of the main circuit, and make connections with the anode.
W W. Rubber washers forming a tight joint between the tubes and anode.
P. A solid copper cylinder which forms part of the main circuit, and is connected to the copper lead at its upper terminal by means of a special solder which melts at 60°C.
R. Series resistance.
R'. Shunt resistance.

the design since it depends upon the means used to insure the final cut-out. In the arrangement described above this period lasts for only a few minutes, but may be extended somewhat in order to give the customer a more adequate warning.

Fig. 2 also shows the assembled device with cylindrical brass case enclosing the cell, resistance units, &c. Through the side arm connection is made with spring contacts enclosed in a box (not shown) very similar to a wall-switch box. The side arm enters this box through a keyhole, and is then turned into place and sealed, in such a manner that it is not possible to tamper with the connection without breaking the seal. All current-carrying parts are thus removed from view, and cannot be disturbed, by accident or otherwise.

The design described above, although most of its features have been tested with satisfactory results under certain selected conditions is not considered to be an entirely perfected or complete design, and several important modifications which are under consideration.

Accuracy Under Service Conditions.—The automatic electrolytic meter is, strictly speaking, an ampere-hour meter. Its accuracy depends on two principal factors, the exactness with which the

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weight of the anode meets the specifications, and the average ratio between load current and shunt current under the conditions of its use.

The weight of the anode is not a source of serious error. The ratio between load current and shunt current is determined by testing the device at a suitable load before it is put in service. The number of ampere-hours which the meter will deliver is then easily calculated from the weight of the anode, and the current ratio. The ratio is subject to variation, depending upon the conditions of service, because of the fact that the shunt resistance of the electrolytic cell, forming about 6·5 per cent. of the total shunt resistance, is not a constant quantity. The series resistance of the cell, so long as the metallic circuit is complete, is nil. Both series and shunt resistance coils are made up of alloys which have no temperature coefficient of resistance under ordinary conditions of use. The only variable which interferes with the accuracy of registration is the electrolytic resistance within the cell itself.

This resistance varies with time, with temperature, and with the magnitude of the load. Over a considerable period of time these variations tend to balance each other to a very large extent unless the device is operated continuously under extreme conditions. Under average service conditions an accuracy of ± 2 per cent. is easily attainable, while rather extreme conditions produce a variation of not more than ± 4 per cent.

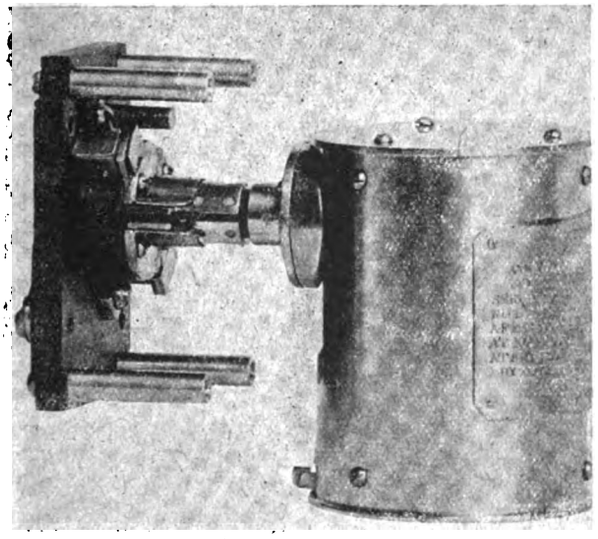


FIG. 3.—THE METERING CAN COMPLETE.

Fig. 3 is a view of the complete device, and from Fig. 4 will be seen the size of the device in comparison with a meter of the ordinary type.

Fig. 5 shows a typical registration curve of a five-ampere automatic electrolytic meter, showing the per cent. registration at various loads from 0·1 ampere to 5 amperes. Starting at about 78 per cent. registration at 2 per cent. load, it reaches 96 per cent. at 15 per cent. load, and 98 per cent. at 25 per cent. load, registering slightly more than 100 per cent. above 50 per cent. load.

Comparison with Watthour Meter.—It might seem at first glance that the direct-current watthour meter has a considerable advantage over the electrolytic meter in the measurement of very small loads, but when the energy required to operate the two instruments is considered this advantage largely disappears. In the first place, taking the Thomson C 6 watthour meter as typical of its class, the meter ordinarily found in present use has a constant potential coil loss of about 5 watts. This loss is continuous, 24 hours per day, whether or not any current is being used. The electrolytic meter does not require any consumption of energy when no current is being used. This potential coil loss is also of considerable importance when current is being used, *especially at light loads.*

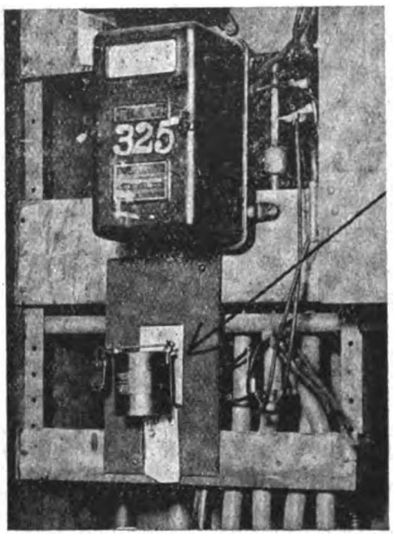
In general the sale of electric service by units of energy may have definite and valuable advantages, but most of these advantages disappear when we consider only small residence customers, especially those who cannot now be said to return any profit to the central station company. In reality such customers are buying, not electrical energy measured in kilowatt hours, but electric service as such, and if the extent of their use of such service can be more economically measured in ampere-hours there is much to be said in favour of the adoption of such a system.

SUMMARY OF ADVANTAGES.

The advantages of the automatic electrolytic meter for small residence service may be summarised as follows:—

1. It does away with the necessity of monthly meter readings and computations preparing and posting on ledger sheets, of bills for each individual customer.

2. It reduces the meter investment cost as compared with meters in present use. A very accurate estimate of cost for the electrolytic meter cannot at present be made, but will not be more than 50 per cent. that of present meters at the very highest, possibly much less.



Electrolytic meter, same capacity as watt-hour meter above.

FIG. 4.—VIEW SHOWING THE SIZE OF THE METERING CAN COMPARED WITH THE USUAL TYPE OF METER.

3. It greatly reduces the amount of energy required to operate the meter, and in this way makes a saving for both company and customer.

4. It adapts itself very well to the peculiar requirements of residence customers, as compared with large light and power customers since the former are users of electric service rather than merely of electric energy. There is no basic reason why the same system of metering should be used for two classes of customers whose requirements are so inherently diverse.

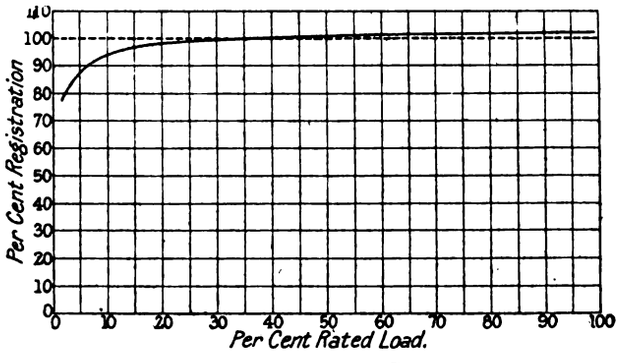


FIG. 5.—REGISTRATION CURVE.

5. By virtue of the above-named advantages it makes possible a profitable return to the company from customers now classed as unprofitable. In similar degree it increases profits where these are now very small or makes possible rate reductions which might otherwise be unfair.

6. It simplifies greatly the relation between central station and customer by putting the sale of electric service on an ordinary merchandise basis. For example, a full-size, half-size or quarter-size meter can at approximately corresponding prices. An entire average year's service is purchased as one transaction, but billed in 12 equal monthly instalments.

The device is due to Mr. E. O. Schweitzer, of the Edison Commonwealth Co. (Chicago), from whom we have received the above particulars.

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Some Notes on Loop Tests for Fault Localisation.

By G. W. STUBBINGS.

Localisation tests for faults on underground cables fall mainly under two heads: fall of potential tests and loop tests; capacity tests for discontinuities on underground cables for electricity supply being rarely required. Of the two former tests, the fall of potential is the simpler and more convenient, and is usually adopted when possible. This test suffers from the disadvantage of requiring a constant fault resistance if accurate results are desired. It is true that fall of potential tests can be made with faults of varying resistance, provided that means are available for maintaining a constant testing current; but to do this a delicate adjustable resistance and an ammeter are required. This additional apparatus not only complicates the fault localising equipment, but also calls for the services of a second observer. For faults of varying resistance loop methods are far preferable, as the variation in

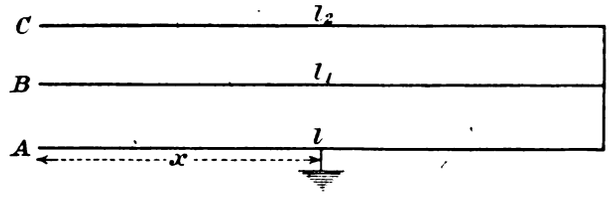

FIG. 1.

resistance will then cause no difficulties. Loop tests can be made in two ways, according as the fault is contained in the galvanometer or the current circuit. The former method is capable of a greater number of modifications for varying conditions, but has the disadvantage that the testing current must be provided by a battery, which battery with its adjustable resistance considerably increases the weight of the testing gear. Further, as the fault is in the galvanometer circuit, the small E.M.F. of the fault will frequently cause difficulties. The second method, in which the fault is in the current circuit, is by far the more convenient for many reasons, chief among these being the fact that the testing current can be obtained from the live mains through a small bank of lamps.

The most convenient form of apparatus for loop tests is one similar to the fault localising bridge first described by Mr. F. Charles Raphael. This set consists simply of a resistance slide wire stretched over a scale, together with an appropriate movable contact and terminals. If, as is usually the case, the length of the slide wire is 1,000 mm., the position of the movable contact when the bridge is balanced will give directly the factor by which the length of the cable loop must be multiplied in order to obtain the distance of the fault from the testing position. This factor, which is the distance in millimetres of the movable contact from the terminal connected to the faulty cable, divided by 1,000, will be referred to hereafter as the reading of the bridge.

The simplest case of a loop test occurs when a return cable of cross-section the same as that of the faulty cable is available, and of this particular case nothing need be said. This condition is, however, not often fulfilled, and it frequently happens that the return cable available is of a cross-section different from that of the cable under test. If the two cross-sections are known with certainty, it is a simple matter to calculate the equivalent length of the return cable. If this information is not known with certainty, or even if it is, and there are known to be a number of joints on the return cable, it becomes desirable to use a method in which the equivalent length of this cable is not required to be known.

If current be available at each end of the faulty cable, a test to meet this case is easily carried out, the method consisting in making the ordinary test first from one end and then from the other. If a be the reading of the bridge, testing from the first position, and b the reading at the second position, l the length of the faulty cable, l_1 the equivalent length of the return cable, and x the distance of the fault from the first position, it is easily seen that $a=\frac{x}{l+l_1}$ and $b=\frac{l-x}{l+l_1}$, from which is obtained $x=l\frac{a}{a+b}$, a result which does not contain l_1.

If current be available only at one end of the faulty cable, the problem is not quite so simple. It frequently happens, however, that in three-wire systems two return cables are available. In such a case one of the good cables can be made alive to furnish a supply of testing current at the second position. In this case, however, it is possible to devise a test which can be made at the one position, thereby saving the trouble and delay in moving the testing gear. In this test the three cables are all connected together at the far end, as shown in Fig. 1, and three loop tests are taken in the ordinary way, the loops being formed as follows: A and B; A and B and C in parallel; B and C; calling the readings of the bridge for these three tests a, b and c respectively, and the equivalent length of cables, B and C, l_1 and l_2 respectively, we have

$$x=a(l+l_1)$$

$$x=b\left(l+\frac{l_1l_2}{l_1+l_2}\right)$$

$$c=\frac{l_2}{l_1+l_2}.$$

$$x=b(l+l_1c).$$

By eliminating l_1 from the first and fourth of these equations we finally obtain

$$x=l\frac{ab(1-c)}{a-bc}.$$

The saving of time by making all observations from the one testing position will be considerable.

In cases where only one return wire is available, but the fault is of fairly high resistance, the following is a very good approximate test. The reading of the bridge is obtained as in the ordinary loop test. The far end of the loop is then solidly and efficiently earthed and the test repeated. During this latter test nearly the whole of the testing current will pass through the artificial earth, and very little through the fault. Calling the two bridge readings a and b, as before, we have

$$a=\frac{x}{l+l_1},\quad b=\frac{l}{l+l_1}\text{ and }x=l\frac{a}{b}.$$

This test is one of the greatest simplicity, and should be very useful in cases when the fault is of fairly high resistance, and current can only be obtained at one end of the faulty cable.

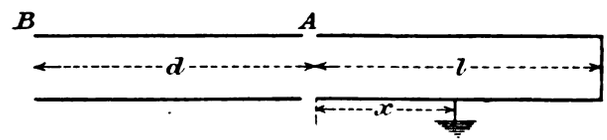

FIG. 2.

A difficult case arises when the above condition of high fault resistance is not fulfilled, and there is only one return wire and current available at one position. In these circumstances it will often be possible to make a second test, using a longer loop, the additional lengths of cable used being the same cross-section as in the original loop. The method is illustrated in Fig. 2, in which A is the first testing position and B is the second position, in which the extra length of loop, d, is requisitioned. When making the test at B the cables at A will be made continuous. If q be the factor for converting the length of the return cable of unknown cross-section to equivalent length of the faulty cable, and a and have the same meanings as before,

$$a=\frac{x}{l(1+q)}$$

$$b=\frac{d+x}{(d+l)(1+q)},$$

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whence

$$\frac{a}{b}=\frac{x(d+l)}{l(d+x)},$$

and finally

$$x=\frac{adl}{ba+bl-al}.$$

Difficult cases of fault localising arise on concentric cables when the fault takes the form of a short-circuit and an earth on the outer conductor. If another cable is available to form a loop, the ordinary methods described above can be employed; but, failing this, the tests available are based on the assumption of a constant resistance in the short-circuit. This assumption renders these tests of inferior accuracy to those in which the loop is formed of good cable; but in the difficult circumstances mentioned they will be useful, if no other method is available.

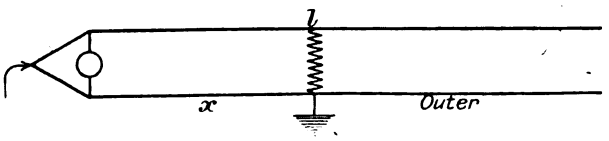

FIG. 3.

The first test is for a twin concentric cable when current is available at each end. The loop is made as shown in Fig. 3, the cables at the end remote from the test being left free. Giving l and x similar meanings to those used above, and calling the resistance of the fault in terms of the cable under test r, we have the inner and outer conductors being of identical cross-sectional area, and a and b the readings obtained by testing from each end in turn,

$$a=\frac{x}{2x+r},$$

$$b=\frac{l-x}{2l-2x+r}.$$

By eliminating r from these equations we finally obtain

$$x=l\,\frac{a(1-2b)}{a+b-4ab}.$$

An alternative method of localising the fault in question consists in making two tests from the one position, the first as above, with the far ends of the cable free, and the second with the far ends of the cable solidly joined together. Calling the first and second readings of the bridge a and b as before,

$$a=\frac{x}{2x+r},$$

$$b=\frac{x}{2x+\frac{2r(l-x)}{r+2l-2x}}.$$

By eliminating r the final result is

$$x=l\,\frac{2(b-a)}{1+4ab-4a}.$$

Most of the above tests have been described before in a slightly modified form, in connection with the use of a battery for the supply of testing current and a Post Office bridge. In this form they were of little use to the average mains engineer. It is hoped that the adaptations for use with the method of loop testing, in which testing current from the mains is employed, will be useful. The above results may also serve to point out the wide field of application of loop methods. Fall of potential tests, although extremely easy to carry out, are not capable of yielding results of equal accuracy to those obtainable by loop methods. If these latter methods were to receive a little close study by mains engineers, it is very probable that they would become more popular.

A British Electrical Proving House.

DISCUSSION.

At the meeting of the Institution of Electrical Engineers on Thursday, May 9, when Mr. C. Turnbull read his Paper on this subject (which was abstracted in our last issue) the PRESIDENT, prior to the reading of the Paper, gave a brief account of the Council's attitude on the subject. He said he made suggestions over 20 years ago, and again three or four years ago, that an institution of the character proposed in the Paper should be established. The need for it was generally admitted. The Council did not think the Proving House should deal with research properly so called, but should deal with a commercial kind of testing, and not with matters of high accuracy, such as were dealt with by the National Physical Laboratory. The Proving House, in the Council's judgment, would not be the authority to formulate rules or issue standard or other specifications, but should see whether the rules and specifications of other competent authorities were or were not complied with. It should affix its hall-mark only to articles of British, or rather Imperial manufacture. Until recently he had been of opinion that it should be an entirely independent body, his reason being that its Board should consist largely of manufacturers and also partly of users, consulting engineers, municipal and company electric supply authorities, and so on, and he had felt that if it were attempted to found the Proving House as an offshoot of the National Physical Laboratory it would be impossible to have that commercial control, and that its certificates would be regarded as somewhat academical. But the war had effected great changes in the N.P.L. as well as in so many other things, and it had lately been carrying out a large amount of commercial testing, notably in connection with glassware for chemical purposes, and Advisory Boards had been set up, in connection with the N.P.L., on which commercial interests were largely represented. That removed his former objections to the founding of the Proving House as an offshoot of the N.P.L. The latter was to all intents and purposes a Government Department. It was under the control of the Advisory Council for Scientific and Industrial Research, and it would have ample funds at its disposal. The Council were of opinion that the following would be a suitable constitution for the Board of Management of the Proving House. Three of its members should represent the Institution of Electrical Engineers of which the President for the time being would be one), six the BEAMA, one the Cable Makers' Association, two other Associations representing British manufacturing interests, two the I.M.E.A., three the Power Companies, two the Electrical Contractors' Association, two the Fire Insurance Companies, one Shipping Insurance Companies, one Tramways Associations, two Consulting Engineers, two the Engineering Standards Committee, one the N.P.L., one Professorial Staffs of Technical and Engineering Colleges, two large buyers, such as railways and docks, one representative of exporters and merchants of electrical plant, six Government Departments. These made a total of 38, and out of these it was proposed that there should be elected an Executive Committee of 11.

In the discussion following the reading of Mr. Turnbull's Paper,

Mr. H. H. BERRY said there was something in the nature of an electrical proving house already established in the United States. He referred to the National Board of Fire Underwriters of the U.S.A., a powerful body supported by every institution of note in the U.S.A., and particularly by the manufacturing interests. The Board issued the National Electrical Code, which laid down the type and dimensions of apparatus that would be admitted. It was a clever stroke of business that had worked to our detriment, as British electrical manufactures offered in Canada had been unacceptable, not because they would not pass the tests of the American Proving House, but because they did not conform to certain dimensions. The National Electrical Code, primarily drawn up to take care of fire risks, had never been designed to look after the life hazard, and apparatus for purposes where the fire risk was not great had been allowed to have scanty design which would not have been tolerated here. They would gain tremendously by having the N.P.L. at their back. The Proving House should not admit goods of foreign origin.

Mr. ROGER T. SMITH said the author's scheme appeared to overlap the work of the N.P.L., the Electrical Research Committee in the Department of Scientific Research and the Research Committee of that Institution; the author also wanted it to teach the Engineering Standards Committee their business. The bodies most suitable to ask the Engineering Standards Committee to prepare specifications were the Institutions of Civil, Mechanical and Electrical Engineers, the Iron and Steel Institute and the bodies representing the marine and shipbuilding and other industries. His view was that the Proving House should test materials, apparatus or plant specified by the Engineering Standards Committee or referred to in the Institution's wiring rules or rules of that sort, and not mix up research with testing. With regard to duty (1) mentioned in the Paper, he did not think the Engineering Standards Committee wanted assistance, and he did not approve of duty No. 2, relating to drawing up rules. Research on rubber was not work for the Proving House. The Engineering Standards Committee had a specification for lamp holders already, and the Proving House should test lampholders to that specification. The testing of insulating materials was the function of the Research Committee of the Privy Council or the Research Committee of that Institution. He agreed with the suggestion that the Proving House Committee should co-operate with the N.P.L.

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Capt. W. P. DIGBY thought the Governing Committee of the Proving House should include representatives in Calcutta, Melbourne, Johannesburg and other places in the Colonies selected by the local branches of the Institution. He agreed that the Proving House should deal only with Imperial products so far as certification was concerned, but it should make life tests of foreign made articles. Amongst the tests prescribed in the National Electrical Code was the testing of tumbler switches at rated load and rated voltage for 5 or 6 thousand operations in succession. He did not know any firm here who would be ready to submit to that test. If the Proving House did not study American, German, Italian and Swiss products, a great deal of its Imperial value would be lost.

The PRESIDENT said the research work would be better done by the N.P.L. than by the Proving House. They would not shut themselves out from learning because they did not use the Proving House to do it.

Mr. C. P. SPARKS said he welcomed whole-heartedly the programme put forward by the President. The Wiring Rules Committee worked first in a small way and later was one of the constituent bodies creating the Engineering Standards, but the chain was incomplete without the Proving House. He was afraid if Mr. Turnbull's scheme were followed, valuable as it was, little or no progress would be made, as there was an enormous difficulty, viz., the question of finance. It would probably cost £5,000 or £6,000 to build up a new organisation. Members would be convinced of the importance of having the N.P.L. at their backs by reading the important Papers read by Sir Richard Glazebrook recently before the Royal Institution.

Mr. P. ASHBY (of the Board of Trade) said the Board attached great importance to the development of standards in British industry. Standardisation was important, both in the direction of securing interchangeability of parts, whereby the convenience of users was promoted and manufacturing facilities increased, and in the direction of establishing some institution which would give an authoritative hall-mark to products, and give the comparatively inexpert purchaser some assurance of the quality of the goods. The Board were of opinion that the establishment of a National Proving House for electrical plant, apparatus and instruments would be likely to be of great service to British industry, both in home and overseas markets. He thought it should be confined to goods of British manufacture so far as certification was concerned, and that it should ultimately be as far as possible independent of trade control. If it was to attain the international standing and authority they desired, it must be free from all possibility of suspicion that it was in any way influenced by private interests.

Mr. A. R. EVEREST said the movement for establishing a Proving House was the outcome of a discussion a year ago in which manufacturers who were menbers of the BEAMA took part, and at which certain resolutions were agreed to and communicated to the Institution. The question was what would the certificate of the Proving House prove. The requirements in the construction of apparatus were found in a long list of rules—Board of Trade, Home Office, Institution of Electrical Engineers, London County Council Theatre Lighting, Lloyd's Rules for the Use of Electricity on Ships, Admiralty Standards, Engineering Standards Specifications, the Rules of Municipal Supply Authorities, and Insurance Companies and other bodies. The BEAMA recommended that all rules dealing with constructional features of electrical machinery and apparatus should be collected, co-ordinated and issued by the Engineering Standards Committee only, that all rules and regulations dealing with installation should be collected and co-ordinated, and issued by one competent authority (which they all felt should be that Institution). Then a Proving House was wanted to certify whether machinery or devices were complying with the appropriate rule. The Proving House should be rather for checking the dimensions of lamp sockets, switches, &c., than for calibrating instruments of precision, meters, and so on. The only way of utilising certificates of material would be to have a certificate on every piece of the material sold. Every part must be stamped, and he did not know whether that was within the scope of the Proving House they were discussing.

Mr. W. R. RAWLINGS said the contractor would welcome the proposal now under discussion. When Mr. Wordingham started to establish a proving house of his own at Manchester the contractors were up in arms against him, but nothing was more conducive to the elimination of the jerry wireman than the proposal now before them, which would help to eliminate jerry material. The average supply authority cared naught so long as it could sell juice, and the insurance companies did not care how rotten the installation was; it was better than gas, oil or candles. They should aim for the standard of efficiency that the Institution had aimed at through their Wiring Rules. He hoped the use of apparatus not passed by the Proving House would be declared illegal. He wished the Institution Wiring Rules could have the same power behind them that was behind the Home Office Regulations.

Mr. W. R. COOPER said he was in full sympathy with the idea of establishing a Proving House. Apart from the trade advantages, it would lead to a great improvement in design, and joining up with the N.P.L. would avoid overlapping. He was glad to hear that the Council were not in favour of the Proving House carrying on research. There seemed to be four functions for a body of that kind. In regard to design, it would certify whether a switch (for example) had the recognised length of break, whether an ironclad switch was so made that one could get the cables in and out properly and get the proper continuity. The second function was to certify as to performance, *e.g.*, whether a fuse would stand a dead short circuit with a 5,000 kw. generator behind it. (He did not know whether the author proposed to test the performance of small motors, &c.) The third was the testing of material. Here there was a difficulty. The Proving House could certify whether material in the manufactured article was to specification, but he did not think material as manufactured could be standardised. In regard to the fourth function—certification of life—it was impossible to state the life of a cable, accumulator or lamp because one never knew the conditions under which it was to be used.

Mr. C. LE MAISTRE said the certification of a very large number of articles would perhaps be somewhat difficult. The Engineering Standards Committee for a long time endeavoured to secure the use of a brand on all articles made according to their specifications, but it was found that the Committee not being a corporate body could not own a brand. The Committee had now been incorporated, and had the brand as a proprietary article. With regard to the co-operation of the Proving House with the overseas Dominions, the Engineering Standards Committee was bringing into being Engineering Standards Committees in 12 or 14 centres abroad. A Canadian Committee had actually been constituted, and the Indian Government was forming a powerful Committee covering the whole of the engineering industry, and would work in two or three centres, somewhat after the Indian Railway order. There was also a Committee in South Africa, which had accepted the proposal to work in direct co-operation with the Committee in London. Committees were being formed in other countries, with the help of the new Department of the Board of Trade and the Foreign Office.

Mr. H. W. CLOTHIER said there was this important connection between research work and the Proving House work. The Proving House would be the natural authority to meet with the troubles and to find the necessity for invention. It was true that America had large well-organised research establishments, but in this country we had something which he contended was going to be just as useful. We had the small works with individual initiative and liberty of action, and it had been agreed that to develop trade with our Colonies co-operation was necessary. The Proving House would be a means of co-operation. The manufacturers with their research work had carried things up to a state of more or less perfection, and now they were working well in unison, collecting their designs and bringing out the best features, and these in time went through the fire of the Engineering Standards Committee and became the National Standards. He thought the Proving House must do something more than prove that apparatus was up to the national standard. It must collect the standard specifications and requirements, including the overseas rules, and take an attitude of commercial protection.

Sir RICHARD T. GLAZEBROOK said he approved of the connection of the Proving House in some way with the N.P.L. For 15 years he and his staff had been doing what they could to bring the advantages of the benefits of scientific investigation to bear on industrial and commercial problems, and the Proving House was one of the steps necessary to complete that work. There would be an advantage to the Proving House in being in direct connection with the men who did the research. His lectures on this subject had been referred to, and he would like to read the following paragraph from them: "It is not our object merely to apply with rigid fairness the laws laid down, and be pleased rather than otherwise, like the mythical examiner, when we plough every sample. The standards set must be reasonable, but they must tend to raise the quality of the product itself. Recurring defects must be watched and investigated, and the tests modified to prevent them; you must gain the confidence of the manufacturer and lead him to realise that you are out to help him, and that you really know something, probably more than he does, of the strength and weakness of his goods." Members of the staff of the Proving House, especially the senior staff, should have every opportunity for promoting research and calling attention to scientific questions that needed careful investigation. The Advisory Committee of the Proving House should be closely connected with the trade. They had in the N.P.L. several committees of that kind, and work of the greatest importance had been done by the Advisory Committee for Aeronautics. The tests and research required by the Committee were carried out by the N.P.L., and some arrangement of that kind could be made with regard to the Proving House. He agreed that certificates should only be given for Imperial products; but, as had been suggested, foreign products might be investigated and reports made upon them to the Governing Committee.

Mr. G. SCOTT RAM said he thought the Proving House was very badly wanted. One of the first difficulties it would be up against would be to find the specifications of the articles it was going to prove. Most of those that existed were on the scientific more than on the commercial side. With regard to life tests, a switch might comply with all the usual items that were specified, and yet fail hopelessly within three months of use in a factory. It would be necesary for the Proving House to test materials as well as design. There were on the market and in use lamp-holders which softened at the ordinary temperature of a 60-watt lamp.

Mr. J. G. PEARCE said a difficulty with regard to the proposed connection with the N.P.L. was that the N.P.L. was recognised as our premier independent laboratory, and the discussion had shown that there were grave disadvantages attaching to its use as a laboratory for industrial research. The works laboratories would deal with immediate works requirements and would link up with the industry as a whole and probably with the research associations which would investigate questions common to the industry. The Proving House would concern itself with the safety of the public, and work in parallel rather than in series with any existing laboratory or group of laboratories. A Proving House and a laboratory for scientific research were better carried out separately with separate financing, though close co-operation might be essential. There was an economical limit beyond which concentration defeated its own ends. If the Advisory Committee of the Proving House would not be subject to the protection of the Executive Committee and the Royal Society, it was difficult to see why it should be at the N.P.L.

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Mr. D. N. DUNLOP said the BEAMA appreciated the interest the Institution was taking in trade and commercial matters. It was refreshing because of the little gibes one heard as to the lack of interest on the part of manufacturers in science. He thought it was putting the boot on the wrong foot, and that there had been neglect on the part of science in relation to manufacturing interests. But there was now a desire to come together. The Underwriters' Board in America was purely an insurance proposition originally, and the peculiarity of the buildings both in Canada and the United States caused the same rules to be followed. If trade interests were in control of the Proving House he thought the result would be satisfactory. The manufacturers would welcome association with the N.P.L. He did not think the Government were going to pay for it. In America the manufacturers bought stamps and put them on their manufactures. If the manufacturers had to find the money they would get a form of protection without a tariff. A tariff of 10 per cent. would not keep out cheap Japanese and German stuff. The contractor, who was in competition with others, was interested in buying the cheapest fittings he could get, but if a mark of quality were put on goods, indicating that they complied with the Standard it would largely protect the home and the Imperial market. With regard to stamping foreign goods, he thought we shou'd have to stamp anything that complied with our requirements.

Mr. TURNBULL, replying to the discussion, said he thought Capt. Digby, Mr. Ram and Mr. Sparks had answered Mr. Roger Smith's criticism. Mr. Smith objected to the Proving House assisting the N.P.L., but when the Institution Wiring Rules Committee got out the carrying capacity of wires they asked the N.P.L. to help them and the Committee's help was extremely useful. As Mr. Ram said, switches might comply with the specification, and so might cables, and yet have no life. That being so he did not feel disposed to modify No. 1 rule. He thought the Engineering Standards Committee would find the Proving House a very useful assistant. If the manufacturers made more use of the N.P.L. they would find it as useful in the peace-time struggles as it had been in the war struggles. He hoped the work their President began so many years ago would come to fruition in the time he continued to be President.

U.S.A. Production and Distribution Costs.

Through the application of efficient management in the production or manufacture of commodities well-nigh irreducible economies have in many instances been effected in the United States. Operations have been minutely studied, and as a result excessive movements have been eliminated and effective methods introduced, thus reducing costs and increasing the output considerably. It is an almost endless task to review the vast economies which have been effected in industrial establishments in the production of commodities through the application of scientific principles. Perfection has as yet not been achieved, but the high state of efficiency that obtains in the matter of production stands out in vivid contrast to the woeful lack of efficiency in the matter of distribution—the handling, storage and transporting of commodities so economically created.

It is a fact that the distribution phase of industry has not kept pace with the production, but the chaos that exists and which, to a large extent, has been accentuated by conditions engendered by the war, is attracting more and more attention, and may prove to be the forerunner of such action as may be necessary to rectify the many existing evils.

That a realisation of the critical transportation conditions existing is at last dawning on this country is evidenced by the statement issued recently by the Conference Committee of National Preparedness. It is said: "War production is already hampered by shortage of cars and locomotives, lack of ample terminals, storage, and other facilities; newspapers almost daily report mills closed or running half-time, mines restricting needed output, and ship building delayed. By using motor trucks or trackless trolley, and also when conditions permit, water transportation, much of the delay, the inefficient use of equipment and the congestion of expensive, inexpansible terminal facilities could be greatly minimised. Why should not subways in cities like New York carry parcels, perhaps food, and even freight, at least during the dull hours of the day and night? Devices for quickly loading and unloading trucks to connect with terminals, storehouses and markets seem quite within the limits of man's ingenuity. Nothing short of the combined local and national effort can prevent our present transportation facilities from proving utterly inadequate to meet the needs for carrying on this war to a speedy decision." The selection and utilisation of the best available methods at piers, terminals and warehhouses, for the receiot and storage of goods, both temporary and otherwise, and for the prompt despatch of goods received for shipping, is a partial solution of the problem.

It is generally admitted that transportation equipment must be selected on an engineering basis. Concerns contemplating a revision of their transportation methods should call in the services not only of a truck salesman, but a transportation engineer, who can unbiasedly and intelligently analyse the problem in all of its phases. In this way the recommendations will enable not only the purchase of proper equipment, but will also assure its proper use, and a minimum initial investment with the lowest number of units and auxiliaries, together with the lowest operating cost, will be obtained. In some instances many thousands of dollars a year can be readily saved by concerns having any considerable amount of distribution.

The first important factor to be carefully considered is a modern means of conveying the material and finished product in the factory to the shipping point, the selection of suitable mechanical conveyers and the intelligent routing and placement on carriers. The next factor is the systematic storage of the material, and also the finished product, pending use and shipment. Then follows the consideration of the means of shipping from the factory. If trucks or cars are to be loaded there must be a despatch system to avoid delays at the points of loading and destination. This is especially important when products are delivered to wharves and railroad terminals where there is a tendency for unnecessary "peak" demand for service. It is estimated that 50,000 vehicles are constantly engaged in trucking to piers and terminals on the west side of New York City alone. Nearly every merchant sends his trucks to the terminals at about the same hour, and the result is a dearth of business between 7 a.m. and 9.30 a.m. at the receiving pier, and a dearth of business between 1 p.m. and 3 p.m. on the shipping platform. Long lines of vehicles wait outside for hours before they can get on to the piers or up to the platforms. If the business were evenly distributed at both points during the whole or part of 24 hours by means of day and night shifts, an annual estimated waste of over $1,000,000 chargeable to delay at the New York terminals alone would be eliminated. If freight upon arrival were properly handled and delivered it is likely that the steamship and railroad companies could decrease space now given to receiving and despatching freight, while the extra area thus obtained could be devoted to a future increase in business. Much distribution can be effected at night when trucks can operate at a good speed owing to the absence of traffic congestion, and with minimum danger and maximum economy.

As an example of the relative cost of distributing commodities the following tables based on figures prepared a couple of years ago by a late vice-president of the New York Central Railroad are interesting. A manufacturer in Philadelphia sends 1 ton of freight to a merchant in New York City, and from the time the freight leaves the manufacturer the Philadelphia charges were as follows: Labour cost of loading on a wagon, $0.25; unloading at freight station, $0.50; cost to railroad in billeting and other clerical work, $0.40; and actual operating expense of loading and switching freight car, &c., $0.25; a total of $1.40. The cost of handling in New York is as follows: Terminal costs on New Jersey side of North River (average of all railroads), $0.15; lighterage, $0.80; terminal cost on water front of Manhattan Island, $0.50; and cartage expenses in New York City, $0.80; a total of $2.25. The terminal charges at both ends are total to $3.65 on 1 ton of freight. It costs the railway to haul freight 3 mills per ton per mile, or for the 90 miles between Philadelphia and New York 27 cents per ton. The cost of getting a ton of freight started on its journey on one end and handling it from the Jersey City terminal to the consignee's store at the other end is nearly 14 times as much as the cost to haul the goods all the way from Philadelphia to New York. To haul a ton of freight 1,000 miles from New York to Chicago costs $4, or 65 cents less than the terminal charges at both ends. In other words, it costs more to load a barrel into a car at Chicago and to unload it at New York than it does to move the same barrel between the two cities on the railroad. The fact that drayage and terminal expenses of freight transportation is 22 per cent. more than the line haulage of the same freight over 1,000 miles of railroad is a condition toward which every effort should be exerted to remedy. Co-operation between railroads, steamship and express companies, trucking concerns, manufacturers and the public itself is apparently vital. It seems that the full measure of possible success can only be obtained when the local transportation and the handling of freight in the terminals are considered jointly, instead of as two separate and distinct phases. If the existing trucking concerns could work out a method of systematically co-operating in the development of a scientific schedule of operation much could be accomplished. Otherwise, it appears that the railroads must either go into the delivery of freight direct from shipper to consignee, or that large and efficient local transportation companies will have to be formed to sympathetically work with the railroads in the elimination of freight congestion with its attending losses.

The future will undoubtedly bring into existence an extensive application of co-operative deliveries the advantage of which have already been proven in a number of instances, and are quite obvious to the impartial investigator. This development is now being advocated by the Commercial Economy Board of the Council of National Defence, and in this connection the one-delivery-a-day plan is strongly recommended as an addditional means of tremendous saving. No matter what type of equipment be employed, or whether co-operative methods be used, it is essential that operating costs be known, and it is an unfortunate fact that only a small percentage of users really know the operating costs of their transportation equipment, and more often than not the actual costs are greater than those assumed. A standard method of cost accounting, if universally adopted, would prove of immense value. If we take the total cost of transportation, considering the cost on the various phases of transporting a commodity from the raw material to the finished product, and from the producer to the consumer, the figure becomes startlingly large. There is no doubt but that much of this excessive cost can be eliminated by systematic handling throughout the entire journey. It is said that "probably in no other part of our existence are so many economies possible as in that great phase of industry—distribution. And, while at the moment, the changes which will take place will primarily be for the furtherance of the objects of war, they will nevertheless prove of great benefit to industries engaged in peaceful pursuit at the end of the war."

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An Electrical Proving House.

The discussion held last week by the Institution of Electrical Engineers on the desirability of establishing a British electrical Proving House will, we think, be regarded with general satisfaction. The idea of forming such an establishment has been mooted more than once. It has been strongly favoured by the President, Mr. C. H. WORDINGHAM, for some years; but the time for its adoption did not seem to have arrived, or at least the support was inadequate—the two are not synonymous, and unfortunately in this country support of a scheme often has a considerable time-lag compared with its desirability. It is now realised much more thoroughly that an institution of this kind would be very beneficial.

With regard to its scope, a great deal of the work which should be undertaken is quite obvious. The Proving House would concern itself essentially with certifying the design of manufactured articles to specifications, and with the performance of such articles, so as to ensure that they are actually, both in design and performance, what they purport to be. This hall mark would have a very important effect in increasing the trade of home manufacturers of good repute, in limiting shoddy work, and in the improvement of designs. As to how far such testing should go, there may be some difference of opinion. We hold the view that materials, as materials pure and simple, should not be tested by such an institution, nor should an attempt be made to vouch for the life of cables or of pieces of apparatus. The specifications, however, should be drawn with a view to ensure a reasonable life, and the function of the Proving House should be to certify compliance with the specifications where this is possible. In the case of chemical products—and to some extent cables come within this category—this is often not possible.

In creating an institution of this kind it is important to define its activities and its relations to other bodies. We already have the National Physical Laboratory, which is able to carry out a certain amount of work of a kindred nature, but it cannot act adequately as a Proving House; the work is of a different character. Nevertheless, there is a very great deal to be said in favour of a Proving House which is run in close conjunction with the National Physical Laboratory. By so doing, the status of the Proving House would be at once accepted, and the one institution would be, as it were, the complement of the other. Take, for example, the question of research. Mr. C. TURNBULL, on whose Paper this discussion arose, suggests that the Proving House should be an institution which would carry out a considerable amount of research. We are of the opinion that research should be wholly beyond its scope. The function of the Proving House should be to prove that the manufactured articles are what they claim to be, and the work carried on by such an institution would be chiefly in the nature of routine. Nevertheless, in the course of these tests, we do not doubt it will be found that research in one direction or another is necessary if certain observations are to be understood. In that event it would, in our opinion, be for the board of management to ask the National Physical Laboratory to carry out such definite researches as may be found to be desirable. By so doing, overlapping and the duplication of effort would be avoided.

At the opening of the discussion, Mr. WORDINGHAM stated the attitude of the Council in regard to the whole question, and we were glad to find that his announcement dealt with some of the points to which we have referred. A Committee of the Council has been considering the whole question, and has come to the conclusion that it would be highly desirable to form a Proving House which would be a sort of off-shoot of the National Physical Laboratory, but would be managed by a virtually independent board, such board being thoroughly representative of the interests concerned. Further, the conclusion had been reached that research should not be undertaken by the proposed institution. It appears to us that the scheme outlined by Mr. WORDINGHAM should prove thoroughly satisfactory, though small modifications in detail may be necessary in the proportion of trade representation if the work is to have a thoroughly commercial value; but at the same time there must be no losing sight of the fact that the tests must be of a thoroughly independent character. In other words, the tests must be really practical and the Institution itself must inspire confidence.

One or two speakers made reference to the obvious fact that the work of such an institution is bound up with specifications for construction, on the one hand, and with rules for installation on the other. So far, specifications are largely lacking, and would have to be evolved. On the other hand, when we come to rules for installation, it may be said that we are at present suffering from having too many of them, and that they should be properly co-ordinated by one authority. It is pretty evident that a great deal of work must be done in these directions before the Proving House can do its work fully. This, however, need not prevent steps being taken to bring into being an institution which is undoubtedly very necessary for the well-being of the electrical industry.

Reviews.

Power Wiring Diagrams. By A. T. DOVER. (London: Whittaker & Co.) Pp xvi. + 208. 6s. net.

This book is essentially for all who are connected with the design and use of switchgear and control apparatus. The contents are what the title implies, and the compilation has been carried out very thoroughly and conscientiously. The book is small enough to be carried in the pocket, though this handy arrangement has entailed the use of small blocks and type. Occasionally the small blocks are troublesome, because the connections lose distinctness, but this criticism only applies to a few diagrams, and might not be raised by those who do not object to small print, &c. As far as possible, the diagrams have been drawn to be representative of the actual control apparatus to which they refer, but in certain cases a detailed diagram has been supplemented by a schematic diagram, in order to facilitate the tracing of the circuits.

After a list of the abbreviations and conventional signs adopted, we come to section I, which deals with continuous-current motors and control apparatus. The standard internal and external connections of the different motors are given, along with the diagrams of controllers for printing presses, machine tools, pumps, cranes, lifts, &c. In section 2, diagrams are given for two and three-wire, continuous-current generators, for balancers, and for potentiometer-connected field rheostats. Section 3 is devoted to continuous-current switch panels, and includes panels for generators with rotary or static balancers, for boosters, for charging and searchlight sets, &c. Alternating-current circuits are reached in section 4,

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which deals with single-phase starters, controllers for polyphase motors (including motors with pole-changing windings) and the wiring for cranes. Power transformers and static balancers are dealt with in section 5, and instruments, instrument transformers and relays in section 6. Section 7 is devoted to leakage protective systems, and includes diagrams for detectors and indicators in continuous-and alternating-current mining installations, core-balancing leakage system for three-phase circuits, current-balancing system for transformers and alternators, and voltage balancing split-conductor and auxiliary sheath protective systems for feeders. The next section deals with alternating-current switchgear and panels, and includes oil switches, panels for alternators, motor-generators, rotary converters, two and three-phase feeders. The last section contains descriptions and diagrams of the Tirrill and the Brown-Boveri automatic voltage regulators.

There are two appendices—one giving tables and data, the other photographic illustrations of control apparatus. We do not agree with the temperature rise and overload rating of continuous- and alternating-current motors and generators given in Table II., which seems to be, or should be, out of date. It would be much better to give the rules laid down by the Engineering Standards Committee.

No attempt has been made to make the above summary of the contents of the book complete, but it will enable the reader to form a good idea of the valuable information imparted and the wide range covered. Mr. Dover is to be congratulated on the success he has made of such a painstaking and laborious task. One cannot lay down a book of this kind without thinking how good it would be to make it compulsory to supply a proper diagram of connections with all electrical machinery and apparatus. STANLEY PARKER SMITH.

Radio Communication: Theory and Methods; with an Appendix on Transmission Over Wires. By JOHN MILLS. (London: Hill Publishing Co.) Pp. xi.+205. 7s. 4d.

It is stated in the preface that this book is the substance of a course of lectures given by the author in 1917 to a company of the U.S. Reserve Signal Corps troops. Two such companies were formed from the employees of the Western Electric Company and trained by other employees. The author is a member of the research staff of the company, and this course of lectures, together with some laboratory work, constituted the training in radio communication. As one would expect under such circumstances, only present-day apparatus is dealt with, no attempt being made to describe obsolete apparatus and methods, however great their historical interest. Although the author claims to have adopted a method involving no mathematics except elementary algebra, the treatment is more mathematiacl and less descriptive than one might have anticipated. This is probably unavoidable in view of the author's statement that "the aim throughout has been to present fundamental principles and methods rather than detailed instruction as to apparatus and its operation." To expound the fundamental principles of radiotelegraphy, except in a very superficial way, requires a higher standard of mathematical knowledge than can be fairly described as elementary algebra.

The 175 pages are divided into eight chapters and an appendix. The first chapter deals with resistance, inductance, &c., the representation of sinusoidal alternating functions by vector diagrams and by vector operators. The statement on page 3 that "the ratio at any instant of the E.M.F. to the resulting current is the instantaneous value of the impedance" is misleading, unless it be clearly stated what E.M.F. is meant; if the resultant E.M.F. be used, the ratio is the ohmic resistance. The sections headed "General expression for conjugate vectors" and "Omission of a conjugate vector" with such formulæ as

$$v=[E\cos\theta+jE\sin\theta]e^{j\omega t}+[E\cos\theta-jE\sin\theta]e^{-j\omega t}$$

serve to illustrate what is said above as to the mathematical standard essential to a proper appreciation of the book.

Chapter II. deals with the telephone receiver and the variation of its characteristics with frequency. On page 35 it is stated that above the resonant frequency "power is returned to the receiver winding by the moving diaphragm; that is, we have generator action. This is somewhat analogous to the induction motor, which . . . acts as a generator when driven above synchronism, delivering energy to the input line." This is a very strange analogy; mechanical power is supplied to the induction motor to drive it above synchronism and enable it to act as a generator. The absence of such a source in the case of the telephone should have led the author to suspect that something was wrong. Although the motional resistance of a receiver changes from positive to negative on passing beyond the resonant frequency, the motional power does not change sign, but reaches a maximum, and power is no more returned to the winding than it was below resonance.

Chapter III. deals with thermionic valves, and Chapter IV. with various types of detectors; the treatment of the latter is so brief as to amount to little more than a classification. Oscillatory circuits both single and coupled, are considered in the following chapter; the resonance curves of Fig. 46 have a very unfamiliar shape. Chapter VI. is devoted to the various method of producing undamped waves. Ether waves, aerials, long-distance transmission formulæ, &c., are considered in Chapter VII., and various practical appliances and methods in Chapter VIII.

In the appendix, the ordinary telephone transmission formulæ are developed, and the equivalent T worked out for a section of the line. The selection of problems which follows is almost entirely of a purely mathematical nature, the object being to familiarise the student with such questions as "What is $10\,\varepsilon^{j\omega t}\times 5\varepsilon^{j\pi}$?" Of the three tables with which the book concludes, the first gives values of ε^{x}, the second, sines and cosines, and the third, definitions of the practical electrical units. As an example of the latter we have: "Reactance—the Ohm That portion of the impedance which represents the impedance in an equivalent series circuit of the reservoir for energy storage," which, although true, sounds somewhat involved.

On the whole, however, the book can be recommended to those wanting a brief, concise outline of the principles of modern radiotelegraphy. G. W. O. HOWE.

Tables of British Decimal Coinage, Metric and British Weights and Measures. By A. J. LAWSON. (London: Eyre & Spottiswoode, Ltd.) Pp. 211. 5s. net.

The set of tables compiled in this work are presented under the auspices of the British-Italian Commercial Association. In an introduction by the chairman (Mr. R. Benson) the hope is expressed that the book will help to stimulate fuller intercourse between the two nations: its entire contents are bilingual, the British and Italian equivalents being placed side by side throughout. In anticipation of the recommendation of the Institute of Bankers being adopted, tables are given for the conversion of Italian lire into English decimal equivalents (*i.e.*, the pound sterling divided into 10 florins, 250 pence and 1,000 "mils").

Tables for converting from the metric to the British system for measures of length, area, volume and capacity are likewise given, and there is also matter of special technical and engineering interest, such as the data on tensile strength, pressure conversions, standard screw threads, railway curves, &c. The report of the Institute of Bankers appears as an appendix.

The book should prove useful at the present time, when the question of adopting the metric system is under consideration.

Sir Charles W. Macara, Bart.: A Sketch of Modern Lancashire. By W. HASLAM MILLS. (Manchester: Sherratt & Hughes.) Pp. 334. 6s. net.

Events in the labour world, and especially the growing movement towards what is now known as "industrial reconstruction," render this sketch of modern Lancashire and the account of the life work of Sir Charles Macara of absorbing interest.

The work of Sir Charles Macara in connection with the cotton industry is not only of national importance, it attracted attention in all the chief countries of the world. To an exceptionally deep technical knowledge of the industry, he united in a marked degree the faculty of talking to the workman as

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man to man. "He neither strutted not did he seem to condescend."

This book traces the development of the industrial system of the cotton industry up to the celebrated Brooklands Agreement in 1893, which, with its subsequent additions and modifications, became the standing example of the industrial councils now the subject of so much discussion. The conception of community of interests between workers and employers was developed in relation to industry generally in the scheme brought before Parliament in 1911. At the time, its promise was but imperfectly fulfilled, but its essential principles are receiving the fullest recognition do-day. Even more impressive is the account of Sir Charles Macara's work towards the internationalisation of the cotton industry. This will long remain a shining example of the solution of commercial and industrial problems by international consent. The war has shattered much of this fabric, but it will surely be revived in time to come, given in fuller detail, including a sketch of the constitution of the first Industrial Council and the Conciliation Boards, and when the history of the great developments in the industrial world which will doubtless follow the termination of this war are written, a high place will be assigned to the pioneering work of Sir Charles Macara.

Correspondence.

BRITISH ENGINEERING IN CHINA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Does it really matter to us, in 1918, whether British engineering firms were well-represented in China before the war or not? It is, however, as important as it is imperative that your readers should know who represented German firms in China, and elsewhere, in the "Wait and See" days.

As far as the writer remembers, the A.E.G. used to be *aggressively* represented in China by Messrs. Arnhold, Karberg & Co., but he has not the means of finding out whether Arnhold Karberg & Co. and Arnhold Bros. are one and the same firm. Perhaps, Sir, you are in a position to do so?—I am, &c.,

London, May 13. "VERITAS."

[We are glad to publish the above letter so as to clear up any misconceptions on the subject. We could not find the firm of Arnhold Bros. & Co. in the statutory "black" list, and on enquiry we ascertained that there existed in China the firm of Arnhold, Karberg & Co., Ltd., who were agents of the A.E.G. We were informed that the firm consisted of four members, two German and two British. The British members were the brothers Arnhold, who, when the war broke out, left the old firm of Arnhold, Karberg & Co. The latter firm is still trading under German management. The two brothers Arnhold started business on their own account, and called their firm H. E. Arnhold—changed subsequently under a Hong Kong Ordinance to Arnhold Bros. & Co., Ltd. They trade under that style to-day with the complete sanction of the authorities. They (or Mr. H. E. Arnhold) are on the approved list of consignees in China. So far as we are aware, there is no reason to believe that they have, or wish to have, any enemy interests whatever. They have satisfied the authorities to that extent, and we are informed that they are in a position to be very useful to British trade, because of their previous connections. Owing to pre-war liabilities there is also in London and New York a firm known as Arnhold, Karberg & Co. It is, we are instructed, legitimate to trade with the latter firm as they are only the British and American houses of Arnhold Bros. & Co., and have no connection with the Arnhold, Karberg & Co. still trading in China.—ED. *E.*]

Royal Society.—Among the Papers read at the meeting held yesterday was one by Mr. C. M. Williams, on "The Absorption of X-rays in Copper and Aluminium," and one by Dr. T. R. Merton, on "The Electrical Resolution and Broadening of Helium Lines."

Trade Parliaments and Their Work.

By E. J. P. BENN.

IV.—Demobilisation and Apprenticeship.

Joint Standing Industrial Councils could be busily employed if they existed to-day and did nothing else but study the problems connected with demobilisation, apprenticeship, and kindred matters, and prepared reports and plans for the guidance of the Government when the need arises. There are to-day eight million workers, or half of our industrial population, employed directly on the war, either as soldiers or munition workers. To these must be added some millions of civilian workers whose present occupation is dependent on the war. We may, therefore, assume that when the war comes to an end, not less than ten million persons will find themselves, if not actually out of work, at least under notice. It is generally assumed that the Government will keep on its employees—soldiers and others—in their present position and only let them out upon the market at the rate at which the market is prepared to absorb them. This is, no doubt, a very necessary arrangement, but, from the national point of view, an extremely expensive one, and anything which can be done to facilitate the rapid transfer from war of this large proportion of the population must certainly not be neglected. The demobilisation of the Army would be better described as the remobilisation of industry, and it is obviously a much more difficult job for industry than for the War Office. It must be remembered that these ten million people have been absorbed into the war by degrees. Lord Kitchener's first demand was for 500,000 men, and that was thought to be rather a large order at the time that it was first given. We have taken four years to divert this huge army from its normal work to war work. The reverse process will have to be done at a much more rapid rate. We shall be in direct competition with every nation of the world in this matter. Whoever wins the war, the nation which can restart its industries most rapidly will win the world's markets.

So long as the debate on demobilisation is confined to such general principles as those stated above the matter seems easy; it is when we get down to details that the difficulties become more apparent. Every trade has its necessary proportion of skilled and unskilled workers; every factory depends upon the proper arrangement of different classes of workers. There are very few trades that can be kept going unless all departments are run on about the same pace. The War Office knows nothing of these matters, and unless it is informed by the trades themselves of the classes of labour which should be demobilised first utter chaos must ensue. There will be gangs of machine hands without a fitter, fitters without hands, labourers without foremen, and foremen without labourers. The elaborate process of combing out, under which the less essential workers have been taken first, has been performed very gradually and with much painstaking on the part of tribunals and others. The reverse process will have to be performed at a much more rapid rate and cannot be successfully accomplished without the most elaborate and detailed and expert plans carefully prepared beforehand. The same sort of question will arise as to the preference to be given to particular trades. For example, it is no use supplying the fancy leather trades with labour until tanners and curriers are first put to work.

There is another big class of problem which comes under the term apprenticeship, which can only be settled by each trade and which will demand the early attention of Whitley Councils. Under this heading we class all those problems which arise from the fact that our boys of 18 will have lost four or five years of the most valuable period of their lives. The problem starts with the medical student and finishes with the boy in the factory. All through the professions and the trades we find innumerable customs under which the youth begins as a learner, then becomes an improver, and then a second, and, finally, a first hand. Between 18 and 23 or 24 in every walk of life a youth is really learning his business. The war has cut this period clean out of the lives of hundreds of thousands of young men, and the most careful arrangements will have to be made to provide for the problems that have thus arisen. The articled clerk who was willing, as a boy of 18, to live at home and take £30 or £40 a year as pocket money has suddenly become a young man who ought to know his business and ought to be earning a proper wage. Now, if this problem is left to individual bargaining between man and employer the consequences will be very serious, and it is obviously necessary for each profession and each trade to lay down principles which shall guide all the individuals concerned.

There is still another side to this great subject—the question of the disabled and the unfit. After every previous war in history the streets have been crowded with beggars recruited from this class.

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No nation has a clean record so far in this respect, but if the British nation is determined to do anything it is certainly determined that those of its sons who have been disabled in the present war should be properly treated when that war comes to an end. It is agreed that this is not a matter for charity. Our heroes are not to be submitted to the indignity of accepting alms. It becomes, therefore, the duty of each profession and each trade to provide for its own disabled. It is surely absurd that the skilled cabinet maker should have to start his life over again and learn some totally different trade. It is obvious that, even though his abilities may be seriously impaired, his past experience of his own trade must be capable of being turned to some account.

There can be no arguing as to the need of Joint Standing Industrial Councils to consider all these problems, and in this branch of work we are free from the discussion as to whether Labour has a right to participate. All these things can certainly be arranged far better by a Council composed of equal parts of employers and employed than by any sectional organisation.

Provincial Electric Supply Committee.

The annual meeting of the Provincial Electric Supply Committee was held on the 30th ult. The chairman (Mr. H. B. RENWICK) presided, and amongst others the following representatives were present:—

Sir Henry Mance (Oxford Co.), Sir J. S. Harmood-Banner, M.P. (Midland Co.), W. L. Madgen (British Electric Federation), F. E. Gripper (Edmundsons), Emile Garcke, A. A. C. Swinton (Cambridge Co.), J. E. Spagnoletti (Banbury Co.), J. G. B. Stone (Electric Supply Corpn.), G. H. Jackson (Northampton Co.), J. Herbert Edwards (Stroud, &c.), Talfoud Ely and J. J. Jeffery (Ross Co.), C. Shirreff Hilton (Birkdale Co.), H. B. Harvey (Kent Co.), K. A. Scott-Moncrief (Hendon Co.), W. B. Esson (West London & Provincial Co.), C. W. Spencer Hawes (Reading Co.), H. B. Leather (Minehead Co.), John Christy and Leonard Christy (Clevedon Co.), Napier Prentice (Suffolk Co.), F. W. Reynolds (Coatbridge Co.), H. A. Alger (Richmond Co.), F. C. McQuown (Bournemouth Co.), H. W. Bowden (Woking Co.), J. L. Shand (Newcastle Co.), and T. Petersen (Uxbridge Co.).

The CHAIRMAN explained that the Committee was started in the beginning of 1917 with an original membership of 61 provincial companies. The list now showed 106 companies as members of the Association, in fact, practically the whole of the important provincial supply companies throughout the kingdom. The Association grew out of the co-operation of the provincial companies under the appeal made by Mr. Renwick to the Excess Profits Commissioners, which resulted in the provincial companies being placed on a very favourable footing. The chairman, in reviewing the work of the year, ran over the various matters which had chiefly occupied the Committee's attention, including the amendments to the Courts (Emergency Powers) Bill (by which clauses protecting water, heat, light, traction and power were inserted), the evidence given by the chairman on behalf of the provincial companies before the Board of Trade Electric Power Supply Committee, negotiation with the Inland Revenue authorities with regard to increased depreciation, local rating, leaving certificates, wages and bonus orders, &c. Also the Conference with the Board of Trade to obtain increases in the maximum prices scheduled in provincial provisional orders and with the same department and the Ministry of Munitions whereby support had been given to the companies in their revision of unremunerative long-term contracts. The position of companies using fuel oil had also been protected through the Petrol Controller of the Ministry of Munitions. Electric vehicles had received consideration and the Committee were co-operating with the Institution of Electrical Engineers in regard to electric cooking. The Committee had also taken an important part in connection with the revision of the reserved occupations list and the Ministry of National Service. At present the question of coal supplies and economies was the chief matter being dealt with.

Sir HARMOOD-BANNER, M.P., said that the results of the year's work were quite sufficient to show that they had acted wisely in creating the Association and supporting Mr. Renwick in his inauguration of the Committee, and although there were anxious times in front, the companies' interests in Mr. Renwick's hands would be well looked after.

Sir HENRY C. MANCE expressed his appreciation of the assistance rendered to him by the Committee during the year, and he urged the need for close co-operation and co-ordination of interests.

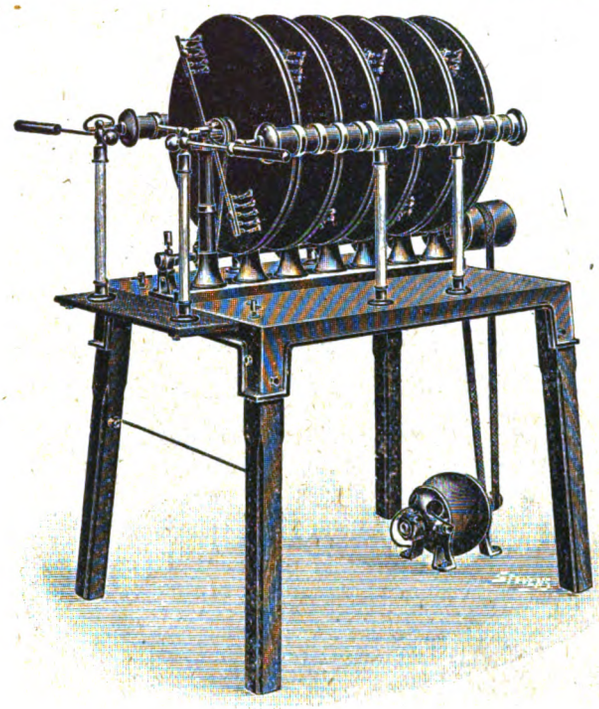
Mr. EMILE GARCKE referred to the great success Mr. Renwick had achieved in bringing together such a representative body and the excellent work done during the first year.

Mr. Madgen, Mr. Campbell Swinton and Mr. F. E. Gripper also spoke on the work done during the past year.

Mr. RENWICK, in reply, explained that the very successful results obtained must be taken as due largely to the assiduous work put in by the Executive Committee and without whose assistance he would not have been able to place such an excellent report before them.

The Static Machine of the Medical Supply Association.

The general experience has been that the electrostatic influence machine is not a very trustworthy piece of apparatus from the point of view of getting discharges easily in any state of the atmosphere. This is one reason, no doubt, why it has not come into more general use. It is claimed that such difficulties have now been overcome in the machine manufactured by the Medical Supply Association. As to why the result should be superior, no very definite explanation can be given, for the simple reason that the principles underlying the working of such machines are still by no means fully understood. The makers attribute the better working to the fact that the speed of rotation is much higher than in the older class of machine. This higher speed is rendered possible by the special form of construction that has been adopted. The plates are made of ebonite and are 3/16 in. thick, being 22 in. in diameter, and run at 900 revs. per min. in opposite directions. They are made in three layers, the centre layer being strong mechanically; the outer layers are of a different quality of ebonite, being more brittle and therefore less able to bear a high speed of rotation, but better from the point of view of static electricity. The plates, as a whole, however, are sufficiently strong to withstand this high speed.



ELECTRICALLY DRIVEN STATIC MACHINE.

As will be seen by the illustration, the machine is mounted upon an iron stand and is motor driven. The pairs of plates are so mounted that they are easily removable, and as no sectors are used they can be very easily cleaned whilst in motion. We understand that currents of $\frac{1}{2}$ to $\frac{3}{4}$ milliampere at 50,000 volts with an X-ray tube in circuit may be obtained. We need scarcely say that such machines are very convenient for X-ray work and medical purposes, and it is possible that they might be used with advantage for experimental work in connection with electroculture. It will be remembered that Lemstrom's pioneer work was carried out by means of machines of this class.

Parliamentary Intelligence.

ALDERSHOT GAS, WATER, &c., BILL.

The Bill promoted by the Aldershot Gas, Water and District Lighting Co. was recently passed by a Committee of the House of Lords.

Mr. VESEY KNOX, K.C. (who, with Mr. Jeeves, appeared for the promoters), outlined the gas and electricity powers of the Bill. As to the supply of electricity, Aldershot Urban Council had their own undertaking, and Farnborough Urban Council obtained powers in 1899 which were revoked in 1904 by the Board of Trade, because the Council had done nothing with them. If a supply of electricity were to be provided economically and profitably in a district of that kind, it must be by the gas company, who could use gas in generating electricity; and the whole of the management and collection being in the same hands, the cost would be much less than if there were separate gas and electricity organisations.

Mr. R. W. EDWARDS, managing director of the Company, said the delay in exercising the powers which the Company obtained to supply

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electricity had been due to the time occupied in experimenting to secure the right type of generating engine. They had had some experience of the advantages of running gas and electricity undertakings together.

Provisional Orders for 1918.—In reply to a question, Mr. Wardle, Parliamentary Secretary to the Board of Trade, states that the decision of the Board of Trade not to proceed with any applications for electric lighting provisional orders this Session, with the exception of two in regard to which the Board are satisfied that there is urgency, has been taken as a matter of policy under the discretion given to the Board by the Electric Lighting Acts, pending any action that may be taken as a result of the report of the Coal Conservation Sub-Committee of the Reconstruction Committee and of that of the Electric Power Supply Committee, and was not in any case based on the merits of the application. The authority granted to the Corporation of Rotherham in August last was to supply electricity in bulk to a neighbouring undertaking, and to certain specified premises, and was given by departmental Order in the interests of economy in generation and of war services.

Patents and Designs Bill.—Sir A. Stanley stated in the House of Commons recently that it was intended to re-introduce the Patents and Designs Bill in the present session, and the measure would contain clauses dealing with the extension of the life of patents, the working of which had been prevented during the war.

Post Office (No. 2) Bill.—This Bill, which authorises an increase in the rates of postage for letters, postcards, book packets and parcels, was read a second time in the House of Commons last week.

The Postmaster-General (Mr. Illingworth) announced that the postage on letters for the troops would continue to be at the present rates.

Private Bill Legislation.—The County of London Electric Supply and the Yorkshire Electric Power Bills were read a third time in the House of Lords last week. The third reading of the Shropshire, Worcestershire and Staffordshire Electric Power Bill has been adjourned until after Whitsuntide.

Legal Intelligence.

Post Office Tube Railway Award.

Mr. J. H. Oakley has issued his award on the claim by the Great Eastern Railway Co. for £33,393 compensation from the Postmaster-General owing to taking so much of the sub-soil as is required for the Post Office Tube Railway at Liverpool-street station, and for injuriously affecting the adjoining lands by carrying out such works. The award gives £6,884 for the right of user of the sub-soil of the lands and a further sum of £2,680 in respect of damage to the company by the severance of the lands or otherwise injuriously affecting the said lands by the exercise of the powers conferred by the Post Office (London Railway) Act, 1913. The case was reported in THE ELECTRICIAN for April 5.

Paton v. Enever.

In the King's Bench Division last week Miss Evelyn M. Paton, sued Mr. Edwin Alex. Enever, engineer, to recover £1,500 advanced to defendant.

Plaintiff gave evidence to the effect that she had advanced £1,200 to defendant, and subsequently, at defendant's suggestion she became interested in the formation of an electric power company under the title of the "E.M.P." Co. She never offered to finance the proposed company, and the money advanced was simply a personal loan to defendant.

The defence was that the money was advanced by plaintiff to form a company which, obviously, was more or less of a speculative character. Ultimately defendant submitted to judgment for the amount claimed. The company was going on well, and if plaintiff would only give him reasonable time the money would be repaid.

Judgment was entered for plaintiff with costs.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W.1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain of the Week.—Captain W. Darley Bentley.

Next for Duty.—Captain E. G. Fleming.

Monday, May 20.—Commandant's Parade at Waterloo Station, 8.45 a.m., for work at Esher. Dress: Marching Order, with Rifles. Midday and tea rations to be carried.

Tuesday, May 21.—Lecture on Demolitions, 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, May 22.—No. 1 Company, Drill, Knotting and Lashing, 6.30–8.30. Recruits' Drill, 6.30.

Thursday, May 23.—No. 2 Company, Drill, Knotting and Lashing, 6.0–80. Recruits' Drill, 6.30. Signalling Section, 6.30–8.30. Ambulance Section, 6.30–8.30. Band Practice, 7.0.

Friday, May 24.—Musketry for the whole Corps, 5.30–8.0.

Saturday, May 25.—Entrenchments, Revetments, &c., for the whole Corps, 2.45–4.45. Recruits' Drill, 2.45–4.45.

SPECIAL NOTICES.—All drills will take place at Headquarters unless otherwise stated.

The M.O. will attend for the examination of Recruits on Thursday evening at 6.0.

Summer Camp.—Arrangements are now being made for this Camp to start on August 3.

Patent Record.

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

March 27, 1918.

5,395 GRYLLS & HEAPE. Electric arc lamps.
5,398 ESTELLE. Electrolytic production of iron.
5,404 BERRY. Means for obtaining h.t.d.c. voltages.
5,420 FILIPPONE. Auto-generating portable electric lamps.
5,421 MIDDLETON. Interlocking mechanism for electric switches, &c.

March 28, 1918.

5,452 SMITH. Machines for winding insulated wire, &c.
5,476, 5,477 and 5,478 AUTOMATIC TELEPHONE MFG. CO., RAY & SAVIN. Telephone systems.
5,479 MATSUSHIMA. Apparatus for electrolysing salt solution.

April 2, 1918.

5,584 SHELL. Device for electrical transmission of sound.
5,585 FURSE. Portable stand for electric lamps.
5,633 PRICE. Dynamo electric machines.

April 3, 1918.

5,665 PRIDDLE. Connectors for electric cables.
5,712 LATOUR. Audion or lamp relay or amplifying apparatus. (3,4/17, France.)

April 4, 1918.

5,746 TELFORD, GRIER & MACKAY. Varying candle-power of electric lights.
5,747 ROBERTS. Position indicator for tramcars, &c.
5,749 FORSSELIUS. Ball contact commutator brush.
5,770 BUSHNELL & KILLINGSWORTH. Magnetos.
5,771 BEAVER. Tee or branch joints of armoured electric cables.
5,774 BIBIRE & CLAREMONT. Electric speed controlling apparatus.
5,779 B.T.-H. Co. Lanterns for gas-filled electric lamps.
5,780 B.T.-H. Co. & WHEAT. Electric lamp fittings.

April 5, 1918.

5,841 CARNEY & LACEY. Cooling electric machinery, &c.
5,860 B.T.-H. Co. (G.E. Co.) Sound producing devices.
5,867 MARCONI. Electric accumulators. (5,4/17, Italy.)
5,881 HUNTINGTON, MANIFOLD & POOLE. Electric heaters.
5,886 & 5,887 BRILLOUIN. Wireless telephone installations. (8,10/17, France.)

April 6, 1918.

5,866 AKTIESELSKAB ARENDAL SMELTEVERK. Electrode holders. (13,4/17, Norway.)
5,917 B.T.-H. Co. (G.E. Co.) Electric lamps.
5,918 SIEMENS & HALSKE A. G. Electric measuring apparatus.
5,927 LATOUR. Audion or lamp relay or amplifying apparatus.
5,936 DAVIS. Electric accumulators.
5,937 MULLARD. Electric resistances.

April 8, 1918

5,953 WILKIE. Elbows, &c., for electric conduits.
5,966 REYROLLE & HOWARD. Electric switches.
5,970 B.T.-H. Co. & HAMLYN. Starting switches for a.c. motors.
5,971 B.T.-H. Co. (G.E. Co.) Incandescent cathode devices.
5,982 MAPELLI. Ignition magnetos for internal combustion engines. (6/4/17, Italy.)
5,986 HENLEY. Brushes for dynamo-electric machines, &c.
5,992 VILLIERS. Electro-magnets with movable cores or armatures.
5,993 VILLIERS. Means of adjusting and indicating travel of machines or instruments operated by core or armature of electro-magnet.

April 9, 1918.

6,001 HUMPHERSON. Gas and electric cooking stoves.
6,007 ILLINGWORTH. Electric cut out.
6,021 ASHTON. Electro-massaging apparatus.
6,038 JONES. Systems of electro mechanical illuminated recording winding engine signals.
6,039 FLEMING. Electric furnaces.
6,055 NAAMLOOZE VENOOTSCHAP VITRITE WORKS & CHIJSEN. Bases for incandescent lamps.
6,059 SOKAL. Primary batteries.
6,068 WADE. (*See* Metallurgica Italiana.) Insulators for supporting electric cables.

April 10, 1918.

6,087 BENNETT, GILLOTT & MARPLES. Incandescent electric lamps.
6,090 FERNANDEZ. Automatic cut-outs.
6,101 HUNT. Electrolytic treatment of ores.
6,104 HOLLIS. Controlling a.c. power stations.
6,110 SMITH. Magneto.
6,131 BENITEZ. Process for generation of electrical energy.

April 11, 1918.

6,138 WALSALL HARDWARE MFG. CO., BROOKS, FRANKS & READ. Electric switches.
6,146 GREEN. Electric signalling systems.
6,180 B.T.-H. Co. (G.E. Co.) Insulating materials.
6,196 MONTELIUS. Transformation of electrical energy. (24/3/17, Sweden.)
6,215 TIGERSTEDT. Telephone receivers. (31/3/17, Denmark.)

April 12, 1918.

6,222 ROBERTS. Means for indicating in connection with electric circuits.
6,243 M.L. MAGNETO SYND. & HULSE. Driving couplings for magneto-electric machines.
6,247 LUZY. Pocket lamps with mechanical electric generator. (15/10/17, France.)
6,255 ORLING. Photo-electric aircraft revealer.
6,256 BRUSH ELECTRICAL ENGINEERING CO. Liquid resistances.
6,257 THOMSON, SPOT WELDER CO. Electric welding apparatus. (8/10/17, U.S.)
6,260 TURNER. Electric signalling apparatus.
6,272 CONTET. Electric car lighting, &c. (18/5/17, France.)
6,273 BENJAMIN ELECTRIC (LTD.) Electric lighting apparatus.

April 13, 1918.

6,298 BROWNLOW. Machines for cutting lamp bulbs.
6,307 COLLETTE. Electric generators and motors.
6,310 MACKENZIE. Telegraph systems.

April 15, 1918.

6,327 BENJAMIN ELECTRIC (LTD.). Signalling devices for motor vehicles. (18/6/17, U.S.).
6,342 MCKENZIE, HOLLAND & WESTINGHOUSE POWER SIGNAL CO. Railway traffic controlling apparatus. (16/4/17, U.S.)
6,370 SANTINELLO & WILCKDEN. Ignition magneto. (14/4/17, France.)
6,384 EDISON-SWAN ELECTRIC CO. & HIATT. Valves of wireless transmission systems.
6,386 STERLING TELEPHONE & ELECTRIC CO. & DAVEY. Automatic telephone exchange system.
6,388 TEASDALE BUCKELL. Telephones.

April 16, 1918.

6,418 LANGDON-DAVIES & SOAMES. Magnetic friction clutches.
6,419 MACKINTOSH. Controlling and operating railway and tramway points.
6,432 EXLEY & LEIFNER. Electric cells.
6,453 BELL. Electrically-heated machine for stamping metal articles.
6,459 BOSCH AKT. GES. Electrodes for spark discharges (16/4/17, Germany.)
6,466 LANDIS & GYR A.G. Electricity meters. (19/4/17, Switzerland.)

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Commercial Topics.

Small Tools.

The Minister of Munitions has issued the following order:—

No person shall on or after June 1, 1918, until further notice manufacture any small tool as hereinafter defined, or any part thereof, except under a licence issued under the authority of the Minister of Munitions. Every person engaged in the manufacture of small tools shall make such returns as shall from time to time be required. A list of the small tools included in the Order are set out, and applications for licences should be addressed to the Controller of Machine Tools, Charing Cross-buildings, London, W.C. 2, and marked "Small Tools."

* * * *

Electric Safety Lamps.

In the Order (No 524) issued by the Home Office in March last, certain modifications of existing safety lamps are made, and a few new types are included.

Among the electric lamps approved for general use is the Joel-Fors safety lamp, type 303M (made by Messrs. John Mills & Sons), which is identical in design with type 403M, by the same firm, but of smaller proportions.

The amendments to the schedules of former Orders include an amended specification of the "Ceag" miners' electric safety lamp, "so far as regards lamps made in the United Kingdom" (the lamp is made by the "Ceag" Miners' Supply Co., Ltd.); the Joel-Fors electric safety lamp, type 403M, and the Joel-Fors electric inspection lamp, type 303C, both made by Messrs John Mills & Sons.

* * * *

State Control of Industry.

Dr. Addison, M.P., who presided last week over a conference of employers and Labour representatives called to consider the formation of an Interim Industrial Reconstruction Committee for the glass industry, said that the problems of demobilisation did not simply relate to the movement of workers or the restoration of pre-war employment.

There were questions relating to raw materials, credit and orders to work for. Both employers and employed were equally restless under Government control, but industries could emancipate themselves from such control by organising and appointing a number of people to do the job for themselves. In many trades employers had turned their works inside out in order to manufacture something different from what they were making before, and the first essential for restarting some trades was that they should be re-equipped with machinery. The Government intended to take steps to get the industries working as speedily as possible. We had to look to maintaining and extending our hold in the markets of the world. By comprehensive organisation we could give brains and inventive capacity much greater chances. It was vital to the welfare of industry that there should be better understanding between employers and employed.

* * * *

Future of National Factories.

According to the British Empire Producer's Organisation, a sum of 66 million pounds has now been invested in national factories, but as this amount represents expenditure during a period of highly inflated prices, it is not likely that a valuation at the end of the war would nearly reach such figures.

A much larger amount has been advanced by the Government for the extension and equipment of private works, and provision is allowed for comparatively rapid depreciation in those cases. The Organisation claims that it is, therefore, necessary to form some clear conception of the place of national factories in our economic system of the future, as any uncertainty is likely to have a disturbing effect just when vigorous and confident enterprise is most essential; and it is already being made a subject of legitimate complaint that orders are being diverted from private works which were hastily mobilised for war work, and saved the country when the national factories were all unready.

* * * *

Tramway Fares.

The Select Committee of the House of Commons on Tramways (Statutory Requirements) has been taking evidence as to the necessity of getting power to increase beyond the statutory limit the maximum tolls and charges which may be demanded on tramways and light railways.

Mr. R. J. Howley said that in certain cases tramway undertakings were in a position to increase fares substantially, while in other cases they were so tied down by statutory restrictions that no increase could be made. Some form of relief was therefore called for. The Tramways and Light Railways Association maintained that it was not in the public interest that those who had found capital for public services should be forced, through no fault of their own, into financial difficulties, with no means of redress. Without private enterprise many sparsely populated districts would be without tramway facilities.

The chairman of the Committee is Sir Wm. Pearce, and the other members are: Sir Jas. Boyton, Mr. Broughton, Mr. Cochrane, Sir A. Fell, Mr. Nugent, Mr. Rendall, Mr. Tootill and Mr. Watt.

* * * *

Board of Trade Electric Power Committee.

It is reported that this Committee has completed its task, and the chairman (Sir Archibald Williamson, M.P.) has submitted a unanimous report which will be published shortly.

Commercial Policy After the War.

In the House of Commons on Monday Mr. Bonar Law said that the Government, following the example of the French Government, would denounce all commercial conventions containing a general clause regarding "most favoured nations."

The decision had been come to in view of the probable scarcity of raw materials after the war, and the necessity for providing for the needs of the British Empire and the Allies. The Government had not changed its policy expressed in the Paris Resolutions, and had reason to believe that America was very anxious for unity in economic control.

* * * *

Reconstruction Problems and Electric Power Supply.

It has been decided to form a Reconstruction Committee for the West Riding of Yorkshire, and the Provisional Committee has already passed the following resolution on the supply of electric power:—

That in view of the importance of electrical energy in the development of agriculture and other industries, the West Riding Law and Parliamentary Committee be requested to consider (special regard being had to the Yorkshire Electric Power Bill, 1918.) the need for securing the means of obtaining adequate provision of electrical energy in all parts of the county wherever it can be shown it is reasonable that such provision should be called for.

As the Board of Trade have reported that the time is inopportune for discussing the proposals of the Yorkshire Co. for extending its powers, the Company has abandoned the portions of the Bill to which exception was taken by the County Council.

* * * *

Standardisation of Electrical Appliances in Ontario.

On Jan. 1, 1918, the Hydro-Electric Commission of Ontario issued a notice with regard to the standards which are requisite for electrical machinery, apparatus, appliances, &c. The Commission orders that on and after three months from the date of the notice no electrical machinery, apparatus, appliances, devices, material or equipment used, or to be used, in the generation and distribution of electrical energy may be used in Ontario unless and until the design and construction of same has been submitted to the Hydro-Electric Power Commission of Ontario and approval of such has formally been obtained. It is stated that it is the intention of the Commission that all such material shall be subject to the same tests and be made in accordance with the same standards as are required of local and American manufacturers. A standard is considered necessary throughout the entire American Continent, and the one adopted is that of the Underwriters Laboratories of Chicago.

Electricity Supply.

Extensions.

Bury St. Edmunds.—The Council has decided to supply electrical energy for power and lighting to Messrs. Robert Boby (Ltd.), provided the firm contribute £400 towards cost of laying mains, &c.

Edinburgh.—At the last meeting of the Sub-Committee of the Electric Lighting Committee, Sir Alex. Kennedy submitted plans with reference to the proposed extension of the Portobello power station, so as to be able to supply electric current to the Lothian coal fields, &c.

Gillingham.—The Director of Electric Power Supply Department of the Ministry of Munitions has approved the installation of a new Diesel set, and application has been made to the Priority Department for the necessary authority to place contracts.

London County Council.—At Tuesday's meeting the following loans were sanctioned for electricity purposes:—

Woolwich Borough Council, £18,195 for a Babcock & Wilcox boiler with accessories, and for extension of the generating station buildings; Hammersmith Borough Council, £3,000 for purchase of 13 transformers.

Wakefield.—Application has been made to the L. G. Board for authority to borrow £6,000 for the electric supply undertaking.

Wolverhampton.—Mains are to be extended to give a supply of electricity to the Clyno Engineering Co.

General.

Blackburn.—The borough electrical engineer (Mr. P. P. Wheelwright) has undertaken the work of inspecting various works and factories in the locality in connection with the economy in coal consumption.

Blackpool.—At the local Tribunal last week Mr. Chas. Furness, tramways manager and electrical engineer, appealed for a tramway permanent way foreman, aged 35, Grade II., and married.

Mr. Furness stated they ran 1¼ million car-miles per annum. Owing

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to the lack of material the track was in a worse condition than ever before. He had recommended the Tramways Committee putting on another gang of at least 30 men, otherwise they would run to a standstill. It would mean the top-covered cars coming off, and it was, therefore, more essential than ever that the man should be retained.

Temporary exemption until Sept. 30 was granted.

Bolton.—The Electricity Committee proposes to secure new premises in Knowsley-street for the electricity fittings department.

Electricity in Rolling Mills.—At the recent meeting of the Sheffield Forge & Rolling Mills Co. (Ltd.) the chairman (Mr. A. E. Siddall) said that his main idea was for them to be fully equipped when the war was over, as, owing to the enormous increase in plant throughout the steel trade, the Company must be in a position to meet great competition. The whole of their new mills would be electrically driven. He was convinced that was going to be the method of propulsion of all machinery, and when they got it he did not fear any competitor in the country.

Electric Power Engineers' Asscciation.—The Midland section held a very successful smoking concert at Birmingham on the 10th inst.

Mr. R. A. Chattock, the city electrical engineer, of Birmingham, presided over a large and representative gathering, and spoke of the need for organisation among the engineers of the electrical industry. He hoped that all present would do everything in their power to make known the Association, of which he was a member. Primarily the Association desired to improve the status of its members, and to better their positions, particularly with regard to the younger ones. Employers of trained engineers would have to realise that they must pay for the goods. He referred to the widespread nature of the movement, and the danger, in case of duplication of organisations, of losing importance in the eyes of employers. The I.E.E. were interested in the present trend of affairs and with similar objects to themselves in view, desired to co-ordinate the efforts of all electrical engineers.

Haverfordwest.—A special meeting of the Corporation will be held to consider a scheme of electricity supply.

Marylebone (London).—Mr. C. H. Smythe, chief assistant engineer has been appointed acting chief engineer of the electricity department in succession to Mr. A. H. Seabrook, at a salary of £750 per annum.

The Electricity Committee has passed the following resolution: "That this Committee desires to place on record its great regret at losing the valued services of Mr. A. H. Seabrook, for the past nine years general manager and chief engineer of the electricity undertaking. The Committee recognises that in Mr. Seabrook it has had an officer of marked ability and exceptional energy, whose services to the undertaking in the critical period of its extension have been invaluable."

Norwich.—It has been decided to increase the salary of the city electrical engineer (Mr. F. M. Long) from £700 to £800 per annum.

Plymouth.—The Electricity and Street Lighting Committee recommend that the salary of the borough electrical engineer (Mr. E. G. Okell) be increased from £650 to £700 per annum.

Sheffield.—The Electric Supply Committee recommend that if owing to shortage of staff it is impossible for any member of the official staff to take his annual holiday he should be paid double salary for that period.

Torquay.—The salary of the acting borough electrical engineer, Mr. Keenan, has been increased to £230 per annum.

Wrexham.—The salary of the borough electrical engineer (Mr. W. G. Pickvance) has been increased to £450 per annum.

The Corporation will also supply annually to Mr. Pickvance's residence up to 5,000 units of electrical energy free of charge, but he will be charged for all energy used over this amount at ⅜d. per unit (plus percentages added during the war) with ¼d. per unit discount, and premiums in respect of pupils will be paid over to the Corporation.

Electric Traction.

A "Tube" Train Accident.—The Board of Trade inspector (Lieut.-Col. Pringle), in his report on the collision between two "Tube" trains near Warwick-avenue station on Feb. 25 last, finds that

The collision was due primarily to the train which ran into that in front of it travelling at a speed and in a manner contrary to rule, at a time when the automatic signals were at danger, and secondarily to the fact that the rear of the foremost train was not illuminated by red lights. He suggests that as a red light at the rear of all "Tube" trains is of great importance for safety, a permanent oil tail light should be used in preference to the existing electric system of tail lighting.

Dundee.—The Council has abolished halfpenny tramway fares, and in future 1d. will be charged for a journey covering three consecutive stages, any distance over that being 1½d.

Halifax.—The Tramways Committee has decided that, having regard to the important industries in the town, it is inadvisable to reduce the local tramway services any further.

Hampstead (London).—The Borough Council has decided to purchase two electrically propelled tipping trucks for coal handling at the electricity station.

The present cost of handling the coal is approximately £1,364 per annum, and it is estimated that the new method will effect a saving of £300 a year. The cost of the two electrically propelled trucks will be about £1,117.

Lowestoft.—The Board of Trade has declared that the powers of the Corporation in respect of the portion of tramway No. 2, authorised by the Lowestoft Corporation Act, 1901, which lies between Lowestoft North Station and the borough boundary, shall be at an end as from April 12, the working of such portion of tramway having been discontinued for three months.

Nelson.—The Tramways Committee recommended the abolition of half-penny fares.

Sheffield.—The Board of Trade has intimated that it will raise no objection to the use of double-deck tramcars on the Walkley route, and the Tramways and Motors' Committee recommend the purchase of 12 second-hand double-deck cars from the London County Council.

Stoke-on-Trent.—Last week the Council refused to seal the new agreement with the Potteries Electric Traction Co. giving them a renewal of their lease until 1932 upon certain conditions.

Wallasey.—The Board of Trade has suggested to the Council that the local tramway service should be reduced by one-third, in order to economise coal, &c.

West Hartlepool.—In future tramcars will cease running at 10 p.m., and cars on Sundays will not commence until 1.30. During weekends the privilege fares granted to members of H.M. Forces will be discontinued.

Telegraphy and Telephony

Leeds Automatic Telephone Exchange.—The new automatic telephone exchange will be inaugurated to-morrow (Saturday) afternoon, when the 7,000 odd telephones now operated from the Central Exchange will be simultaneously switched over to the automatic system.

Marconi Stations in Argentina.—The Argentine Government has set aside $90,000 m/n (about £7,800) to meet payments in terms of contracts entered into with the Compania Marconi de Telegrafea sin hilos del Rio de la Plata for the provision and erection of wireless stations at Cordoba and Tucuman.

Radio-Telegraphy in Mexico.—What is reported to be the first radio-telegraph station in Mexico is being erected in the Tampico oil district.

South American Cables.—It is reported that the Western Union Telegraph Co. has been accorded permission (without monopoly rights) to lay and work two new submarine cables.

One will start from Nictheroy (Brazil) and connect the island of Itaparaica, Aracape, Fernando Noronna, Parahyba, Natal, Belem and the Antilles, and the second will be laid from Nictheroy and connect up the Argentina via Paranaguà and Maldonado.

Imperial Notes.

Australasia.—At the recent annual meeting of the New South Wales section of the Electrical Association of Australia the President pointed out that while the war had given an impetus to the manufacture in Australia of electrical apparatus, and orders had been placed which would otherwise have gone abroad, had the firms been prepared, they could have secured a greater volume of work. Orders for electrical machinery have been placed with local manufacturers at exceptionally high prices.

In the development of the large electro-chemical and electro-thermic industries requiring a steady supply of power, it is probable that eventually the water powers of the State will be brought into operation in spite of the fact that coal is plentiful and only costs from 15s. to 20s. a ton. Water power can be developed economically and investigations show that 100,000 kw. could be delivered on the sea coast line. This would enable producers to manufacture all products of the electric furnace, including steel, carborundum and alundum, graphite for electrodes, lubricants, calcium carbide, as well as the preparation of cyanamide, alkali and probably aluminium.

The Tasmanian Hydro-Electric Department recently announced that owing to the increased demand for electrical energy in Hobart, and the inability to secure new plant, no further extensions would be made to the network and no further poles or distributors would be run to connect up consumers. No electric heating or cooking apparatus or motors will be connected.

The report of the West Australian Commissioner of Railways for the year ended June 30 last, states that the Perth electric tramways, which are now supplied with current from the Government power-house, showed a gross profit of £31,523 and a net profit of £4,683, after paying £26,840 as interest. Earnings per car mile were 16·96d. (compared with 17·03d. in previous year) and working costs 11·19d., or 12·71d., inc lud

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belated repairs. Earnings increased by £6,785 and the decrease in receipts per car mile was due to the extension of the workers' ticket concession. The extension of the overhead transmission line to Fremantle is well in hand.

There are a number of electrically propelled vehicles working in Christchurch (N.Z.), and the city electrical engineer expects a large increase in the number after the war.

The Hydro-Electric Power & Metallurgical Co. is establishing electrical plant at Electrana for treating zinciferous ores by the Gillies process and carbide works, with plant for making electrodes for the furnaces.

The Wollongong (N.S.W.) correspondent of the "Australian Industrial and Mining Standard" says Hoskins Ltd.'s coke ovens, in the Dapto district, are being adapted for electric operation. Everything is driven electrically, including the discharging ram.

The N.S.W. Public Works' Department power-house at Port Kembla is to be enlarged to enable it to supply current to municipalities in the district and on the tableland.

In anticipation of the opening of the first section of Melbourne's electrified suburban railways in June, the Victorian Railways Commissioners are holding classes for motormen, shunters and guards. About 150 men will be required for the Sandringham-Essendon line.

Stawell (Victoria) Council is conferring with Ararat Council on a joint scheme to supply electricity for Stawell and Ararat by utilising water power from the Grampians.

Mr. E. H. Miller (manager of Messrs. Harper's Starch Mills, Port Melbourne) has developed a system of generating water gas from soft coal and burning the gas under the tubes in tubular boilers. Morwell brown coal has been found particularly suitable for this purpose.

Canadian Hydro-Electric Power.—The Special Commission under the Public Utilities Act (Chief Justice Meredith and Justices Kelly and Sutherland) has decided that the Electrical Development Co. is not entitled under its charter to develop more than 125,000 H.P. at Niagara for commercial uses, and that the contention that it may exceed this amount if the average quantity used does not exceed 125,000 H.P. is unfounded.

South Africa.—The Department of Industries of the Union of South Africa has been advised that a company is now being formed to undertake the manufacture of electrolysers for use in the preparation of hydrochlorate of sodium.

Foreign Notes.

Hydro-Electric Power in Portugal.—A temporary hydraulic survey office has been established by the Portuguese Government to investigate the possibilities of the rivers of the country as regards their utilisation for the generation of power and for irrigation purposes. The Cavado and Douro rivers will be the first to be investigated.

Hydro-electric Power in Spain.—In the Spanish Senate last week Señor Cambo announced in the course of a debate on railway transport that the Government was occupied with a large scheme for the further development of hydro-electric energy, and for working the main railways of the country electrically.

A good deal of the hydro-electric plant in the country is of German origin, and in view of the extensive waterfalls in Spain the Government's proposals are important.

Japan.—The following is an extract from a report by the British Commercial attaché at Yokohama:—

At the end of 1916 there was a total of 3,744,141 houses lighted by electricity, with 9,035,468 lamps in use, having a total candle-power of 98,011,153. The amount of electricity generated for industrial purposes was 624,516 H.P. There was a mileage of lines for street cars amounting to 892, the length of telegraph wires was 45,000 miles, and that of submarine cables 5,900 miles. The number of telephone exchanges was 1,135, there being 222,516 telephones in use, and 152,911 applicants for the telephone service to be supplied.

"The Ohm" states that electrical, chemical and other industrial machinery soared last summer owing to the inflation of industry, 10 H.P. motors being advanced to 700 yen ($350). But most of these machines being all home manufactured, with the less favourable financial conditions, and also with the decreasing demands for machinery for factories, an average fall of between 10 and 20 per cent. was brought about in the market of general machinery, the 10 H.P. motors dropping to 580 yen ($290).

Norwegian Demand for Electric Automobiles.—It is reported that owing to the great scarcity of petrol and in view of the increased supply of electrical energy by hydro-electric plants, there is an extended use of electric automobiles.

Hitherto petrol cars have been practically the only ones in use in the country. For several months past no petrol has been received, and as there are but few electric cars in Norway, automobiles have practically disappeared. There is, therefore, a great demand now for electric cars and storage batteries and other apparatus.

Norwegian Hydro-Electric Energy.—The "Times" reports that a Swedish proposal to transmit the hydro-electric energy still unused in Southern Norway to the Trollhättan works, near Gothenburg, and from there to transmit the surplus energy thus produced to Denmark, whose industry may thereby be less dependent on fuel supplies from abroad.

Miscellaneous.

Alien Enemy Company Wound Up.—Last week Mr. Justice Younger made an order, on the petition of the Board of Trade, to wind up, under the Trading with the Enemy (Amendment) Act, 1916, the Calmon Asbestos & Rubber Works, Ltd.

Mr. AUSTEN-CARTMELL (for the Board) said it was a clear case of enemy control, and the business having been wound up by order of the Board there was nothing now left except to wind up the company.

His LORDSHIP raised a point as to whether there was not some procedure under which the company could be disposed of without going to the expense of a formal winding-up. The company had no debts, and there was nothing for it to do, and it seemed a pity that they should have to go to all the trouble and expense of a winding-up, merely for enabling somebody to give a receipt to the Controller for those small sums of money.

Alleged Threats to a Non-Union Man.—At the Marlborough-street (London) Police Court last week, Albert Edward Owen, electrician, was charged on remand, with assaulting Albert Edward Muller, electrical fitter, and he was also summoned for using violence to Muller with the view of intimidating him and preventing him from following his employment. G. W. Turner was also summoned for threatening Muller.

The proceedings were instituted under the Conspiracy and Protection of Property Act, 1875, and the Trades Disputes Act, 1905. The three men were employed by the New System Private Telephone Co., Great Portland-street, and on Muller going to work on the morning of April 29 he was approached by Owen, to whom he admitted that he was not a member of the Electrical Trades Union. Owen told him that the committee had given him a week to join, and Muller replied, "Let's get the war over first." On returning from Tottenham later in the day (about 12.30 p.m.), Muller alleged that he met a number of men, among whom were Owen and Turner, who threatened him if he did not join the Union. Owen told him he could not go into the premises because he was not a member of the Union. He walked into Euston-road, being followed by Turner, and there Owen struck him in the face with his fist, knocking him down, and while he was on the ground Owen struck him behind the ear. Muller, who went back to the shop and complained, was so injured that he had to be attended by a doctor.

Mr. R. L. MURRAY, chief engineer of the firm, said he was not a member of the Electrical Trades Union. So far as he knew, there were two who were not members, and all the rest were. At 8.30 on the morning of April 29, Owen came to his office and put a paper there to the effect that a shop meeting of the Union had passed a resolution that if Muller was engaged he would be given one week to join the Union, failing which they would down tools. They also asked for other guarantees as to work, &c. He asked for a day to consider the matter and Owen said he thought that was fair. He went outside for half a minute, and came back and said the men would not stand it, and were going to down tools.

In cross-examination, WITNESS said he did not know that it was a Union shop, because he had engaged men not in the Union, but who afterwards did join. He had no intention of trying to turn the shop into a non-union one.

Both defendants were committed for trial, £40 bail in each case being allowed.

Breach of Home Office Regulations.—At Sheffield, on the 1st inst., Messrs. Thos. Firth & Sons (Ltd.) were fined £20 for allowing Thomas Henry Jenkinson, unaccompanied by a competent person, to undertake the cleaning of a transformer house, during which he was killed.

Enemy Firm Wound-up.—The controller of the Brimsdown Lamp Works (Ltd.) has applied for a release. Any objections to be sent to the Board of Trade before May 22.

Lord Roberts Memorial Workshops.—At these workshops permanent employment is given to nearly 1,200 disabled men.

Owing to the demand for greater provision for the increasing number of wounded, able and willing to undertake work, an extension fund has been started for providing new buildings and plant, and to help this fund a special appeal will be made in London and the suburbs from May 20 to 28 at hotels, shops, works, &c. No flags will be sold, but the public will have the chance of filling model "Tanks" (made by the men in the workshops) with coins to aid this excellent work.

Military Service Exemptions.—Under the new Military Service Act the following will not be called up for medical examination until further instructions are given:—

Employees of electricity supply undertakings and cable companies, newspaper staffs, education officers and teachers and wireless school instructors.

Educational.

Birmingham University.—Dr. R. S. Heath, vice-principal, professor of mathematics and registrar, has decided to retire owing to ill-health.

Carlisle Science School.—The Carlisle Education Committee has approved a scheme for starting a science school.

Mr. F. W. Chance has offered £4,000 and some local firms have guaranteed £1,000 per annum for 5 years for equipping the chemical and physical laboratories.

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Tenders Invited and Accepted.

Water-Tube Boilers, Superheaters, Stokers, &c.

SUNDERLAND Corporation invite tenders for the supply and erection of two water-tube boilers with integral superheaters, mechanical stokers, vertical cast-iron tube economisers, steel plate chimneys, &c. Specification and form of tender from the general manager, Mr. Alfred S. Blackman, and tenders to the town clerk, Mr. H. Craven, Town Hall, Sunderland, by first post May 29.

Turbo-Alternator, Condensing Plant, Switchgear, Boiler, &c.

ISLINGTON (London) Lighting Committee require tenders by noon May 24 for (*a*) 5,000 kw. steam turbine, alternator, exciter, condensing plant, switchgear, &c.; and (*b*) water-tube boilers, coal conveyor, telpher, steam piping, &c. Specifications from the Electrical Engineer, Eden-grove, Holloway, N. 7.

Motors and Transformers.

WARRINGTON Electricity and Tramways Committee require tenders by noon, May 22, for supply of motors and transformers. Specifications from Borough Electrical Engineer.

BEDFORD.—The Council has ordered 4,600 yards of lead-covered cable from Siemens Bros. & Co., at £3,559.

CARDIFF.—The Corporation has placed an order with the Premier Cooling & Engineering Co. for the erection of cooling tower, &c., at £5,219, and with Rees Roturbo Mfg. Co., for motor-driven pumps at £433.

GLASGOW.—The Corporation has accepted the following tenders:—

Mavor & Coulson, commutators for tramways department; Dick, Kerr & Co., repair of two 3,000 kw. turbine sets, £23,000; Electromobile (Leeds) Co., one five-ton electric tipping vehicle (with lead battery), £1,430.

LUTON.—The Council has accepted the tender of the British Thomson-Houston Co. for the supply and erection of two 1,000 kw. converters (at £8,004) and switchgear (at £489).

NEWPORT (MON).—The Corporation have accepted the following tenders:—

The British Westinghouse Electric & Mfg. Co. for e.h.t. and l.t. switchgear, British Electric Transformer Co. for a 300 k.v.a. works power transformer, and William Grice & Sons for an invincible wet air filter.

SHEFFIELD.—The Council has placed an order with Edmund Taylor (Ltd.) for constructing a concrete and brick tank for oil storage for the electricity Department.

Stoker Contracts.—Erith-Riley stokers, constructed in Lancashire by Erith's Engineering Co., Ltd. (70, Gracechurch-street, London), have been ordered for the largest-unit boilers in Europe, viz., for double-ended Richardson-Westgarth boilers, 20,700 sq. ft. heating surface, hourly evaporation 100,000 lb., from and at 212 deg., corresponding to about six tons slack coal hourly, at the Bow power plant of the Charing Cross, West End & City Electric Supply Co.

These units are remarkably compact, the total area including the stokers being only 23 × 36 ft., or 828 sq. ft. For convenience of working, a central wall divides the unit into two parts, each with its 12-retort Erith-Riley stoker burning 3 tons coal hourly. At Fulham electricity works, the Erith-Riley stokers are two-thirds the size, viz., 8-retort stokers burning 2 tons of coal hourly; all sizes (from 4-retort to 12-retort inclusive) are used in British central stations under Stirling, Woodeson, Thompson, Niclausse and Babcock boilers, both land and marine types, burning all coals from best washed smalls to the cheapest slacks, smudge and duff, and effecting great economies in labour as well as in fuel bills; as the coal is fed, the fires sliced and the incombustible ash is continuously discharged, with no manual labour. As combustion is smokelessly completed within the thick bed of burning fuel, and equally distributed over any number of self-cleaning retort-units, no brick arches are used, and proportionate results are assured. The 12-retort size is 20 ft. wide, but there is no limit to the size of boilers, when fired with this fully-automatic stoker, requiring no manual labour. Repeat orders from central stations at Hull, Worcester, Thornhill, &c., are in progress, and many repeat orders have already been completed.

Appointments Vacant and Filled.

A junior shift engineer is required at Barnsley with experience in E.H.T. A.C. and L.T. D.C. 3-wire supply. Salary £156 per annum, plus 12½ per cent. Applications to the acting borough electrical engineer, Mr. T. W. Hibbert *See advertisemen'*.

A draughtsman is wanted by controlled firm for motor control gear. *See advertisemen'*.

Edinburgh Corporation is inviting applications for the position of manager of the Edinburgh tramways. The salary offered is provisionally £1,000 per annum.

The Council of the University of Birmingham invites applications for the Chair of Mathematics. Stipend £600 a year. Applications to the Secretary, Mr. Geo. H. Morley.

Mr. Geo. A. Newsome, manager of the Dumbarton Burgh & County Tramways, has been appointed manager of the Darwen Corporation tramways at a salary of £250 per annum.

Mr. G. Brander has been appointed manager of the Dundee, Broughty Ferry and District Tramways in succession to Mr. D. Fisher, resigned.

Business Items.

Eustace G. H. Firth and Arthur S. Russell (trading as Firth & Russell), electrical engineers, 70 and 72, Kirkstall-road, Leeds, have dissolved partnership. Debts by Mr. A. S. Russell and Mr. H. F Moore, who continue the business as Firth & Russell.

Circuit-Breakers, &c.—We have received from Messrs. George Ellison, Perry Bar, Birmingham, a copy of the firm's abridged catalogue, containing illustrated descriptions and prices of their manufactures, including circuit-breakers, a.c. starting and crane control gear, switches, brake solenoids, cable fittings, &c.

The firm have also issued their price list No. 19, dealing with trailing cable sockets and plugs attached to totally enclosed air-break circuit-breakers.

Switchboards.—Messrs. Johnson & Phillips, Ltd., Charlton, S.E. 7, have issued a booklet giving illustrated particulars of the design and construction of their all steel draw-out truck type switchboards.

Simplex Fittings.—The catalogue of electric light fixtures issued by Simplex Conduits (Ltd.) being out of print, and the present conditions making it impossible to issue a new and more complete one, the company, for the convenience of their clients, have issued a

10 IN. LUXURO BOWL.

booklet illustrating a few of their new designs, together with some of their better known patterns.

It is hardly necessary to point out that fittings not actually in stock must be accompanied with a permit from the Ministry of Munitions. There is, however, quite a demand for the lesser expensive fittings for the offices of the many new munition works and departmental offices. The Company has still a fair stock of pre-war fixtures and would be pleased to send illustrations and quotations upon request.

Liquidations.

The Electricity Supply Co. for Spain (Ltd.) is being wound up voluntarily, and Mr. D. Merry del Val, 45, Grosvenor-place, London, has been appointed liquidator.

A meeting of the creditors of the Electrolytic Alkali Co. (Ltd.) (in vol. liq.) will be held at the office of Messrs. Harmood-Banner & Son, 24, North John-street, Liverpool, on May 21.

A meeting to receive an account of the winding-up of the Grondal Kjellin Co. (Ltd.) will be held on June 7 at 20, Abchurch-lane, London, E.C.

Municipal Accounts.

Halifax.—The Corporation tramway accounts for the year ended March 31, 1917, show gross capital expenditure £421,555 (increase £1,147), of which £233,944 is outstanding.

Revenue was £115,074 (compared with £113,602 in previous year), gross profit £38,938 (against £41,356) and net profit £15,112 (£19,055). Revenue per car-mile was 13·48d. (12·41d.), and working expenses were 8·92d. (7·90d.). Passengers carried were 21,180,584 (21,024,003) and car-miles run 2,048,772 (2,195,980).

Haslingden.—At March 31, 1917, the gross capital expenditure of the electricity department was £20,411 (increase £2,935), of which £2,017 has been redeemed.

Year's revenue was £5,600 (against £4,898 in previous year) and net deficit £298 (against profit £394). Working expenses increased from £3,719 to £4,790. Units sold were 1,073,932 (845,010) and average price obtained was 1·155d. (1·29d.).

Capital expenditure on the tramways was £39,481, of which £29,436 is outstanding. Year's revenue was £8,647, and after meeting working expenses and capital charges the net profit was £419 (compared with £1,021). Passengers carried were 1,341,252 and car-miles run 148,094 (150,676).

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Liverpool.—The accounts of the electric supply department for the year ended Dec. 31 last show gross capital expenditure £2,228,980 (increase £269). Loans have been redeemed to the extent of £775,260, sinking fund amounts to £356,735 and reserve to £184,516, and renewals fund to £102,842.

Revenue was £455,753, and the balance carried to net revenue account, after providing for working and general expenses, cost of new services and meters, gratuities, superannuation, &c., was £230,306. Interest required £73,200, sinking fund £57,207, renewal fund £35,298, and £65,000 is contributed to general rate.

The tramway accounts for 1917 show gross capital expenditure £2,068,430, of which £965,845 has been redeemed. Revenue was £829,440, working and general expenses were £572,582, leaving gross profit £256,858. After meeting capital charges and rent of leased lines, and placing £42,243 to reserve the balance (£125,000) was devoted to relief of rates. Passengers carried were 172,842,494 (157,636,595) and car-miles run 12,630,577. The number of men employed when the war broke out was 2,700, and 2,200 have left to join H.M. Forces. The passengers have increased by 40,000,000 over pre-war years, due to increase of 50 per cent. in railway fares, abolition of some and reduction of other local railway services, diversion of shipping from other ports to Liverpool, increase of Admiralty work, and in the number of factories. The net profit (£167,243) shows an increase of £21,271 over that of 1916. The increase in general expenditure compared with 1913 was £244,300. The total amount contributed in relief of rates since 1897 is £922,899, while £887,032 has been placed to reserve, renewal and depreciation fund and £592,116 has been paid in rates and taxes.

Companies' Meetings and Reports.

Direct United States Cable Co. (Ltd.)

The 75th ordinary general meeting was held on Tuesday, Sir JAMES PENDER, Bart., chairman of the company, presiding.

The MANAGER AND SECRETARY (Mr. William Miles) having read the notice convening the meeting and the report of the auditors,

The CHAIRMAN said: Gentlemen, under the arrangement with the Western Union Co. our income remains unaffected, and we receive our annual rental, which has permitted the directors to pay the usual dividend of 4 per cent. Since the lease was entered into we have been untortunate as regards cable repairs generally, and in the last seven years the expenditure we have been called upon to make under that head has amounted to £149,880, or an annual average of £21,413. During the past year the cost of maintaining the cables amounted only to £6,932, and as we were able to transfer £33,439 to the reserve fund out of the year's revenue, we finished the year with an accretion to the reserve fund of over £26,000. I regret, however, to have to inform you that our main cable is again interrupted in very deep water, and we have to face a very considerable expenditure in restoring it. The prime costs in an adventure to repair a deep sea cable are ship hire and cable used in the repair. So far as the former is concerned, you will not need me to tell you that, while at all times an expensive matter, it is in these war days trebly expensive. The difficulty of arranging an expedition is enhanced because the control of all vessels, including cable repair ships, is vested in the Admiralty. The exigencies of the time have prevented us having the sole use of the vessel, and we have had to bow to the decision of the Admiralty that we can only have her services when she has completed other work. If, therefore, it should be that she is precluded from effecting the repair of our cable before the 12 months has expired which is given to us under our lease with the Western Union Co., it will be not because of any delay or fault on the part of this company. I can only add that we have succeeded in obtaining the use of a vessel that has previously effected most satisfactorily deep sea repairs of our main cable, and that your directors have every hope that the present expedition will be successful. The other expense is that of the length of cable that will have to be inserted, and this interruption has occurred in such a position that it is right I should warn you that it will probably be found necessary to insert a very considerable length of new cable. I have on previous occasions referred to the fact that we had in stock a long length of deep sea cable which we had manufactured before the war at a very low price. That is a matter upon which we may congratulate ourselves, because if a length of 300 miles has to be inserted we shall have paid for the cable about £40,000, instead of £82,000, which represents its value to-day. I beg to move the adoption of the accounts and that the final dividend of 2s. per share be approved.

Mr. JOHN VARLEY seconded the motion, which was carried unanimously. Mr. John Varley and Lieut.-Col. the Hon. T. H. A. E. Cochrane were re-elected directors, and Messrs. Deloitte, Plender, Griffiths & Co. were re-elected auditors.

ALTRINCHAM ELECTRIC SUPPLY (LTD.)—During the past year 33 new installations were connected, and after allowing for disconnections and reconnections there were on Dec. 31 last, 1,740 consumers. After providing for interest on debentures, &c., the profit was £6,536, and with £502 brought forward the total was £7,038. Deducting dividends on the preference shares due to Sept. 1, 1917 (£2,410), the sum available is £4,628. Of this sum £1,000 has been placed to reserve for income tax, and £1,500 for depreciation of plant, &c., leaving £2,128, out of which sum the directors recommend the payment of a dividend of 3s. 6d. per share upon the deferred shares, absorbing £1,225. In order to cope with a prospective increased demand for current for power the directors have deemed it advisable to make further additions to the plant, mains, &c. (about £2,500 having been expended thereon), and during the current year additional expenditure will have to be made for this purpose. In order to provide for the outlay already incurred, and for the general purposes of the Company, a further £5,000 debentures have been issued. Under the articles it is only possible to issue debentures against the issue of a like amount of shares, and 5,000 preference shares have also been issued, upon 2,550 of which 1s. per share has been paid up.

BABCOCK & WILCOX (LTD.)—The net profit during 1917, subject to excess profits duty, was £444,513, and with £56,495 brought forward the total was £501,008. The interim dividends (paid in November last) of 3 per cent. on the preference, 2½ per cent. on the second preference and of 6 per cent. on the ordinary shares absorbed £107,076, leaving £393,932. The directors recommend that the following dividends be paid for the half-year ended Dec. 31, 1917—viz., 3 per cent. on the preference and 2½ per cent. on the second preference shares (less tax), and 9 per cent. on the ordinary shares (tax free), absorbing £156,876: also that £150,000 be placed to reserve and £10,000 granted to the staff pension fund, leaving £77,055. 15s. 5d. to be carried forward. The company's works are fully occupied, to the extent of the labour available, on national requirements directly or indirectly connected with the war. Of the staff and workmen, 2,063 joined the forces, of whom 99 have been killed in action. Owing to the machinery being operated by unskilled labour, and the impossibility, due to the shortage of skilled labour, of keeping it in the usual state of repair, it has been considered necessary to provide for the exceptional wear and tear of same. The Directors report the formation of the Sociedad Espanola de Construcciones Babcock & Wilcox, in which this company has a considerable interest, and which will be under the company's technical management. Two of their directors (Mr. Knight and Mr. Kemnal) have been appointed directors in the Spanish company. Mr. Frederick G. Bourne has retired from the board and Mr. Edward H. Wells, president of the Babcock & Wilcox Co. (of New York), has been appointed a director in his place.

BATH ELECTRIC TRAMWAYS (LTD.)—Mr. J. B. Hamilton, who presided over the recent meeting, said that the earnings for 1917 had been larger than ever before, and the number of passengers carried was larger. The traffic and other receipts showed an increase of £4,784 over 1916. The expenses of operation and cost of maintenance had been considerably increased owing to the large advances made in the cost of labour and of all materials

CHISWICK ELECTRICITY SUPPLY CORPN. (LTD.)—The revenue for 1917 was £31,143, against £20,523 in 1916. The profits, after writing off £1,407 for depreciation and paying sinking fund premium and trustees' fees, were £9,776. Interest on first mortgage debenture stock absorbed £3,600, leaving £6,176. The directors recommend a dividend on shares of 6 per cent. (less tax), that £1,400 be placed to depreciation reserve, and £1,008 carried forward.

COALITE (LTD.)—Mr. H. Willmott, who presided over the recent annual meeting, said that the invention and patent rights for the Coalite process throughout the world, with the exception of Great Britain and Ireland, were again assessed at the purely nominal figure of £5,000. After explaining their holdings in other companies, &c., he said the possibilities resulting from the carbonisation of coal at low temperatures were well-nigh boundless, and their experience induced the belief that the low temperature distillation of coal would go far to solve the problem of obtaining sufficient oil for the nation's present requirements. When peace came again they might hope that the pioneer work now being done in Great Britain would enable them to exploit their process in most of the countries of the world.

LONDON & LANCASHIRE FIRE INSURANCE CO. (LTD.)—The 56th annual meeting has just been held, and the account submitted was an exceptionally favourable one in all departments. The premium income amounted to £3,497,074, and the surplus on underwriting to £602,833. Interest on investments produced £132,696, while income tax and excess profits duty absorbed £200,000, and depreciation on investments a further £200,000. The reserve funds now stand at £4,078,996.e

LYMINGTON ELECTRIC LIGHT & POWER CO. (LTD.)—Capt. Keppel Pulteney, who presided over the recent annual general meeting, said the result of the past year's trading was a profit of £1,510, compared with £1,155 in the previous year, and after paying interest on debentures (£450) and income-tax (£91) and adding £342 brought forward, the balance was £1,311. The directors recommended that £600 be placed to reserve, and a dividend at rate of 5 per cent. per annum be paid on the preference shares, leaving £390 to be carried forward. The increase in income was due to the efficient management of Mr. C. L. Holman, who under great difficulties had carried on the work with a reduced staff.

MACKAY COMPANIES.—The report of the trustees for 1917 states that income was $4,519,364 dividends paid on the Mackay Companies' shares required $4,425,198 and operating expenses $89,058, and the balance carried forward was $5,108. Owing to the entry of America in the war there was a perceptible slackening of general business towards the end of the year, and the cost of maintaining and operating telegraph and cable lines is constantly increasing, but the telegraph and cable rates have remained unaltered. The reasons which made it necessary for the Government to take over the control of the railroads do not exist in the case of the telegraph companies, and in the case of the telegraphs the public is being served to its complete satisfaction. The long distance telephone business of the Postal Telegraph Cable Co. has been constantly increased and extended, and as the Bell Telephone Co. has used the telegraph side of the composite circuit (an arrangement by which there is obtained both a telephone and telegraph use of two wires at the same time), the Postal Telegraph Cable Co. has felt that it is quite fitting for them to use the telephone side for long distance telephone service, which has been much appreciated by the public. The Commercial Cable Co.

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have, by means of comparatively inexpensive electrical contrivances increased the capacity of their cables very substantially. The income of the subordinate companies was greater than was required to pay the dividends of the Mackay Companies, but the policy adopted has been to obtain from them only sufficient funds to meet those dividends. The dividends on the common shares were increased on April 1, 1917, from the basis of 5 per cent. to 6 per cent.

NITROGEN PRODUCTS & CARBIDE CO. (LTD.)—Mr. A. E. Barton, who presided over the meeting last week, said the directors recommended payment of a final dividend of 3 per cent. making 6 per cent. for the past year. The Odda factory had worked throughout the year, but did not maintain its maximum output continuously, owing to the difficulty of obtaining raw material, but there had been a good demand for both carbide and cyanamide in Sweden and their works had run without interruption. Work at Aura had been continued notwithstanding increased cost and shortage of labour. The large installation in France had been running continuously since the last meeting, and other plants were nearing completion. After dealing with the extent to which fertilisers are used in Germany, in this country and in India, Mr. Barton said the war had proved the vital necessity of possessing a home production of nitrogenous compounds. In order to make Great Britain absolutely self-contained with regard to the necessary raw materials, the installation of adequate and cheap electric power was essential. In order to demonstrate the possibility of producing power at a sufficiently low rate in this country to enable those products to be economically produced, they had during the past two years conducted extensive investigations and made trials by carbonising over 1,000 tons of coal. That had led to the conclusion that the only way those industries could be established in this country was by linking up the various processes to one another in such a manner that the by-products of one were utilised as the raw material of another. It was also essential that the power and the processes should be in the same hands and worked under one control. The only means of obtaining cheap electric power was by acquiring a large and suitable coalfield, which must be developed on an extensive scale by carbonising the coal at high temperatures, recovering all the by-products therefrom, passing the coke through producers, and employing the rich gases from the carbonisers and the gas from the producers for firing boilers to work steam turbines operating large electric generators. He said that for the scheme 120,000 H.P. would be necessary, which would be utilised in the production of carbide of calcium, cyanamide (notrolim), ferrochrome, ferro-silicon and other ferro-alloys, the treatment of zinc concentrates and in the manufacture of various other electro-chemical products. It would make this country absolutely independent of the importation of nitrate of soda, and also render this country independent of foreign sources for its ferro-alloys. A scheme such as he had outlined, including the purchase of a colliery, would entail a very large outlay of capital, and it would be difficult to undertake it under present conditions, but they were preparing plans and estimates for a complete installation of 120,000H.P., so that they might be in a position, if thought advisable on the cessation of hostilities, to initiate and co-operate in the establishment of an industry of that nature in this country.

NORTH METROPOLITAN ELECTRIC POWER SUPPLY CO.—The net revenue for 1917, apart from interest and dividends, amounted to £76,150, compared with £71,390 in 1916. Adding interest and dividends and amount brought forward the total is £80,912. After providing for mortgage, loan and debenture interest, transferring £2,000 to debenture reserve, and placing £7,500 to renewals reserve, the directors propose a dividend at rate of 6 pe cent. per annum, with a bonus at rate of 8s. on the ordinary shares, leaving £2,726 to be carried forward. Year's capital expenditure was £51,677, and now totalled £990.420. In September last the Ministry of Munitions agreed to give the Company further financial assistance in providing additional plant required to meet the continual increase in the demand for electrical energy. The Company were furnished with funds, amounting to £50,000, the Ministry receiving an allotment of 40,000 fully-paid preference shares at par and accepting as security for a loan of £10,000 5 per cent. mortgage debentures of a nominal amount of £12,600. The total number of units sold represented an increase ot approximately 18 per cent. over 1916. The linking-up of the electricity undertaking with that of the Metropolitan Borough of Hackney has been completed and is proving mutually advantageous.

New Companies.

GOREY GAS, WATER & ELECTRIC SUPPLY CO. (LTD.) (4,552).—Private company, reg. in Dublin on April 3, 1918, capital £3,000 in £1 shares, to take over the business of the Gorey Gas & Water Co. (Ltd.) (in liquidation). First directors are:—P. S. Hutchinson, W. Armstrong and H. H. Armstrong. Reg. office: Esmonde-street, Gorey, Co. Wexford.

J. E. & S. SPENCER (LTD.) (150,316)—Private company. Reg. £10,000 in £1 shares, to take over the business carried on as J. E. & S. Spencer, and carry on the business of iron merchants, engineers, metal tube manufacturers, electricians, &c. Agreement with S. Spencer, Sir Ernest Spencer, H. Spencer Smallman and T. H. Spencer. First directors are S. Spencer, Sir Ernest Spencer, T. H. Spencer and H. Spencer Smallman. Reg. office: 16, Dowgate-hill, E.C.

J. S. ZENELECT (LTD.) (150,368).—Private company. Reg. April 24, capital £3,000 in £1 shares. To carry on the business of manufacturers, dealers, mechanical and electrical engineers, machinists, electricians, &c. First directors are T. W. Norman and C. A. Cooper (both permanent). Reg. office: Silver-street, Wellingborough.

City Notes.

ADELAIDE ELECTRIC SUPPLY CO. (LTD.)—An interin dividemd at rate of 10 per cent. per annum has been declared for the half-year ended Feb. 28.

BRITISH EVER-READY CO. (LTD.)—A final dividend at rate of 10 per cent. has been declared on the preference shares for the half-year ended March 31, and a final dividend on the ordinary shares at rate of 10 per cent. per annum, plus 7½ per cent. bonus, making 17½ per cent. for year.

BRITISH INSULATED & HELSBY CABLES (LTD.)—A circular relating to the scheme for the reorganisation of capital has been issued. The directors have decided, with the sanction of the Treasury, to reorganise the capital by capitalising £500,000 of its reserves and issuing to the ordinary shareholders the amount so capitalised in fully-paid ordinary shares. Each ordinary shareholder will receive one fully-paid ordinary share for every ordinary share now held by him. An extraordinary meeting will be held on the 27th inst. to consider the scheme.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The directors recommend payment of a final dividend on the ordinary shares for the half-year ended Dec. 31, 1917, of 6. per cent., making 10 per cent. for the year.

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—A dividend of 5 per cent. has been declared on the ordinary shares, making 10 per cent. (tax free) for the year ended March.

CLARKE, CHAPMAN & CO. (LTD.)—Last week Mr. Justice Astbury sanctioned a scheme of arrangement between the company and their shareholders. It was explained that the company had both ordinary and preference shareholders, and under the memorandum the preference were entitled to 6 per cent. cumulative dividend. The scheme proposed that the preference shareholders should have an increase in their preferential dividend.

EDISON SWAN ELECTRIC CO. (LIMITED & REDUCED).—A petition for confirming a resolution reducing the capital of the Company from £888,071 to £698,307 has been presented to the High Court.

ISLE OF THANET ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—The Treasury has sanctioned the issue of £17,500 6 per cent prior lien debentures of £100 each.

The Round Table.

By "kVA."

EVENT OF THE WEEK.—We receive a letter from a Government Department type written on *both sides of the paper!*

* * * *

At a certain searchlight station a young subaltern was inspecting the equipment. He had the engine started, and the lamp was not turned on. The voltmeter read 110, but the "sub" insisted that it was wrong. "Why doesn't it read 65?" he asked the sergeant, who protested in vain that the lamp was not on. "Have a voltmeter that reads 65," said the "sub," "and don't argue!"

* * * *

Some of the answers to technical questions by the green horns in the Electrical Engineers (R.E.'s) are quite amusing.

Explain the use of trunnions.—Trunnions are there to be cleaned!

What is a compound-wound generator?—A machine for use in compounds!

What are lines of force?—The lines which radiate from the positive carbon!

Explain the use of the arc deflector.—This is to set the carbons by.

One "student" was asked to give his views on residual magnetism. The officer tried to help him by asking where he resided, and he replied: "At the barracks." "Well," said the officer, "what is residual magnetism?" "Why, the sort that resides at the barracks!"

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, May 14, 1881.]

ELECTRIC LIGHT AT ROME.—During Holy Week the Coliseum was lighted by the electric light. The effect is said to have been grand in the extreme, the details of this splendid ruin being well defined.

MAXIM V. EDISON.—The appeal being taken by Mr. T. A. Edison in the interference case of "Maxim against Edison" has been decided against Edison's claim by the "Board of Examiners-in-Chief" of the United States Patent Office.

COMPLAINT AGAINST THE ELECTRIC LIGHT.—The Campbel-town steamer "Kintyre" was proceeding up the Clyde early on Thursday morning, and after passing Greenock Steamboat Quay she ran aground at Garvel Point. She was got off when the tide rose and proceeded to Glasgow. It is stated that the cause of her getting out of the regular channel was the glare of electric light on the steamboat quay blinding those in charge.

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THE ELECTRICIAN:

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CONTENTS.

NOTES	55
Arrangements for the Week	57
Rolling Mills and the Electric Drive. By L. Rothera, B.Sc. Illus.	58
A Note on the Relation of the Audibility Factor of a Shunted Telephone to the Antenna Circuit as Used in the Reception of Wireless Signals. By Balth. Van Der Pol, Jun., D.Sc. Illustrated	60
Power Factor and Its Improvement. By E. W. Dorey. Illustrated	61
Some Transient Phenomena in Electrical Supply Systems. By Prof. E. W. Marchant, D.Sc. Illustrated	63
Trade Parliaments and Their Work. By E. J. P. Benn	65
Use of Coke for Steam Raising	66
NATIONAL RESEARCH COUNCIL	66
A Method of Testing the Registration of Current Rushes on Meters. By J. A. Miller and W. Von Krukowski. Illustrated	67
The Lighting, Heating and Power Order (1918) and the Best Methods of Making Economies in Lighting	68
CORRESPONDENCE	68
On the Thermo-Electric Properties of Fused Metals. By Charles Robert Darling and Arthur W. Grace. Illustrated	69
Ironsafe Power Switchboards. Illustrated	70
Volunteer Notices	70
Patent Record	70
Commercial Topics	71
Electricity Supply	71
Tenders Invited and Accepted	74
Companies' Meetings and Reports	75

Notes.

The Improvement of Power Factor.

ON those networks which deal with large supplies of power the diminution of power factor has become a somewhat serious matter. It leads to inefficient use of a certain proportion of the plant and of the mains, and owing to the fact that capital charges exercise a great effect upon the charge that can be made for power this factor cannot be ignored. The power factor of three-phase motors generally varies between 0·8 and 0·9, depending upon the size, speed and load. As the load is reduced, the power factor generally falls rapidly to still lower values. It may be said that low power factor is due chiefly to the installation of larger motors than are really necessary and to motors which are run light for a considerable time. It may be argued that it is not to the advantage of a consumer to install motors which are too large. This is, no doubt, the case, but in order to be on the safe side motors are frequently installed which are really larger than is necessary. The net result is a low power factor. Many attempts have been made to introduce a tariff so that it will be to the interest of the consumer to improve his power factor. A meter, by Prof. ARNÒ, with this object in view was described in THE ELECTRICIAN in 1914. In order to avoid special meters some undertakings make a fixed charge per kilovolt ampere of demand, plus a running charge per kilowatt-hour. A tariff of this kind gives a suitable inducement, but is by no means on a correct basis. In an article which we publish this week Mr. E. W. DOREY splits up the charges into those which are affected by power factor and those which are unaffected, and he thus arrives at a fixed charge per kilovolt-ampere of maximum demand, but varying with the power factor. The metering equipment comprises a kilowatt-hour meter and a kilovolt-ampere-hour meter, with maximum demand attachment. There is necessarily some complication about such methods of charging, but where large powers are in question it becomes highly desirable to induce the consumer to do something towards improving his power factor, and the only way of doing this is to supply him via a suitable tariff.

Boy Welfare Work.

WELFARE work is admittedly a difficult subject. It can only be carried on successfully by persons of tact, for it is apt to give rise to suspicions in the minds of employees until the supervisor has gained their confidence and until it is realised that welfare work is not simply a means of getting something more out of them Although this work is important for workers of all ages, we think it may be said to be doubly important in the case of boys, for boys enter works at their most irresponsible age, and it is important that some lead should be given to them so that proper development should follow. It must be remembered that the boy of to-day is the man of to-morrow and, therefore, in the national interest it is desirable that something systematic should be done in welfare work for their benefit. It must not be forgotten that the present-day factory is liable to be much more monotonous than formerly, owing to the general employment of automatic processes. If there are no healthy interests awaiting the boy worker at the end of the day's work, his superabundant energy may find outlet in undesirable directions. In order to give greater vitality to this movement, the Boys' Welfare Association has now been formed at Sanctuary House, Tothill-street, Westminster, under the direction of Mr. ROBERT R. HYDE, who until recently was carrying on the movement under the Ministry of Munitions. We think it would be well for employers to communicate with Mr. HYDE, who has issued a leaflet on the subject. It is pointed out that where 80 or more boys are employed there is sufficient work to occupy the supervisor for the whole of this time, but in the case of small firms this is not practicable. In that case two or three firms in close proximity may combine to share the services of a supervisor. This official, who is, of course, paid by the firms in question, would be largely concerned with the engagement of boys, watching their progress, keeping in touch with local continuation schools for their benefit, encouraging healthy habits and thrift, and in the organisation of indoor and outdoor games and sports, the formation of a cadet corps with week-end and summer camps and similar relaxations, which latter, in all probability, are the most important. We are glad to note that the new Association is willing to send a representative to discuss the movement with heads of firms, or to address meetings of foremen or managers.

Economies in Lighting.

THE Lighting, Heating and Power Order has been the subject of much discussion, and there now seems reason to expect that it may be considerably modified by the adoption of some form of combined ration of gas, coal and electricity. The Order furnishes a good example of the need for thorough discussion and preliminary survey of the ground when regulations of a highly technical character are to be issued. Scientific and technical societies have a duty to discharge in promoting such discussions, and we cannot help thinking that the results

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would often be much better if their co-operation were sought more fully before public announcements are made, instead of afterwards. It is not entirely a pleasant task to criticise Orders and regulations already made, but it is often a duty, assuming that the criticism is constructive, so that when defects are pointed out some better alternative procedure may be suggested. The discussion before the Illuminating Engineering Society on May 14 revealed a number of points in which the Order is open to criticism, and no doubt these may be modified in due course, either by alterations in the Order, or by sympathetic methods in its enforcement. So far as lighting is concerned it was clearly shown that the economy in coal possible through curtailments in this direction is relatively small. Mr. GASTER, in opening the discussion, rightly emphasised the false economy involved in diminutions to a point inconsistent with safety, health or efficiency of work—an aspect that has been emphatically endorsed by the Health of Munitions Workers Committee. In this country the illumination provided in the average factory is probably still on the low side. In America, where higher values prevail, recent experiments appear to have shown that an improvement in output of 8 to 25 per cent. was secured by a further advance. The efforts of the Illuminating Engineering Society have therefore been concentrated on an object on which no difference of opinion can exist—the avoidance of waste of light. A series of recommendations to consumers has been issued by the Society, with the concurrence of the Board of Trade, explaining the most judicious methods of making economies, and containing, in an Appendix, some definite data on the illumination and consumption in gas and electricity necessary for various classes of work. The endorsement of these figures gives the factory manager something definite to go upon, and they should be a help in deciding difficult cases. It would probably assist the objects of the Authorities considerably if similar data on heating and power consumption could be prepared and issued by engineering bodies concerned with this aspect of the Order.

Metering Current Rushes.

WE draw attention in our present issue to a simple method of testing the accuracy of meters whencurrent rushes are passed through them. Cases of this kind arise not infrequently, and there are certain consumers whose meters are incessantly subjected to shocks of this character. It has been supposed that under these conditions meters read too low, but Messrs. MOLLINGER and KRUKOWSKI give reasons for thinking this is not the case. They propose to take three induction meters of a similar character, the errors of which on a steady load have been noted and compared. Then they pass a steady load through one of these meters, and by means of a motor-driven commutator they pass the current alternately in a series of jerks through one or other of the remaining meters, both of which are connected in series through the commutator with the afore-mentioned meter. By means of a formula the errors, if they exist, can be calculated and the metering calibrated. The error increases with the moment of inertia of the rotating system. It appears from the tests that current rushes may cause an induction meter to read high by about 1 per cent., which is almost negligible.

Common Sense in Labour Disputes.

THE position in Belfast in regard to the tramways undertaking has been a little humorous and would not call for attention but for the fact that it indicates a lack of common sense in dealing with disputes. Recently, the 12½ per cent. bonus award became applicable to the tramway employees. It happens, however, that the Act which governs the tramways of Belfast contains the "Aberdeen Clause," which is to the effect that the tramways undertaking must be so run that it does not become a burden upon the rates. The Committee came to the conclusion that if the 12½ per cent. bonus were given to the men it would be necessary to call upon the rates to meet a deficit, and they consequently refused to give the bonus. In response to this attitude the men issued summonses. The Committee then referred the matter to the Government authorities, and as a final result authority is now to be given under the Defence of the Realm Act enabling the Corporation to call upon the rates to meet the deficit. It appears to us that the common-sense method would have been for the Committee to apply to the authorities forthwith without waiting for the men to force the situation. As it is, the course of the dispute looks as though the Corporation were unwilling to pay the bonus, and any feeling of this kind can only cause friction between the employer and the men.

Royal Institution.—It is announced that Friday Evening Discourses at the Royal Institution will be given on May 24th by Lieut.-Colonel A. G. Hadcock, R.A., F.R.S., on "Internal Ballistics"; and on June 7th by Sir Boverton Redwood, Bart., D.Sc., on "The Romance of Petroleum."

Engineers' Club for the Midlands.—At a meeting recently held at Birmingham it was resolved to form an Engineers' Club in Birmingham for the Midlands, and a Committee was appointed to carry the scheme into effect.

The chairman (Dr. C. C. Garrard) said the idea underlying the organisation of the club was that it should offer all the advantages of a social institution combined with facilities for meetings, lectures, &c. It was hoped that it would become the meeting place of the various technical societies in the district. The scheme was part of a larger idea whereby such engineers' clubs would be founded in all the large engineering centres in the country. Dr. Garrard and Mr. J. Fearn were respectively elected provisional chairman and hon. secretary

Largest Electric Ship in the World.—We understand that the first electrically-propelled merchant vessel ever constructed in a British yard, and also the largest electric ship in the world, will shortly make its maiden voyage from a North-East port. It is equipped with Ljungstrom turbo-generators for supplying power to the motors. Tests carried out on foreign vessels show a low fuel consumption, and it is estimated that the British ship, which is of approximately 6,400 tons, will accommodate from 8 to 10 per cent. more cargo than an ordinary steamer of the same size. Experience gained in the trials suggests that the electrical turbine drive and the electrical steering plant will greatly facilitate handling ships in narrow waters or under other navigational exigencies.

The Nature of Phosphorescence.—In a contribution to the "Proceedings" of the American Philosophical Society, Dr. E. L. Nichols describes some curious results obtained in experiments on the phosphorescence of certain sulphides. The decay after excitation appears to consist of two distinct processes, one of which lasts for less than 1/100th of a second, while the other persists for 6/100ths of a second or more. While in both cases the effect is relatively transient this evidence of two separate reactions, apparently corresponding with distinct bands in the spectrum, is interesting. The regions of selective excitation appear to correspond with absorption bands in the transmission spectrum.

New Form of Primary Battery.—A recent French patent (No. 484,436) describes a new method of treating the positive electrodes of primary batteries with a view to introducing metallic oxides as depolarisers. The electrode consists of a shallow plate of copper or iron presenting numerous conical points to the alkaline element in the cell. The edges of the plate are bent over so that it becomes a form of shallow box, into which the depolarising oxide is introduced. This material is mixed in a powdered state with a suitable alkaline hydrate or alkaline earth and introduced into the interior of the box

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formed by the positive and a zinc plate as negative. The whole is sealed with rubber, a small vent being inserted to allow for the escape of gases, and cased in metal stiffening bands.

Measurement of Rapidly Varying Temperatures.—According to "Elektrotechnik und Maschinenbau," special apparatus has recently been contrived to measure rapidly fluctuating temperatures such as an ordinary thermometer is too sluggish to record. At the point of measurement wires of platino-iridium, 0·02 mm. diameter are inserted and are connected to a galvanometer. The deflection varies with the resistance of the wires, and it is stated that variations in temperature with a frequency of ten per second may be noted. It is anticipated that the apparatus will be specially useful for studying cyclical variations in temperature in the cylinders of steam engines and combustion engines.

Automatic Extinction of Fires in Transformer Chambers. In a recent issue of the "Elektrotechnische Zeitschrift," an apparatus for automatically extinguishing fires, which is specially applicable to transformer-chambers for use with oil-switches, &c., is described. The principle is similar to that of various forms of automatic extinguishers, such as the "Minimax," the difference from the latter involving mainly details, such as the means of producing pressure to eject the liquid and the variety of extinguishing liquid used. No chemical action is needed to produce the gas-pressure, which is derived from a small chamber of compressed nitrogen, screwed into the top of the apparatus, and is released by striking a knob. The fire-extinguishing fluid is a volatile non-combustible carbon compound, which is stated to be non-conducting to electric pressures up to 40,000 volts. The apparatus feeds a pipe-line running through the transformer or switch chambers, and having two outlets, one in the ceiling over the apparatus, the other near the floor. These openings are closed with fusible plugs, and the upper one has a weight attached to it, which, if released, presses the knob and punctures the gas container. Consequently, in the event of a fire, the upper plug melts, the weight drops, and the non-combustible liquid is forced through the pipe and poured upon the fire. Should burning oil overflow on to the floor the lower fusible plug also opens, and the liquid, issuing from this aperture, extinguishes the oil.

Cylindrical Grinding.—A Paper read by Mr. W. D. Adamson before the Junior Institution of Engineers refers to the important part played by grinding in mechanical processes, especially in the automobile industry. In a grinding machine the wheel and various points in machine design require special study. The introduction of pure abrasives, made in the electric furnace, such as carborundum, alundum, aloxite, crystolon, &c., has been of great importance; wheels uniform in quality can now be repeated in any quantity, and will stand the high stresses induced by modern grinding speeds and feeds. In a wheel 30 in. diameter, with a surface speed of 6,000 ft. per minute, internal stresses may amount to 100 lb. per square inch. The size of cut taken is not the only criterion of work done, though important in heavy duty machines. Another controversial point is the work speed; as a fair average 45 lb. per minute, and a traverse of three-quarters to seven-eighths width of wheel face per revolution may be assumed—equivalent to machining at the rate of 2-3 sq. ft. per minute. The author discusses in some detail the precautions to be taken in fine grinding, where traverse and feed mechanisms are of great importance. All the above applies to external grinding; internal grinding machines employ in general a wheel one-half to three-quarters the diameter of the hole to be ground and are of two distinct forms, one of the lathe type, where both work and wheel rotate, the other similar in principle to the horizontal boring machine for grinding parallel holes. In Germany holes 30 in. in diameter and 60 in. long can be so ground. The smallest hole the author has seen ground was about 0·07in. diameter. In this case the spindle speed was 30,000 revs. per min. In the concluding part of the Paper some special applications of grinding machines, and their use for tool and precision grinding are discussed. Shop gauges are now quite frequently finished on a grinder without being lapped, and the process can be applied even to elaborate forms of tools.

The Industrial Development of South Africa. — Some interesting data were given in the recent inaugural address of the president of the South African Institute of Electrical Engineers (Prof. J. H. Dobson). In reviewing the effects of the war, Prof. Dobson suggested that South Africa has been less unfortunate than some other countries. While the restriction of many necessary imports from abroad has caused great difficulties, there have been compensating advantages and in several directions export trade has been appreciably developed. As regards the electrical industry there have been some elements of progress, for example, various electro-chemical processes have been brought to the practical stage, and the birth of the iron and steel industries of the Transvaal will be watched with great interest. The coal resources of Natal and the Transvaal are among the greatest assets of the country, while other areas, such as the bituminous coal district in Angola, deserve development. The question of liquid fuel is also important. While little mineral oil is available the uses of fish oil, palm and nut oils, and especially alcohol, deserve mention. A factory for the production of motor spirit, with a capacity of 3,000 gallons a day has been erected at Merebank, and it is estimated that more than three million gallons of alcohol per annum could be obtained from the 40,000 tons of molasses, as a by-product of the sugar industry. There appear to be few technical difficulties in the use of alcohol in combustion motors; its use is merely a question of cost. It is somewhat surprising to find that South Africa is not, as a whole, well endowed with sources of water-power (leaving out of consideration the Victoria Falls), but various rivers have falls of a possibly useful character. According to the Irrigation Department of the Power Commission, evidence given before in 1909 the Crocodile River could yield 30,000–40,000 kw. at a low cost. The long distances in South Africa do not, however, yield themselves well to any great national schemes of power supply and distribution.

Obituary.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service are reported:—

Lieut. John Basil Langley (R.A.F.), son-in-law of Sir Oliver Lodge, has been accidentally killed while flying on the South Coast.

L.-Corp. Albert Walker (South Staffs Regt.), formerly a Birmingham Corporation tramway employee, has been killed.

Pte. J. Raynor (L.N. Lancaster Regt.), formerly an employee of Messrs. Dick, Kerr & Co., has died of wounds.

Personal.

Mr. J. B. Adams has been placed in charge of the Board of Trade work in connection with Joint Industrial Councils and Interim Reconstruction Trade Committees. His address is 1, Horse Guards avenue, London, S.W. 1.

Mr. P. L. Bernstein, B.Sc., of the Manchester College of Technology, is recommended for the appointment as assistant lecturer and demonstrator in electrical engineering at the Hull Municipal Technical College.

Arrangements for the Week.

TUESDAY, May 28th.

JUNIOR INSTITUTION OF ENGINEERS, NORTH-EASTERN SECTION.

7.15 p.m. At the Mining Institute, Neville-street, Newcastle-on-Tyne. Paper on "Lightning Phenomena," by Mr. S. A Stigant.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

8 p.m. At the House of the Royal Society of Arts, John street, Adelphi, W.C. 2. Paper on "The Application of Electrical Power to Oilfield Requirements," by Mr. J. W. Burford.

THURSDAY, May 30th.

INSTITUTION OF ELECTRICAL ENGINEERS.

5.30 p.m. At the Institution of Civil Engineers, Great George street, Westminster, S.W. 1. Annual General Meeting.

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Rolling Mills and the Electric Drive.*

By L. ROTHERA, B.Sc.

Summary.—The author refers to the increasing development of electric drive, as compared with steam methods, in rolling mills, and presents some diagrams showing the relation between power demanded and time in typical processes. Five installations in various classes of mills are described, and the characteristic features of the problem analysed in each case.

The most efficient form of drive for rolling mills has been the subject of much discussion in recent years, and rapid progress has been made in electrical methods The first mill driven by electric motors was set to work in 1890 in Sweden, and this example was rapidly followed on the Continent. It was not until some 14 years later that the first large equipment was installed here.

The power installed in our steel and metal works is, however, now well in excess of 300,000 H.P., and this represents only a very small percentage of the total power employed in these industries.

As regards the greatest stronghold of the steam drive—namely, mills with heavy reversing duty—whilst in 1914 only four such electric drives were in operation, there have since that date been no fewer than nine equipments put in hand, with powers at the mill ranging up to 20,000 H.P. Most of the big steel manufacturers are giving consideration to electrical plants, and a further number would have been installed had it been permitted.

In spite of the above difficulties electrical machinery has efficiently met the varying demands, and the adaptability of the electric motor to meet the most arduous conditions has been demonstrated.

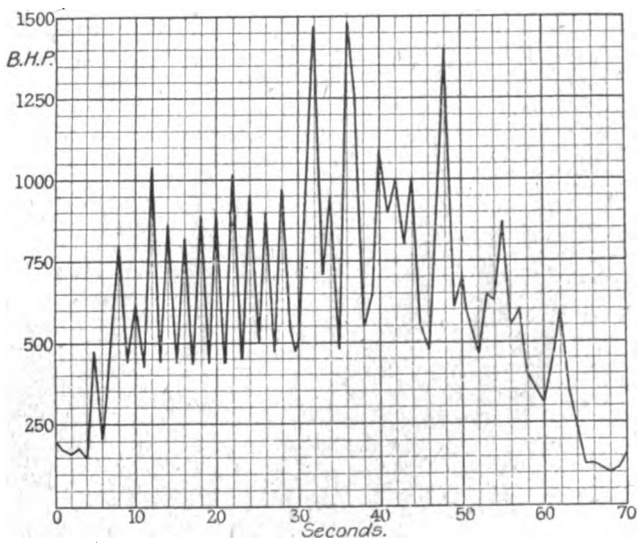

FIG. 1.

In Figs. 1, 2 and 3 respectively are shown the form of power demand in the case of a heavy sheet mill, a wire rod mill and a section mill rolling joists. One must also take into consideration the needs of the mills as regards speed control, and the complications introduced by the lack of uniformity of the power systems on which the motors have to work.

The advantages of the electric drive can be summarised as follows :

1. *Economy of Working, i.e.*, reduction in cost per ton of material rolled. This results from the great rapidity of working and high efficiency of the electric plant at all loads. This economy of working persists throughout the whole life of the plant.

2. *Reduced Space Taken Up.*—Partly on account of the small size of a motor as compared with its output, and partly by placing the motor in the most convenient position, without having to consider the run of steam pipes or the relative position of the boiler house.

3. *Ease of Control*, such as stopping, starting or varying the speed of the drive.

4. *Constant Check on the Power Consumed.*—A recording instrument gives immediate information as to an undue consumption of power, thus enabling defects to be promptly noticed and remedied.

5. *Increased Output from a Given Plant*, resulting from the large overload capacity and constant speed of the electric motor under all conditions of load.

6. *More Uniform Drive.*—The turning moment of a motor is constant for any position of the rotor, whereas a steam engine turning moment fluctuates, depending on the position of the cranks.

7. *Smaller Initial Cost*, especially where electric power is available from a neighbouring central station, and boilers would be required in the event of a new steam engine being put down.

The above represent only the main points that can be put forward in favour of the electric drive. There are also additional advantages, such as the cleanliness of the drive, the small cost of upkeep, reduction in oil consumption, information easily available as to the actual demand on the prime mover for varying classes of material and draughts, &c.

In the description of the representative plants given below, the main advantages leading to the adoption of the electric drive have been touched upon.

I. AN EQUIPMENT FOR TIN BAR ROLLING.

(Designed to deal with 40 tons per hour of tin bars 12 lb. per foot).

The mill originally consisted of two stands of housings, one cogging and one finishing, both three-high. The new conditions to be met involved a plant which would give a considerably increased output and overcome the difficulty of rolling thin bars which have a great tendency to form collars. In addition, close speed control of the finishing train was necessary with a wide speed range to give the best rolling results when dealing with widely varying weights of material.

The question of perpetuating the steam drive or of adopting the electrical drive was fully investigated, and the latter finally chosen

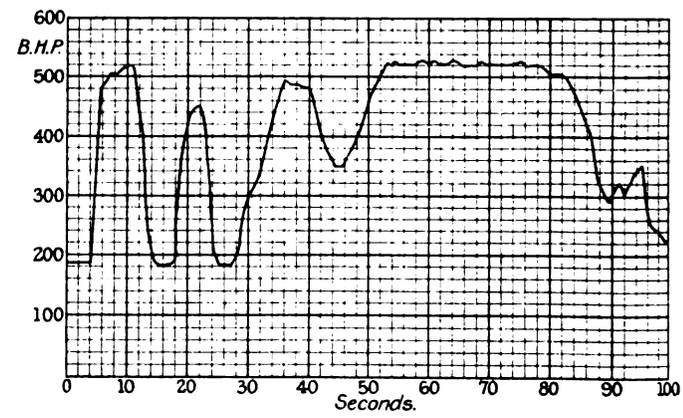

FIG. 2.

for the following main reasons: The whole of the existing boiler plant could be done away with, with its attendant cost of working and upkeep. No steam pipe lines would be necessary, with their interference of cranework, their heavy condensation losses and cost of repair. A reduction in the cost per ton of material rolled. An increased output. Many other factors such as even turning moment and ease of control were additional arguments in favour of the electrical drive.

A power company some eight or nine miles away was in a position to supply the necessary power, and erected an overhead transmission line for the purpose. This conveyed the power at 11,000 volts 25 cycles three-phase into the works where static transformers received it and reduced the pressure to 2,750 volts, at which voltage the large main motors were designed to operate.

For the drive of the 27 in. three-high cogging rolls a 700 H.P. continuous running three-phase motor was put down, coupled to the flywheel which formed part of the old engine drive, a flexible coupling being inserted between the motor and the flywheel to eliminate any harmful effects due to slight out of alignment between the flywheel shaft and the motor shaft. The flywheel weighs about 50 tons and is 12 ft. in diameter.

The motor is designed to give a maximum peak horse power of 5,300, and is direct coupled to the mill, the speed being variable in either direction between 0 and 180 revs. per min.

When designing an equipment for reversing work, two main factors have to be taken into consideration—the maintenance of a steady demand from the supply in place of the rapidly recurring peaks called for by the mill, which may exceed 20,000 H.P. ; and the reversal, in a simple manner, of a mill motor, the rotating portion of which may weigh up to 120 tons. These two difficulties are met by

* Abstract of a Paper read before the Manchester Association of Engineers.

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the introduction of a motor generator flywheel set, the flywheel acting as a reservoir of energy. The motor driving the flywheel is calculated out on the average load taken by the mill over a period, and may be of one-quarter or even one-sixth of the horse power of the mill motor, depending on the class of work being done.

The reversal of the motor is done very simply by altering the direction of the current supplied to its armature by the generator of the flywheel set, the control of the latter being done by varying its field current in strength and direction. Thus, no armature currents, which may exceed 8,000 amperes, need be controlled.

In the original Paper a detailed account of the method of control is given.

II. Motor Drive for 16 in. Merchant Mill for Rolling General Sections.

(Output per shift up to 140 tons.)

This mill was put down with the idea of obtaining very large outputs, averaging about 100 tons per shift, and not only has this output been realised but a very substantial increase has been obtained up to as much as 50 per cent. on occasion. The motor installed was rated for a normal continuous output of 1,000 H.P. with an overload capacity of 25 per cent. above this figure for two hours and 100 per cent. momentarily.

The mill consists of three stands of rolls working three high, of which two stands are employed when rolling angles and three stands when rolling rounds, and is fed from a continuous heating furnace within a short distance of the incoming side.

To meet the various classes of work dealt with in a merchant mill a variable speed is essential. It was decided finally to adopt a composite three-phase set which, whilst taking power from the supply, gave all the characteristics of a direct-current motor, such as easy and efficient speed control, constant horse power—*i.e.*, increasing torque with reducing speed, and a drop in speed from no

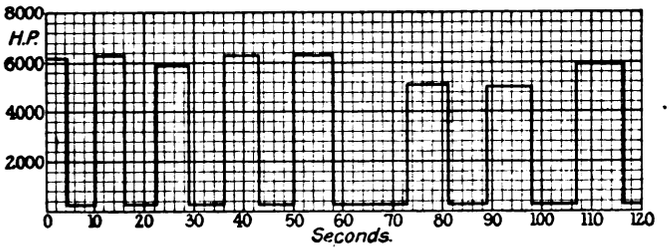

FIG. 3.

load to full load without loss of efficiency, so that a flywheel could be beneficially utilised. This plant was erected and set to work nearly eight years ago, and has been very successful.

A number of other drives of this type have been employed throughout the country with good results, but in modern practice it is now more usual to install rotary converters connected to the three-phase mains, which generate direct current which is applied directly to a direct-current motor on the mill.

The incoming supply in the present instance is at 11,000 volts 40 cycles three phase, and is transformed in static transformers to 2,750 volts, at which it is supplied to the stator of the induction motor.

A three-phase induction motor is essentially a constant speed machine, but its speed can be reduced by inserting resistances in the rotor circuit. If this method is adopted, constant torque is obtained throughout the speed range, and the difference in horse-power given out by the machine at the bottom and top speeds is wasted in the resistances. With the plant in question, the power which at the lower speed would normally be wasted in the rotor resistances, is taken to the slip rings of a rotary converter, and is there transformed to direct-current power which is delivered back to the direct-current nmotor, which is coupled directly to the induction motor. Consequently, the reduced horse power of the three-phase motor with reduced speed is compensated for by the increased power of the direct-current motor, the horse-power output of the set remaining constant independently of the speed.

The motor set in question is designed for a constant output of 1,000 H.P. at any speed between 75 and 150 revs. per min., the lower speed and increased torque being used when rolling the heavier sections.

A flexible coupling mounted on the motor shaft extension couples up to a 40 ton 14 ft. 6 in. diameter flywheel, which is connected directly to the mill.

The speed control of such a plant is carried out by altering the field of the direct-current motor by means of a shunt regulator mounted on the switchboard, and by having this auxiliary motor compound wound, a fall in speed is automatically produced between no load and full load, thus enabling the flywheel to give out a portion of its stored energy when the peak loads occur.

III. Drive for 7 in. Wire Rod Mill.

(Output 3½ tons per hour)

The conversion of this mill to a motor drive marked the beginning of the displacement of steam engines throughout the works and their substitution by electric motors. Before the change was made the old steam engines, two of which were coupled together, drove the mill through belts, had become considerably under-powered and inefficient, and some modification was imperative.

The mill consists of two sets of rolls, the bolting and finishing rolls respectively, originally driven through belts from the two engines mentioned above. When the new drive was installed the belting was done away with, and two motors were directly coupled, one to the bolting roll train and one to the finishing roll train. The motors finally installed were of 400 H.P. for the bolting rolls and 550 H.P. for the finishing rolls. The generating plant was designed for an output of 750 kw. at 440 volts direct current, the turbine being of the mixed pressure type.

A cast steel flywheel about 15 tons in weight, 12 ft. 6 in. in diameter was supplied, and the armature of the motor was mounted directly alongside the flywheel, the whole being supported by two solid bearings carried on an all-round bedplate. This method has the advantage of considerably reducing the over-all length of the drive and of avoiding any form of coupling between the motor and the flywheel.

The motor to meet the varying classes of work was designed with a speed range between 190 and 270 revs. per min. at full load, and a compound winding automatically gives a fall in speed from no load to full load, so that the stored energy in the flywheel may be utilised.

To ensure good commutation under all conditoins of load, a compensating winding is added to the field to neutralise the heavy armature reaction which occurs on peak loads. A diverter mounted on the frame of the machine is used for shunting a portion of the current flowing round the compound winding, and enables the fall in speed between no load and full load to be adjusted at will, thus on light material the average speed of the motor can be kept up by using a less drop in speed.

The finishing mill motor is also of the variable speed type, the range being 400 to 550 revs. per min. at full load. No flywheel was employed in this case, as the peak loads, owing to the long length of material rolled, persist for an appreciable period, and an equalising effect could only be obtained by having a flywheel of a weight which would prove a non-commercial proposition.

The results obtained from this drive were so satisfactory that the conversion of the remaining plant has been proceeding steadily since that date, and three additional motor drives have been installed. It may be stated generally that direct current motors have proved themselves more suitable than three-phase motors over a wider range of work, and for steel works practice it would appear as though such motors would be the more widely adopted in the future.

In the concluding portion of the Paper two other cases are treated, (*a*) a mill for rolling sheets (for corrugating and other purposes), (*b*) a motor for driving sheet mills for brass and copper.

In both cases a constant speed is required, and three-phase motors were utilised. The form of drive for rolling mills is simple in character, and involves no special speed-regulation. In the sheet mills for brass and copper the speed is relatively slow, and a gear train, though wasteful in power, has hitherto been found necessary.

Large Electrolytic Generators in Norway.—Some interesting data are given in the "Electrical Review and Western Electrician," regarding some large generators used by the Norsk Aluminium Co., of Christiania. The units are of 3,000 kw., and are water-wheel driven, each generator being capable of a variation in pressure from 50–335 volts. Their most interesting feature, however, is the fact that as much as 12,000 amperes is handled by one commutator operating at 3,000 revs. per min. Special ventilation is provided by hollow brush brackets, supported at each end by brush rings, also hollow. The brackets are so shaped that a jet of air is forced radially from them in front of each brush. The machines are of the shunt wound, interpole compensated type, designed with a large proportion of copper and relatively little iron, so as to diminish the weight to a minimum.

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A Note on the Relation of the Audibility Factor of a Shunted Telephone to the Antenna Circuit as Used in the Reception of Wireless Signals.*

By BALTH. VAN DER POL, Jun., D.Sc.

In the measurements of the strength of wireless telegraph signals, it is usual on board ship to employ a shunted telephone receiver and to measure the signal strength by the value of the shunt required to reduce the signal strength to a point at which dots and dashes may be just differentiated.

But so long as the phenomena occurring at the contact of the two substances of a crystal detector are neither qualitatively nor quantitatively known, we cannot calculate the relation that exists between the antenna current and the value of the shunt S required to reduce the signal strength to just audibility.

Direct measurements of the antenna current at great distance from the sending station cannot be made, for no ammeter exists with which it is possible to measure high-frequency alternating currents of the order of 5 micro-amperes. The only way, up to the present, to find the value of the receiving antenna current at great distances is to determine the shunt S, and to relate this to the actual antenna currents.

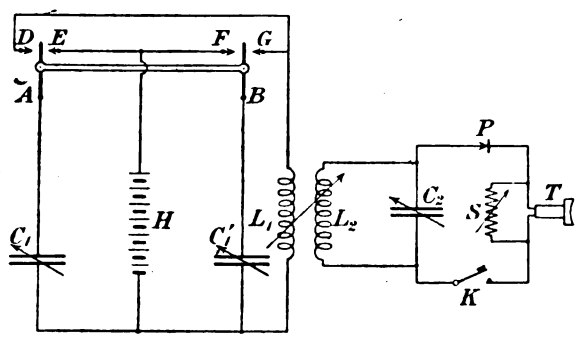

FIG. 1.

"From the two Papers of Austin † it is not quite clear how this factor"

$$Af=(R+S)/S,$$

where R is the resistance of the telephone, is proportional to the *square* of the antenna current.‡

It was suggested that this point could be experimentally examined. The following is a short account of the experiments so far conducted in the Pender Electrical Laboratory of University College London.

To generate high-frequency oscillations of a steady character a double Fleming and Clinton commutator,§ mounted on the same shaft, was used. This commutator, though originally designed for measuring small capacities, but now connected in the circuits as shown in Fig. 1, was found to produce very steady oscillations, of which the amplitude, wave-length, damping, and number of trains per second could be varied at will within considerable ranges.

In Fig. 1 H is a high-tension battery of secondary cells, C_1 and C_1' are two variable air-condensers of approximately equal capacity. The working of the two commutators is such that A is connected to D at the same time that B is connected to F. At this moment the condenser C_1' becomes charged to the voltage of H and any charge on C_1 is discharged through the self-inductance L_1, so that in the circuit C_1L_1 high-frequency oscillations are set up. At the moment when the commutator has revolved through an angle of 90 deg., C_1 becomes charged and C_1' discharges through the same inductance L_1, for at this moment A is connected to E and B to G. The capacity of C_1' was varied, so that with its leads and L_1 it was in tune with C_1, its leads, and L_1. The leads C_1A, $C_1'B$, HE, and L_1G were made up of 20 strands, each 30 metres long. The commutator, which was driven by an electromotor at a speed of approximately 3,500 revs. per min. (467 discharges per second), was not in the same room where L_1 with the receiver circuit No. 2 was placed, to avoid the noise of the commutator interfering with the small sounds to be heard in the receiving telephone. The inductance L_1 consists of a flat vertical coil of one layer of 15 turns with an inside diameter of 8·5 cm. and an outside diameter of 21 cm. Coil L_2, whose distance from L_1 can be varied by known amounts up to 100 cm., has the same dimensions as L_1, but consists of *two* layers. L_2 forms, with the variable air-condenser C_2, a high-frequency circuit from which the signals, produced by tapping the key K can be heard in the telephones T which, in series with a Perikon detector (chalcopyrite $CuFeS_2$ – zincite ZO), are connected across the terminals of C_2. A headgear of two Sullivan telephones [resistances $R=1{,}240\ \Omega$ in series] was used. These telephones were shunted by a variable resistance S as shown in Fig. 1.

The E.M.F. induced in L_2 is proportional to MI, where M is the mutual inductance between the parallel coils L_1 and L_2 and I the current amplitude in circuit No. 1, when only the couplings coefficient $k=M/\sqrt{L_1L_2}$ is small enough not to allow for any appreciable reaction from circuit No. 2 on circuit No. 1. Varying therefore the mutual inductance at a constant primary current has the same effect on circuit No. 2 as varying the primary current I at a constant coupling.

By moving L_1 to and fro the distance between L_1 and L_2 can be determined for which, with a certain shunt S, the sound of the signals, made by tapping the key K, can just be differentiated. The value of the mutual inductance M was then found by the use of a curve calculated from the formula of Maxwell-Rosa.*

$$M=2\pi^2n_1n_2\sqrt{aA}k^{3/2}\{1+3{\cdot}8k^2+15{\cdot}64k^4\ldots.\},$$

where n_1, n_2 are the number of turns of L_1 and L_2,
a, A are the *mean* radii of the coils L_1 and L_2,

and

$$k=\frac{(a+A)^2}{\{\sqrt{(a+A)^2+d^2}+d\}^2},$$

where d is the distance between the flat coils.

In the experiments coupling coefficients were used only between the limits

$$k=0{\cdot}003 \text{ and } 0{\cdot}0002.$$

The wave-length used was about 1,125 metres.

A curve (*see* Fig. 2) was then plotted for which the ordinates indicate the *logarithms* of the mutual inductance for a constant current (which is proportional to the antenna current for a constant coupling), and where the abscissæ give the logarithm of the audibility factor $(R+S)/S$.

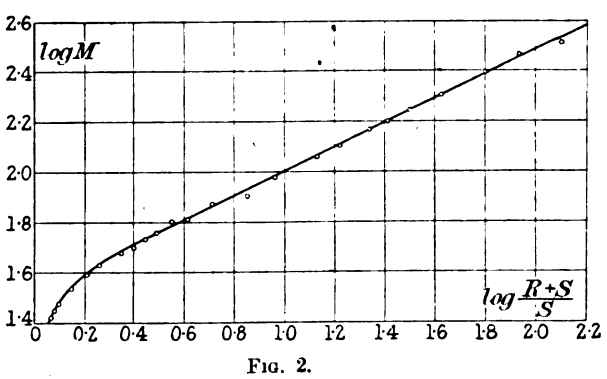

FIG. 2.

For values of $\log(R+S)/S$ from 0·6 to 2·2 (audibility factors from 160 to 4) our experiments indicate the relation

$$(R+S)\,S\sim I^2,$$

for between these limits the curve is a straight line with an inclination angle $=\tan^{-1}0{\cdot}5$.

For values of $\log(R+S)/S$ from 0·08 to 0·6, *i.e.*, for values of $(R+S)/S$ from 4 to 1·2, the audibility factor is proportional to a power of I ranging in this interval from 2 to 0·7.

The assumption that the audibility factor of a shunted telephone is in general proportional to the square of the antenna current, as stated by Hogan, seems to be invalid. For large values of the current we found a proportionality between the audibility factor and the square of the current, and for weaker signals the audibility factor was found to be proportional to a power of the current varying between 2 and 0·7, in agreement with Love's expectations.

* Abstract of an article in the "Philosophical Magazine."

† "Bulletin" Bureau of Standards (Washington), Vol. VII., No. 3, 1911 "Jour." of the Washington Academy of Science, Dec. 4, 1914. calibration was made, and Hogan † assumes that his "audibility

‡ THE ELECTRICIAN, Vol. LXXI., p. 720 (1913): also Love, "Phil. Trans.," Roy. Soc. Lond. Vol. CCXV. A, p. 128 (1915).

§ J. A. Fleming, "Principles of Electric Wave Telegraphy and Telephony," 3rd ed., p. 205.

* *See* "Bulletin" of the Bureau of Standards, Vol. VIII.

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Power Factor and Its Improvement.

By E. W. DOREY.

Summary.—The author discusses the causes of low power factor, and whether the cost of its improvement should be borne by the consumer or by the supply authority. It appears reasonable that the consumer should pay for this improvement, and, in order that he should have some inducement to do so, a special tariff is suggested for power consumers. Finally, the means available for improving power factor are considered, and examples are given showing the financial results obtained.

In the early days of alternating current supply the question of power factor was one that did not merit special attention, due mainly to the fact that the power factor of the supply system was on the whole high, particularly at times of peak load. This happy state of affairs was chiefly the result of the lighting load being such a large proportion of the total load. With the progress of time the ratio of lighting to power load has continued to alter until on most supply systems the lighting load is now a very small proportion of the total load, and thus the high power factor of the lighting load has very little influence on the power factor of the whole system.

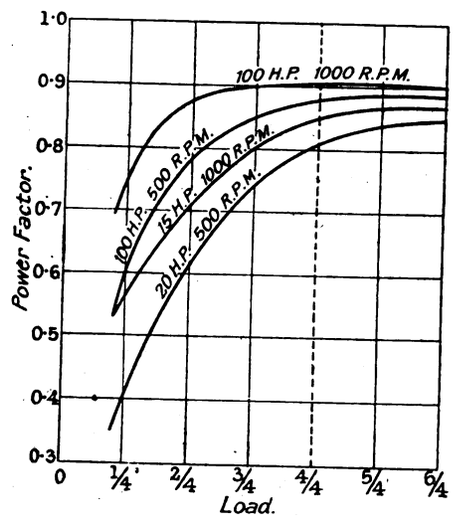

FIG. 1.—CURVE SHOWING EFFECT OF LOAD ON POWER FACTOR.

Summarised, the load on most supply systems consists of :

1. Lighting load.
2. Traction load.
3. General power load.

It is now necessary to ascertain how far these loads can be utilised to improve the power factor where such improvement is necessary.

The lighting load must be left to take care of itself, but the traction load with over-excited rotaries drawing a leading current from the mains can and does considerably improve the power factor of the system.

These remarks, however, are confined to the influence on power factor of the third item, "General Power Load," as on most of the larger power supply systems the traction load, where such exists, is now quite incapable of effecting the improvement in power factor which is necessary, and in many cases the overall power factor is steadily on the decline, although obviously there must be a practical limit to which the power factor will drop.

Let us consider :—

(i.) What are the contributory causes to the continued decline in the power factor ?

(ii.) Should the supply authority or the consumer improve the power factor ?

(iii.) What are the best means of raising the power factor ?

1. THE CONTRIBUTORY CAUSES TO THE CONTINUED DECLINE IN POWER FACTOR.

The chief causes influencing the decline of the power factor of the supply system may be summarised as follow :—

(*a*) The installation of motors of inferior design and construction with low power factor when machines with a higher power factor are obtainable.

(*b*) The installation of larger motors than are really necessary for the duty they have to perform, such motors, therefore, running under loaded, and consequently with a low power factor.

(*c*) Motors running light, or, say, driving idle shafting, and thus taking from the mains a large wattless current.

(*d*) The installation of a slow-speed motor where a higher speed machine could be utilised.

(*e*) The installation of a number of small motors when one or more large motors could economically be employed.

A consideration of the above points will suffice to show that all these influencing factors are directly under the control of the consumer, and it is therefore on the head of the consumer that the responsibility and necessity for improving the power factor of his load should rest.

The following schedules and curves (Figs 1 and 2) show what power factors are obtainable with machines of high-class manufacture, also the effect of speed and output on the power factor.

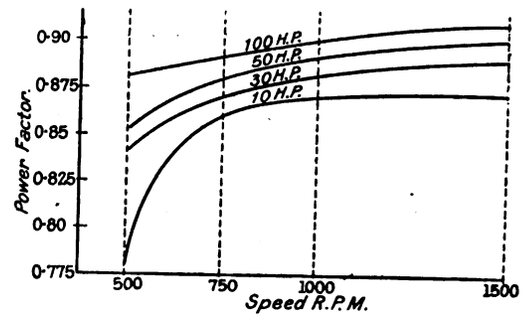

FIG. 2.—CURVE SHOWING EFFECT OF SPEED ON P.F.

Power Factors of Slow-speed Three-phase Motors.

B.H.P.	R.P.M.					
	375.	300.	250.	215.	150.	107.
50	0·84	0·82	0·82	0·75	0·75	...
75	0·85	0·82	0·83	0·76	0·75	...
100	0·86	0·83	0·83	0·77	0·76	0 72
200	0·88	0·85	0·86	0·80	0·79	0 73
300	0·89	0·86	0 86	0·84	0·81	0·74
500	0·90	0·87	0·87	0·87	0·83	0·75

Power Factors of Small Three-phase Motors with Squirrel-cage Rotors.

B.H.P.	R.P.M.		
	1,500.	1,000.	750.
5·0	0·88	0·84	0·83
3·0	0·87	0·80	0·78
1·0	0·85	0·75	0·70
0·5	0·83	0·72	...
0·3	0·80	0·68	...

2. SHOULD THE SUPPLY AUTHORITY OR THE CONSUMER IMPROVE THE POWER FACTOR ?

Although the objection to point (*a*) above may be overcome by the supply authorities insisting on the installation of motors with a high power factor, the supply authority has little control over points (*b*), (*c*) and (*d*), and with regard to (*e*) the enforced installation of a large motor, although from the supply authority's point of view very desirable, may be very objectionable and result in uneconomical working from the consumer's standpoint—*e.g.*, group versus individual driving in a spinning or weaving mill.

It is evident, therefore, that the supply authority is in need of some means of protection against low power factor, and, as

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every wise supply authority engineer knows, it is little use to argue the point with the consumer, but it is necessary rather to so arrange matters that t e consumer has a strong inducement to improve the power factor. Nothing will receive more hearty consideration than an inducement in the form of saving £ s. d. How can this happy result be attained ?

The consumer must be made to pay for low power factor, and this can be effected by

1. Basing the charge on the consumption in kilovolt-ampere hours or on the basis of a fixed ratio of kilowatt-hours to kilovolt ampere hours.

2. On the basis of a fixed rental charge per kilovolt ampere per quarter or per annum of maximum supply demanded plus a running charge per B.O.T. unit consumed.

Dealing with method (1) it will be remembered that an article was written by Prof. Arnò, and published in THE ELECTRICIAN of February 6, 1914, which described what will for convenience be termed the "Arnò meter." This meter integrates neither true kilowatt-hours nor true kilovolt-ampere hours, but two-thirds of the former and one-third of the latter. Assuming, therefore, for the moment that the basis is 1d. per unit (real, apparent or on the Arnò system, two-thirds kilowatt plus one-third kilovolt-ampere), the following would be the revenue per hour at power factor of 80 per cent., and load of 10 k.v.a.:—

True unit meter, 10 k.v.a. at 0·8 P.F.=8 kw. at 1d.=8d.

Arnò Meter, 10 k.v.a. at 0·8 P.F.=8 kw.

$$\left.\begin{matrix} 8\times0{\cdot}66\times1\text{d.} \\ 10\times0{\cdot}33\times1\text{d.} \end{matrix}\right\} \ldots\ldots\ldots\ldots = 8{\cdot}66\text{d.}$$

K.V.A. hour meter, 10 k.v.a. at 0·8 P.F.=10 k.v.a. at 1d.=10d.

ARNÒ METER AT VARYING POWER FACTOR.

10 kw. at P.F. 1·0 =10 k.v.a. =10d.
10 kw. at P.F. 0·8 =12·5 k.v.a. =12·5d.
10 kw. at P.F. 0·6 =16·66 k.v.a.=16·66d.

Inasmuch as the Arnò meter takes care of power factor, it is a step in the right direction, and certainly has more relation to the actual cost per unit sold than a charge based on true units. The Arnò system is based on average power factor conditions, whereas to be fundamentally sound, the ratio of kilowatt-hours to kilovolt-ampere hours should bear some relation to the constantly varying power factor.

For small power consumers having a load up to, say, 30 or, perhaps, even 50 k.v.a., these meters might well be employed with advantage to the power supply authority, as it would provide some *inducement* to the consumer to improve the power factor of his load.

Method (2), however, particularly in the cases of larger loads, say, 50 k.v.a. and upwards, is one that is adopted by several supply authorities, and has a most beneficial effect in inducing the consumer to improve the power factor of his load.

The cost of alternating-current electrical plant, both generating and distributing, including cables, is proportionate (although of course, not directly) to the kilovolt-ampere and not kilowatt capacity of the plant. There are, however, portions of the generating plant which, for all practical purposes, are independent of power factor, and their size and cost depend entirely on kilowatt capacity—*e.g.*, prime movers, including condensing plant, auxiliaries, boiler plant, &c. There can be no question of the justification for basing the rental charge on maximum demand in kilovolt-amperes, and all that remains is :—

1. To ascertain what charge per kilovolt-ampere of demand should be made.

2. What instruments should be used to record the kilovolt-ampere maximum demand.

Dealing with the first point, the charge per quarter or per annum per kilovolt-ampere of maximum demand must be the sum of two component charges.

(*a*) One component based on that portion of the generating plant which is unaffected by power factor, and must therefore remain constant irrespective of the power factor of the load.

(*b*) The second component based on that portion of the generating and distributing plant, including cables which is directly affected by power factor, and should therefore increase proportionately as the power factor decreases. The actual value of the component will, of course, vary according to the nature and size of the generating plant and distribution system, but the following example will illustrate the point :—

(X) represents the component in respect of plant unaffected by power factor.

(Y) represents the component of plant affected by power factor.

(Z) represents the total charge per quarter per kilovolt-ampere of maximum demand.

Power factor.	(X.)	(Y.)	(Z.)
	s. d.	s. d.	s. d.
Exceeding 95 %	7 0	7 0	14 0
Exceeding 90 %, but not exceeding 95 %	7 0	7 6	14 6
Exceeding 85 %, but not exceeding 90 %	7 0	8 0	15 0
Exceeding 80 %, but not exceeding 85 %	7 0	8 6	15 6
Exceeding 75 %, but not exceeding 80 %	7 0	9 0	16 0
Exceeding 70 %, but not exceeding 75 %	7 0	9 6	16 6
Exceeding 65 %, but not exceeding 70 %	7 0	10 0	17 0

Such a scale, when worked out to meet the actual conditions obtaining on the supply system, would graduate the kilovolt-ampere charge so as to severely penalise the consumer with low power factor, which is not only desirable, but justifiable. The principles underlying the basis of charge for method (2) are fundamentally sound.

The consumer, therefore, taking a load of 1,000 kw. would pay as follows :—

	Per quarter
At 80 % power factor 1,000 kw.=1,250 k.v.a. at 16s. ...	£1,000 0 0
At 100 % power factor 1,000 kw.=1,000 kw. at 14s. ...	700 0 0
Saving	£300 0 0

This saving, which is equivalent to £1,200 per annum, would enable the consumer in a short time to recover the capital expenditure necessary to install power factor rectifying plant to raise the power factor from 80 to 100 per cent.

Dealing now with the second point—viz., what instruments should be employed to record the kilovolt-ampere demand—there are three kinds of instruments which might, and, in fact are, employed as follow :—

(*a*) A maximum demand hot-wire ammeter.

(*b*) A maximum demand electrolytic indicator (Reason type).

(*c*) An integrating meter to integrate in kilovolt-ampere hours with lagging power factor and fitted with maximum demand attachment to record the maximum demand in kilovolt-amperes.

Instruments (*a*) and (*b*) are objectionable for two main reasons ; firstly, the difficulty in arranging a satisfactory time lag, and, secondly, that the voltage of the supply must be assumed. Instrument (*b*), however, is on the whole satisfactory for smaller loads, say, 30 k.v.a. and downwards, where possibly the costly instruments which I will refer to under (*c*) are not warranted.

Undoubtedly instrument (*c*) is from all points of view the most satisfactory, inasmuch as an instrument of this description integrates the kilovolt-ampere hours, and can be constructed for three-phase four-wire unbalanced loads as easily as for balanced loads. The writer knows of several instruments of this kind in satisfactory operation in this country, the instruments being in general construction and outward appearance similar to the true watt-hour meter, but the windings are so displaced as to enable the instrument to integrate accurately the kilovolt-ampere hours within the power factor limits for which it is designed, say, 70 to 95 per cent. or 75 to 100 per cent. power factor, as may be required.

The instrument integrates the kilovolt-ampere hours similar to the kilowatt-hour meter, and is fitted with a maximum demand attachment to record the maximum demand in kilovolt-amperes over a *quarter of an hour or longer periods*, as may be necessary. Inasmuch, however, as the consumption of energy requires to be charged on the basis of true B.O.T. units

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a separate watt-hour meter must be installed. The metering equipment for, say, a large consumer would consist of the following :—

Integrating kilovolt-ampere meter with maximum demand attachment.

Integrating kilowatt meter with or without maximum demand attachment.

Re-setting switch to control both instruments simultaneously.

One set of current transformers for both instruments.

The following is a diagram of connections of such a metering equipment with kilovolt-ampere and kilowatt demand indicators :—

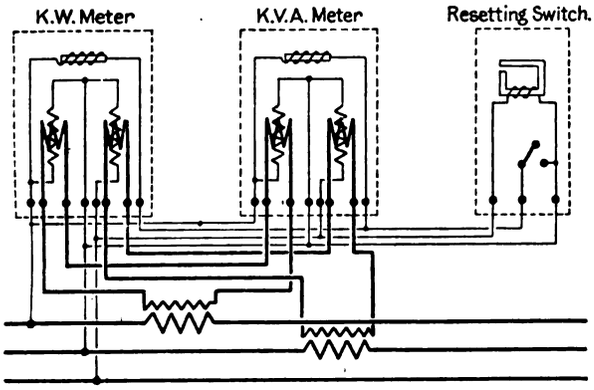

FIG. 3.—METERING EQUIPMENT—THREE-PHASE BALANCED LOAD.

A comparison of the integrations of the kilovolt-ampere and kilowatt meters enables some idea to be formed as to the value of the average power factor of the load. A maximum demand indicator on the true unit meter is not really necessary, but may be installed as a check on the kilovolt-ampere meter. The charges for supply would be based on the maximum demand reading of the kilovolt-ampere meter and on the unit consumption reading of the true unit meter.

The inherent features of the kilovolt-ampere instrument (*c*) described above are such that on a leading power factor considerably less than the kilovolt-ampere hours is integrated, and, in fact, when passing from unity to leading power factor the instrument will not record more than the true kilowatt load. The consumer, therefore, would not be penalised by running on a leading factor which is a necessary condition of affairs. Where a consumer has rotary converters installed and is likely to run with leading power factor, it is essential that the kilowatt instrument be fitted with a maximum demand attachment, as otherwise on, say, 90 per cent. leading power factor the kilovolt-ampere instrument would record considerably less than the kilowatt demand owing to the instrument running slow as mentioned above, whereas the kilowatt instrument would record the demand in kilowatts.

The writer knows of a set of instruments as described above installed at a consumer's sub-station, where extra-high-pressure supply is given to the consumer's rotary converters. The power factor is on the average unity, and during most quarters the integrations of and maximum demand recorded by both instruments does not differ more than 1 to 2 per cent.—*i.e.*, within the accuracy guarantee of the meters. Occasionally, however, the rotaries run with leading and lagging power factors, and the performance of the kilovolt-ampere instrument under these conditions is exactly as described above. These instruments with a kilovolt-ampere basis of charge naturally induce the consumer to run at unity power factor.

(*To be concluded.*)

Some Transient Phenomena in Electrical Supply Systems.*

By Prof. E. W. MARCHANT, D.Sc.

Summary.—This Paper records a number of oscillograms taken on the Liverpool Corporation electric supply system. In order to explain the results observed on the central station records, a number of tests are included of similar phenomena observed under laboratory conditions, in which the instant of closing circuit has been controlled. The theories of the various transients are discussed.

STARTING CURRENTS OF TRANSFORMERS

The study of transient phenomena in electrical supply systems has become, with the increasing size of power stations and distributing networks of great importance. One of the best known transient phenomena is that which occurs when a transformer is switched on to an alternating-current supply system. When 100 periods was the standard frequency the phenomenon was usually of small importance, since in such transformers the flux density in the core was usually kept low in order to avoid overheating, but with 25-period transformers worked at flux densities well over half saturation, the current which may flow when the transformer is switched in may be enormous. Thus, with transformers designed for 10,000 lines per square centimetre the current rush may amount to 400 times the normal magnetising current if magnetic conditions alone are considered; in practice, owing to the resistance of the coils the observed current will be much below this value. In Fig. 1 is shown a current-rush observed on one phase of a 100 kw. three-phase 6,600-volt transformer of the core type, when switched on near the zero point of the pressure wave.

The rush depends on the point of the pressure wave at which the circuit is closed, and on the remanent magnetism in the iron, since the current flowing to the transformer will have to be sufficient to produce this remanent flux density, and may be many hundred times the normal magnetising current. When the transformer is switched in at the same point of the pressure wave, but with no remanent magnetism, the current rush may still be large. The remanent magnetism is not large if the transformer has been standing idle, but if switched in and out at comparatively short intervals

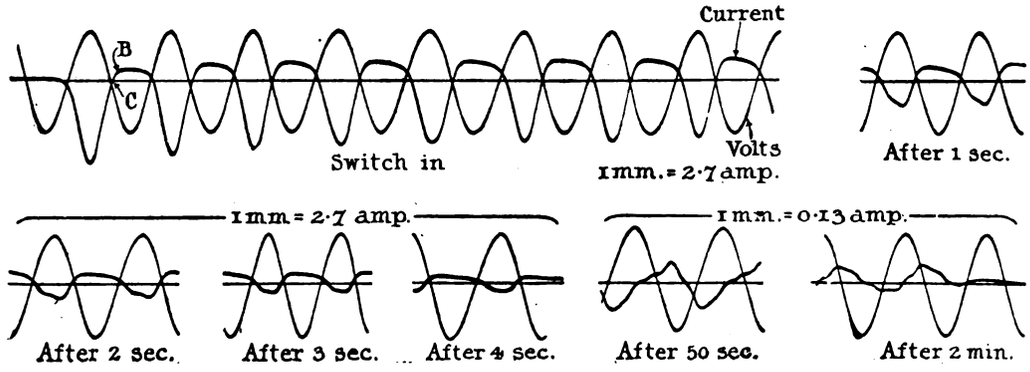

FIG. 1.

* Abstract of a Paper read before the Institution of Electrical Engineers.

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the remanent magnetism may be considerable, and the current-rush may vary within wide limits. The remanent magnetism is usually greater with lap-jointed transformers than with those having butt joints.

A number of tests were made on a bank of three 100 kw. step-down transformers switched on to the mains. The records taken were on one of these transformers. One of these records has been reproduced in Fig. 1. The current curve is 90 deg. out of its correct

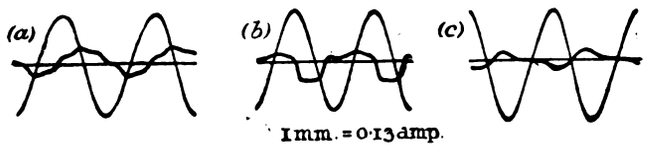

FIG. 2

phase. The maximum value of the current-rush is over 90 times the steady magnetising current shown after two minutes. During the first quarter-period the current is not very large. During the second quarter-period it rises, reaching a maximum at the end of the half-period. Had there actually been no remanent magnetism the current should have continued to remain negative during the third and fourth quarter-periods, but in the curves shown in Fig. 1 the current reverses very soon after the maximum point on the pressure wave, so that there must have been a considerable positive remanent magnetisation of the core at the instant of switching-in.

During the third quarter-period after switching-in, therefore, the flux changes from negative to positive and the current required to produce it does the same, but, since the positive flux is comparatively small, the current required to produce it is small also, and the positive current during this and the fourth quarter-period is relatively small.

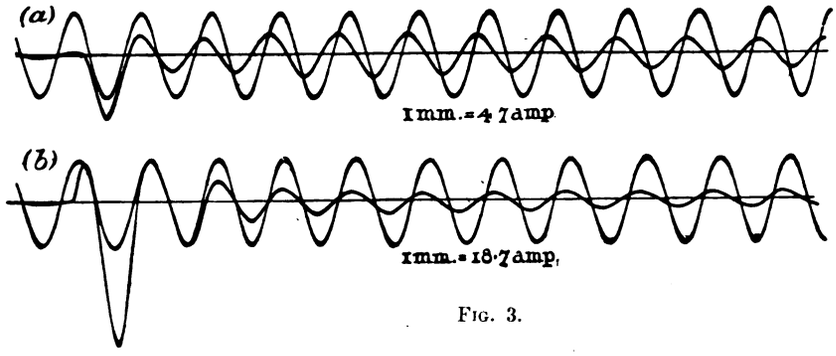

FIG. 3.

The chief effect of eddy currents will be to bring the resultant current-wave more closely into phase with the voltage than the flux curve. This is shown in Fig. 1, and the eddy-current component is clearly considerable. It is interesting to notice how slowly this remanent magnetism dies away. At the end of 50 seconds it is strong and even after two minutes it is appreciable.

One of the most interesting phenomena in connection with these transformers is the remarkable difference there is in the wave-shape of the magnetising current at different times (*see* Fig. 2). In Fig. 2 (*a*) the curve is very nearly symmetrical and the core may be assumed to be in a condition in which it is almost completely demagnetised. The two successive half waves of current are not exactly similar, but show "skew" symmetry, a result due to hysteresis in the iron.

Fig. 2 (*b*) shows a curve also symmetrical in which the core must evidently have been magnetised. In Fig. 2 (*c*) is shown a nearly symmetrical wave (corresponding therefore to a nearly demagnetised core) with a third harmonic of current, in this case a comparatively small one. These differences are interesting scientifically as they show the varying conditions of magnetisation of the iron core in a transformer working under apparently steady conditions. Variations in the magnetisation of the iron may affect considerably the heating of the core.

The factors affecting the current rush are: (1) The condition of magnetisation of the core at the instant of "switching-in," and (2) the instant of closing the circuit. It is therefore impossible to control the "rush," unless the transformer is switched out of circuit at a predetermined point on the pressure wave so as to leave a definite remanent magnetism in the core, and is then switched in again at another predetermined instant.

To further illustrate these points the author shows, in his original Paper, curves obtained for the switching-in of two small transformers, in which the instant of closing circuit was controlled to within 1/1,000th of a second by a switch operated by a contact-maker on the alternator supplying the system.

The effects were the same as those already discussed, but the conditions more rapidly become steady on account of the smaller size of the transformers. For purposes of comparison a 10 kw. 200-volt 50-period transformer was tried, designed for a flux density of about 10,000 lines per square centimetre. In this case the rush of current, though considerable, rapidly dies away, showing that the core soon reaches steady conditions. At the end of 50 periods the current is nearly normal and the wave quite symmetrical.

CURRENT-RUSH ON SWITCHING IN INDUCTION MOTORS.

A current-rush nearly always occurs when an induction motor is switched on to a circuit. This curve, however, is different from that of the transformer. The rotor circuit is closed, and the machine is similar to a short-circuited transformer, whereas in the case already considered the transformer secondary circuit is open. Some tests were made on a motor of 300 H.P. coupled to a continuous-current generator of 220 kw. output. The motor was three-phase star-wound, with 6,000 volts between the lines and taking a current at full-load of 26 amperes per phase; the frequency was 50 periods and the speed 420 revs. per min.

No attempt was made to control the instant of closing circuit, which will not greatly affect the rush of current. The records show that the rush is large, reaching a maximum value of over 380 amperes per phase or nearly 270 amperes R.M.S.—*i.e.*, 10 times the full-load current. This big rush is explained by the fact that there is initially no magnetisation in the stator core of the induction motor. If the machine were running absolutely synchronously there might be a rush due to the same causes as those discussed above, but it will be relatively small, since the flux density in the iron circuit of induction motors is low and there is an air-gap in the iron circuit. Even under the most unfavourable conditions it is not comparable with that found in a stationary transformer.

Two records are shown in Fig. 3. In one of these, Fig. 3 (*a*), the motor was switched in without great care being taken in synchronising it; the maximum current-rush is nearly 10 times the full-load current. In the other case great care was taken to bring the speed of the induction motor-generator to exactly its running value before the switch was closed. The initial rush is nearly the same, but the current dies down much more quickly to its steady value.

(*To be concluded.*)

Glasses for the Protection of Eyesight—A contribution by Mr. W. S. Andrews to the "General Electric Review" (U.S.A.) discusses the effect on the eye of infra-red and ultra-violet energy, and the transmission and absorption of various protecting media, to these rays. Dark mica is one of the materials that afford useful protection against excessive heat, and glasses suitable for goggles for workers near furnaces are described. There is good reason to believe that long continued proximity to such heat sources pre-disposes the eyes to caratact. In many operations the skin, as well as the eyes, needs protection. In regard to ultra-violet light thick ordinary glass affords fair protection in most cases, though special glasses are available; quartz and pebble glasses should be avoided. A point of importance is that the screens used in arc welding commonly allow a considerable amount of light to escape sideways, and this may affect others in the shop, besides the actual operators, who are naturally unprotected by masks. The presence of a strong ultra-violet component in a source is readily detected by the blue fluorescence it excites on sodium salicylate—a substance procurable at any drug store. This material may conveniently be used to test various forms of glasses for absorption of ultra-violet rays.

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Trade Parliaments and Their Work.

By E. J. P. BENN.

V. GOVERNMENT STORES.

The Trade Parliaments which are now being formed will find such a long programme of work to get through that it will be difficult for them at first to decide exactly where to start. They will be wise if they put near the top of their agenda the consideration of the question of the disposal of Government stores. The scandals which followed the disposal of Army property after the South African War are fresh in the minds of readers. These scandals were quite in accordance with precedent, as every war has always been succeeded by the most unbusinesslike proceedings in the matter of stores. If nothing worse than our South African experiences were possible there would, after all, be little cause to worry about the matter. The fact that a few people were ruined and a few more made fortunes by doubtful means is of trivial importance, but when the present war comes to an end a situation will arise such as has never been known. It has been said that this is a war of peoples as well as a war of armies. If one may judge from the catalogues of goods which have been bought by Government Departments in the name of the war it becomes obvious that this conflict has indeed involved the whole of our people and the whole of our property. Raw materials of every kind are to-day almost exclusively the property of the Government. Wool, leather, cotton, and all the metals hardly exist for private purposes. The markets in these goods, which were four years ago the centres of interest in their respective trades, have disappeared. Dealings as we knew them no longer take place, and the whole fabric of trading in these commodities, which has in most cases been the work of generations, has absolutely disappeared. Rightly or wrongly, for the purposes of war, the Government has put certain classes of traders completely out of business. This is most noticeable in connection with raw materials. We have been accustomed to rely upon importers, brokers, jobbers, factors, merchants, and wholesalers, and in the case of the wheat, timber, wool, and other staples most of these agencies have been dispensed with. The situation at the end of the war therefore will be that the Government woll possess hundreds of millions' worth of materials, and it is of vital importance that the old markets and all that they involved or some new machinery capable of performing the same functions shall be ready to deal with the Government and take over these materials for peaceful trading purposes. The space at our disposal only permits of the mentioning of this truly appalling problem in its barest outline. It is brimful of difficulties, and in its details it concerns almost every citizen. The most obvious danger may be stated very simply. The price of a given commodity may have risen to five times the pre-war figure, and traders all over the country will be holding stocks of materials or finished goods which they have acquired at current prices. If at the end of the war the Government were to let loose upon the market its holding of this commodity the whole trade would be absolutely ruined at a stroke. Another case, equally simple, may be mentioned. The Government is the owner of probably three-quarters of all the motor vehicles in existence, and when the war is over these might be put upon the market and buyers filled up with second-hand goods. In the meantime, however, the motor trade has devoted itself to munitions and aeroplanes, has modified its machinery and increased its facilities many times, and will be absolutely dependent on the greatest possible demand for new motor vehicles. The question will have to be settled as to whether the public are entitled to buy second-hand from the Government or whether they are to be encouraged to buy new goods from the trade. Upon the settlement of a question like this depends the life of the motor trade. These are two obvious cases, but there are many hundreds of others. In fact, it would be difficult to find a trade which will not be affected to some extent by a similar situation. The Minister of Reconstruction has appointed a committee to inquire into the risks associated with falling values in connection with stocks. Rising markets are very good from the trade point of view, so long as they continue to rise, but when the top of the curve is reached and the fall begins the position of traders becomes extremely serious. Our business men will obviously have to arrange to overcome any difficulties connected with such stocks as they will hold when the day of peace arrives. These difficulties will be bad enough, and they are undoubtedly entitled to ask that they shall not be accentuated by ill-timed action in connection with Government stores. This is the crux of the whole matter. The traders must state their views before the Government can know what is and what is not a wise course of action.

The circumstances in connection with each material and each class of goods will be different, and those interested in each class must get together and present their plans for dealing with the situation when it arises. It is really surprising how little attention has hitherto been given to this great problem of Government stores. We are all so occupied with the problems connected with the conduct of the war that we have not time to think of the questions that will arise later, but the most superficial consideration of the matter will show that unless Capital and Labour join together now and produce on behalf of each trade detailed schemes for dealing with the enormous issues involved in connection with matters like these there will be very little chance of a rapid transition to a condition of industrial peace. The man in the street is inclined to think that industrial peace depends entirely upon a better understanding between employers and employed. If, however, employers and employed were bound together by bonds of eternal friendship there would be no industrial peace so long as no basis existed for any market and there were no plans for dealing with materials and products.

(To be Continued.)

Use of Coke for Steam Raising.

In the "Times Engineering Supplement," there appears an article on this subject. It is pointed out that large stocks of coke are available, but difficulty is experienced in burning coke on chain grate stokers. With the view to relieving congestion at gas works by promoting the use of coke as fuel for steam raising, various experiments have been instituted under the ægis of the London Coke Committee and their Engineer and Fuel Expert, Mr. E. W. L. Nicol, has now developed and introduced an apparatus for which a patent application has been filed for firing coke and coal on chain grate stokers in two or more superposed layers, a system of blending bituminous and non-bituminous fuels first used by him at an important provincial power station. In its simplest form this apparatus consists of a double-feed hopper, the front compartment being arranged to feed on to the grate suitably graded coke in an even layer the depth or thickness of which is proportioned to the draught available. From the second compartment of the combined feed hopper a layer of bituminous coal-slack is fed, the joint thickness of the two layers being regulated by means of a guillotine door. For use with gas coke breeze, or other non-bituminous fuel in a state of fine sub-division, which is liable to sift through the grate, a three-compartment feed hopper has been designed, the front compartment of which is used for feeding on to the grate a layer of relatively large-sized fuel. This system tends to eliminate loss due to riddling of small fuel through the grate, and also protects the grate from the intense local heating effect common to all non-bituminous fuels.

Following upon the experimental stage of development which has been continued on one set of boilers over a period of two years, Mr. Nicol's system of firing gas coke on chain grates under ordinary conditions of natural draught has now been adopted on a large scale at various tramway, railway and other power stations. Where the quantities handled are large the difficulty of storing, and feeding, both coal and coke to each boiler, or battery of boilers, has been obviated by dividing the overhead storage bunkers into two separate compartments and suitably arranging the shoots. In other cases, as a temporary measure, an overhead bunker has been isolated and used for coke exclusively, from which the coke, elevated in the usual manner by means of a conveyor, is filled into steel tipping trucks from which it is in turn filled into auxiliary coke feeding hoppers attached to the mechanical stokers. The proportion of coke used may, however, be in excess of that of coal, in which case it might be convenient to feed coke, instead of coal, by gravity to each individual boiler.

ACTUAL WORKING RESULTS.

Actual working results given by one important user tend to prove that there is not, as might be anticipated, any loss in boiler capacity due to using by means of this system of blending an average of two-thirds admixture of coke. There is, in fact, a substantial improvement in thermal efficiency due to the unusually low excess of air used and the consequent increase in furnace temperature and relatively high proportion of CO_2 obtainable in the flue gases, as will be seen from the following comparative figures which are based upon (1) average results obtained with coal exclusively, and (2) results obtained with two-thirds coke and one-third coal slack :—

	Coal.	Coke and coal.
Draught, at uptake	⅝ in.	⅝ in. to ¾ in.
Fuel burnt per square foot of grate area per hour lb.	26	26 to 30
CO_2 per cent.	8	10 to 12·5
Excess air, per cent.	159	100 to 65.
Evaporation from and at 212°F. per lb. of fuel as fired, lb.	7	7·8
Evaporation per square foot of grate area per hour, lb.	182	202 to 234

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National Research.

We begin to see signs of recognition by the Naval authorities, and even by the Military also, of the importance of scientific research. The problems of modern warfare are insoluble by any of the methods hitherto used: their solution demands the newest methods of the scientist.

There is good reason, however, for saying that the efforts which are now being made to apply the nation's scientific resources to naval and military problems are inadequate, and have hardly, as yet, touched more than the fringe of the resources which, with careful organisation, might become immediately available.

The method which seems to find favour at present, when a new problem has to be solved, is to call in a scientist or technical expert, give him the minimum of information as to the nature of the problem, swear him to the strictest secrecy, and expect him to evolve a solution forthwith—the incentive offered being the joy of service.

In some cases—so important is strict secrecy deemed to be, and so little the confidence reposed in the experts—the problem, before submission for investigation, is split up into parts, which then are assigned piecemeal to experimenters in different parts of the country.

That such a method must be slow and ineffective is obvious to anyone who has had experience in experimental research, and we feel that thoughtful consideration of the matter by Naval and Military authorities, with a view to the more adequate employment of the nation's scientific and technical resources, is a most urgent duty.

Our weakness in this matter is hardly to be wondered at when the fact is considered that, in Great Britain, organised scientific research, upon a large scale, is all but unknown, and that often the so-called research that is attempted is unworthy of the name. Research is a misnomer when applied to routine tests of indifferent accuracy by inexperienced youths valued at 30s. a week. That something not so very far removed from this is, nevertheless, the conception of research which exists in the minds of members of some of the committees co-operating with the Government Department of Scientific and Industrial Research, seems to be indicated in the following words, which occur in a letter recently circulated among scientists and engineers, a letter asking for offers of help in certain specified researches. The words are: "The lines upon which these investigations will develop cannot be exactly foreseen, and *it would be expected that anyone who undertakes any of this work would bear in mind the objects to be attained and would not content himself with mechanically carrying out a series of tests.*" The words we have put in italics are not only an insult to the men to whom they are addressed, but, more serious by far, they augur ill for the success of the scheme, for they indicate that members of committees whose co-operation has been accepted by the Department of Research appreciate neither the magnitude nor the nature of the work they are trying to advance, nor yet the calibre or attainments of the men to whom they are appealing. And yet the appeal is that these men shall give without material reward—sacrificing even the modest and pleasant right of publication—much time and energy, as well, perhaps, as the best fruits of their long years of earnest ill-repaid work.

The possible importance of national research, both in the hastening of victory and in the assuring, after victory, of continued peace, cannot be over-estimated, and it behoves those into whose charge the organisation of such research has been given to take counsel together very often and to devote perhaps even more attention to the strategy than to the tactics of national scientific effort.

Up to the present the picture we have been led to form of this country's national research is that of a guerilla warfare—extravagant, so far as it goes, but limited and ineffectual. Organisation and co-ordination are required.

Organisation must begin with the definition of the problems that need investigation. It often happens that the men who are actually faced with a problem are incapable of defining it—to say nothing of solving it. In mathematics the complete statement of a problem often carries with it the solution. And in science the clear defining of a problem will often go far towards the solving of it.

A common experience of those who, of late, have tried to help in the solution of scientific problems brought to them by Government Departments has been the difficulty of getting a clear statement of the nature of the problem. Not infrequently it has happened that the first statement of a problem—a statement which has been allowed to form the basis of long and futile research—has proved either incomplete or incorrect. This would have been avoided had the method been adopted of allowing the work of the research experts to begin with the definition of the problem. In many cases such a preliminary investigation of its nature would have shown the problem to be no new one at all, but an old one with well-known solutions ready to hand.

In order to put the experts in a position to define the problem, the fullest confidence would have to be placed in them, every facility offered for preliminary investigation, and in every way the status accorded to them which is commensurate with the great importance of the aims of their work.

Research work cannot be done to order, nor can it be bought. Success therein demands the worker's keenest personal interest, the sort of interest that makes a man impatient of rest or sleep until the work is finished, and such keenness must be coupled with well-trained faculties and a highly developed intelligence. These things are above hire or purchase.

The nation's resources in men thus equipped for research are good, and we have reason for stating that they have hardly yet been touched. The attempts that have been made to use these resources appear to us to have been desultory and half-hearted, and made, often, without understanding.

Some of the most difficult naval problems demanding scientific research for their solution, centre around the submarine. Much research is to-day being devoted to these problems, but we have reason for saying that much of this work is unorganised, un-co-ordinated and inadequate. The data of the problems are in the hands of naval men, and these data are given out with niggardly hand, piecemeal and incomplete, to the men who are expected to solve the problems. We honour very highly the men of the British Navy, and the great traditions which during the past four years they have not only continued to hold, but have nobly emblazed, and it would ill become men of such a navy to allow the fear lest honours should fall to men of more specialised scientific attainments than themselves, to make them withhold from these the means which might lead to the frustration of the enemy.

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Fortunately, during the last six months there has been a tendency to adopt broader views, and with this less restricted policy we hope that increasingly useful work will be done by the civil element which has been working at these problems. The field of the Department of Scientific and Industrial Research is, of course, much broader and more permanent. In a sense, therefore, it is all the more important that the methods adopted by the Department should not be based on any narrow views, but should be such as to lead to the maximum results from the national point of view.

A Method of Testing the Registration of Current Rushes on Meters.*

By J. A. MÖLLINGER and W. VON KRUKOWSKI.

In speaking of motor-meters it is generally assumed that we are dealing with a state of affairs in which the current has temporarily, at any rate, a stationary value. Meters are usually calibrated on this assumption, which holds good generally under ordinary conditions during the working life of the meter. But there are certain types of consumer of a different kind, *e.g.*, lifts, welding machines, &c. There is a good deal of doubt as to whether the current rushes in these cases are properly registered. The view is often held that if the energy is taken in jerks, the meter will read too low, and it is, therefore, well to inquire into the matter.

Let us suppose that the angular velocity of a meter, through which a current I is passing, is ω_0 when the stationary condition is reached. Now let us pass the current I through a meter, which is at rest. The angular velocity increases with the time t according to the curve ω, which depends on the damping constant, the moment

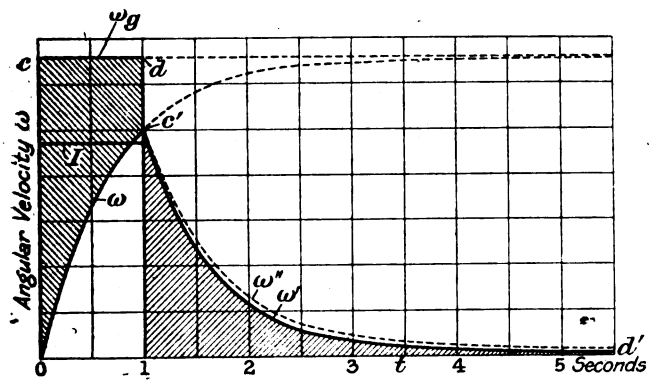

FIG. 1.—CURVES ω AND ω' SHOW THE READINGS ON A DYNAMOMETER METER, WHEN THE CURRENT IS SWITCHED ON AND OFF. CURVES ω AND ω'' APPLY TO AN INDUCTION METER.

of inertia of the armature, and the torque. Gradually this curve reaches the value ω_0. If the meter is switched out at the end of a second, the angular velocity of the armature only reaches the point a', as shown in Fig. 1, which is decidedly less than the full value: it then falls off, according to the curve ω'. In this case the area $0c'd'0$ is plotted out, whereas if a current I had passed in the stationary state for one second, the area $01dc$ would have been plotted out. Now it can be shown theoretically that with a dynamometric meter the two shaded areas are equal to one another. Therefore a dynamometric meter should register correctly, even if the current passes in jerks, the number of the jerks being, of course, immaterial.

With induction meters the damping, due to the iron, causes errors. Take the stationary condition as in calibration. The dampings due to the steel magnets, the voltage-flux, and the current-flux all act together, when the current is switched on; when it is switched off there is no current-flux. The curve ω'', therefore, is rather too high, as shown in Fig. 1, in the dotted curve. The meter, therefore, reads too high by an amount equivalent to the area between ω'' and ω'. But in practice this error is negligible.

The theory can be easily tested experimentally in the case of direct-current watt-hour meters. Keeping the voltage constant, one passes the current rushes through the meter, and measures by a voltameter the electrical charge passing through the current coils. The test on an induction meter can be made by comparing it with a meter that can be used on direct or alternate current, *e.g.*, a dynamometric watt-hour meter. Orlich's pendulum meter can also be used for this purpose. But in this case caution must be exercised, because the pendulum-meter will read much too high in case there is resonance between the period of the current rushes and the periodicity of the pendulum.

Induction meters can, however, be directly tested by the following simple method. As shown in Fig. 2, the voltage-coils of three similar induction meters, Z_1, Z_2, Z_3, are connected to the same network, which has a nearly constant voltage. By means of the change-over switch U, the meters Z_1 and Z_2 can be alternately put in series with Z_3. R is a loading resistance. It is first necessary to determine whether the three meters give the same readings on a steady load; if they disagree, the difference must be noted. Then the switch U is changed over quickly every second. Thus the meters Z_1, Z_2 have current rushes, lasting one second. Being

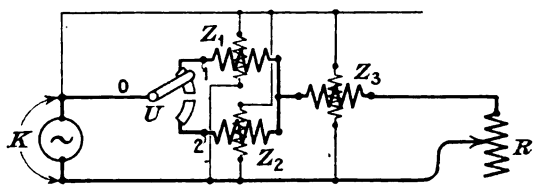

FIG. 2.—METHOD OF CONNECTIONS TO PASS CURRENT RUSHES THROUGH Z_1 AND Z_2 AND A STEADY CURRENT THROUGH Z_3.

exactly similar they should have the same percentage error, which we will call a.

Then $$A'_1=\left(1+\frac{a}{100}\right)A_1\,;\quad A_2'=\left(1+\frac{a}{100}\right)A_2,$$

where A_1, A_2 are the readings which would be shown on the meters Z_1, Z_2 if the load were steady, and A_1', A_2' are their actual readings under the circumstances. The meter Z_3, however, works on a steady load, supposing the change-over switch to be worked sufficiently rapidly, and the resistance R to be of sufficient size. Thus $A_3'=A_3$.

Now $A_3'=A_1+A_2$, whence we deduce from the equations given above that

$$a=\frac{100(A_1'+A_2'-A_3')}{A_3'}.$$

Thus the percentage error can be found from these three readings. For practical purposes the change-over switch, worked by hand, is replaced by a kind of rotating commutator, as shown in Fig. 3. Three slip-rings with their brushes are mounted on a wood cylinder; the middle ring is divided into two halves, each half being con-

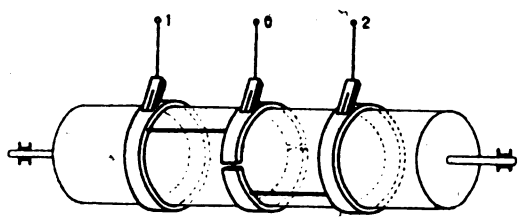

FIG. 3.—SHOWING A ROTATING COMMUTATING DEVICE IN PLACE OF THE CHANGE-OVER SWITCH IN FIG. 2.

nected with one of the outer rings. The middle brush is able to bridge the gap in the ring, and is connected with the conductor 0 in Fig. 1. The other two rings are connected to the points 1 and 2, which are the terminals of the two current coils respectively. This commutator is driven through gearing by an electric motor. The test is continued until the meters are properly calibrated. Seeing that the middle ring consists of two equal halves, the two meters are switched in and out equally. The speed was so adjusted that in one case the change-over took place at the end of 1 second, and in another case at the end of 2 seconds. Theory shows that the error increases with the moment of inertia of the rotating system: a test was therefore made by adding a zinc ring to the edge of the disc. Another series of tests was carried out with polyphase meters and in this case the commutating rotary device was suitably altered. These tests showed that with induction meters, at present on the market, such current rushes as are found in practice may cause the meter to read high by about 1 per cent., which is an almost negligible error. If the moment of inertia is increased by the addition of the ring, the error may reach +1·5 per cent. This method of testing can obviously be equally applied to direct current meters.

* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 25, 1917.

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The Lighting, Heating and Power Order (1918) and the Best Methods of Making Economies in Lighting.

At the annual meeting of the Illuminating Engineering Society on May 14th there was a discussion on the Lighting, Heating and Power Order, the president (Mr. A. P. Trotter) being in the chair.

After the conclusion of formal business, and the presentation of the usual report of the council, Mr. L. Gaster opened the discussion. The object of the Society, he said, in promoting this discussion was to carry out the aim it had always upheld of preventing waste of light. While there were, doubtless, cases of extravagant lighting, where a diminution was justifiable, it was undesirable to make economies in cases where further curtailment would involve sacrifice of efficiency of work or would prejudice health and vision or lead to accidents

Mr. Gaster then proceeded to quote from figures in the report of the Coal Conservation Sub-committee on Electric Power, showing the allocation of coal for various purposes. Of the total home consumption of about 190 million tons for 1913, about 60 million was used for factories and 30 million for the iron and steel industries, while domestic needs accounted for about 35 million tons. In the latter direction there might be possibilities for saving; but the coal supplied to gas and electric supply companies was only slightly over 20 million tons, and of this probably only 5 to 6 million could be regarded as used for lighting. Even if every consumer reduced his lighting by one-sixth, as the Order required, the resulting coal saving would be less than ¾ million tons—only about ½ per cent. of the 1913 coal output.

A diagram was also presented showing the distribution of electric lighting in the United States, according to Mr. P. S. Millar, from which it appeared that industrial and commercial lighting together accounted for about 40 per cent., while the luxury lighting was only a small percentage, and had in this country already been much diminished. Cases were quoted to show that an increase in illumination, even beyond a generous allowance, improved the output and quality of work in factories, and an instance was mentioned where, by diminishing unduly the lighting, an accident was caused, the compensation for which would have paid the entire lighting bill of the factory for 17 months.

In the discussion several points in the Order were criticised, such as the requirement that one-sixth reduction was apparently required on every meter supplying the same premises This seemed a needless complication, and the total consumption in such cases should be dealt with. Attention was drawn to the hard case of consumers who had already made diminutions in their lighting, and it was suggested that a combined rationing scheme for coal, gas and electricity would be helpful in avoiding the anomaly of consumers tending to use more coal in order to economise their use of gas or electricity. In considering large factories, assessors having an adequate knowledge of the requirements of the industry carried on should be appointed by the Board of Trade.

A series of simple recommendations had been prepared by the Illuminating Engineering Society, and issued with the concurrence of the Board of Trade, in order to assist consumers to distinguish between judicious and undesirable methods of economy. The data on industrial lighting, forming an Appendix, will, it is hoped, be specially useful in deciding the requirements of factories.

In what follows we give a brief survey of these recommendations.

The first section briefly explains, with examples, the requirements of the Order; this is naturally subject to modifications in the Order, but the actual recommendations on lighting apply irrespective of any such changes.

Consumers are advised how to ascertain their consumption, and particulars are given of the amount of gas and electricity consumed by typical gas burners and electric lamps. With a view to avoiding waste of light, importance is attached to the selection of efficient types of lamps and burners, and the replacement, so far as possible, of worn out and inefficient ones; the use of properly designed shades and reflectors so as to facilitate the use of lamps and burners of as small consumption as possible; lamps and burners to be turned on only when actually required; frequent cleaning of lamps and accessories. Various suggestions are made regarding methods of diminishing lighting in drawing rooms and dining rooms, halls, passages, &c.

An appendix is added dealing specially with industrial lighting. The fundamental principles, as specified in the Home Office Committee's Report (1915), are quoted, and the following data are presented as a rough guide to the intensity of illumination and consumption necessary for various classes of work:—

Class of work.	Minimum illumination on work (foot-candles).	Consumption per 1,000 sq. ft. of working area.	
		Gas. Cubic feet. Low-pressure incandescent.	Electricity. Watts. Tungsten lamps.
Storage, passage ways, &c....	0·25	3— 5	60— 100
Rough manufacturing work .	1·25	15—25	300— 500
Fine manufacturing work and offices	3·5	40—60	800—1,400
Very fine work on dark materials	10—15	(local lights)	

A practical example of the working of these rules is given.

Correspondence.

ELEMENTARY PRINCIPLES OF CONTINUOUS-CURRENT ARMATURE WINDING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The claim of Mr. Denton on behalf of multiple windings which I intended to criticise in my former letter is that made on p. 850 of your issue of April 12th. It is there stated that for "a four-pole machine to deliver 4,000 amperes four paths would not be sufficient, since 1,000 amperes per brush is excessive, on account . . . of the mechanical difficulty of designing sufficiently rigid brush gear. Eight paths would simplify the design," &c.

Whatever type of winding is used in this case the current per brush set cannot be reduced below 1,000 amperes. Mr. Denton is, no doubt, quite aware of this fact, but his quoted statement easily might mislead those who are not familiar with multiple windings.—I am, &c.,

Sunderland, May 13. W. TOLME MACCALL.

TEACHERS FOR JUNIOR TECHNICAL SCHOOLS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: To those of your readers who meditate applying for some of the posts now being advertised for technical teachers in some of the new day junior technical schools now being started in our technical institutes for boys between 14 and 16 years of age, may I commend the following extract from a Paper by the Principal of the Keighley Technical Institute, as reported in the "Journal" of the A.T.T.I. for February, 1918? Its perusal may, I think, tell of a new class of student with whom the ordinary technical teacher has happily had so far very little experience.

Mr. Watson says: "The teachers who will be required must be well-trained men, both in the theory of teaching and in the special requirements for their work, which will always be strenuous, and for some time, at any rate, will require special qualifications for discipline. It is to be expected that *the pupils in very many cases will be unwilling* to submit to a further course of learning and the discipline which accompanies it. They will be making their first acquaintance with the comparative freedom of the workshops, and they will be brought into contact with the customs, speech and general bearing of their elders. Moreover, the ages, from 14 to 16 years, is recognised by experienced teachers in secondary schools to be the most difficult in the daily school life, and therefore the power of keeping discipline with firmness and tact which requires for its development even in naturally gifted teachers, a considerable number of years of experience, must be looked upon as the most essential qualification for the teaching of these classes."—I am, &c.,

London, May 18. TECHNICAL TEACHER.

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On the Thermo-Electric Properties of Fused Metals.*

By CHARLES ROBERT DARLING and ARTHUR W. GRACE.

In a previous Paper on this subject † an account was given of the experimental methods employed in investigating the behaviour of bismuth up to 560°C., which was the highest temperature attainable with the apparatus described. The present Paper deals with new experimental methods enabling results to be obtained with a num er of metals up to 1,000°C.

Experimental.—The nature of the apparatus adopted is illustrated in Figs. 1 and 2. In the first method (Fig. 1) a silica tube *B*, open at both ends, was inserted about halfway up the vertical tube *A* of an electric furnace (nichrom wound), whilst the lower end of *B* dipped into a vessel containing oil. Prior to insertion in the furnace, *B* was filled with the metal under trial, and the sec nd metal placed in the liquid mass in the form of wires, forming the hot junction *H* and the cold junction *C*. After placing in the furnace the upper part of the metal in *B* was melted, the pyrometer *P* inserted, and the hot and cold junctions coupled to a calibrated galvanometer *G*. Readings of E.M.F. were taken at suitable temperature intervals, the furnace being controlled by an external resistance. A second method (Fig. 2)

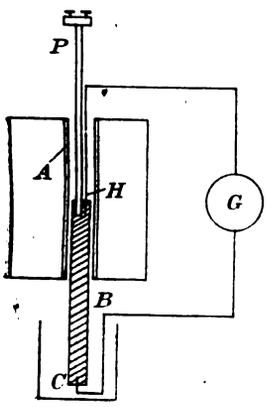

FIG. 1.

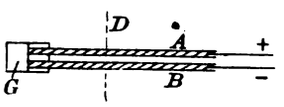

FIG. 2.

was found to be more convenient than the foregoing in the case of metals procurable in the form of long rods. A graphite block, *G*, was bored with two holes, into which were inserted tight-fitting silica tubes, *A* and *B*, 40 cm. long, each containing slack-fitting rods of the metals under examination. When one of the metals was known not to fuse at the temperature attained in the experiment the end was threaded and screwed into the graphite. This element was inserted in the tube of an electric furnace and used in the horizontal position, wires of the same material being taken from the cold end to the measuring apparatus. When placed in the furnace to a distance indicated by the line *D*, continuity of the circuit was maintained between the liquid portion in the furnace and the

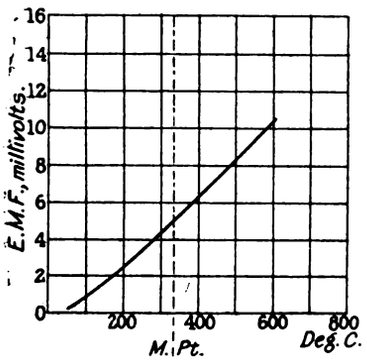

FIG. 3.

solid part beyond *D*. Temperatures were measured by means of a thermal couple of Hoskins' alloys. This couple was inserted in a cavity in the graphite block *G*, and in taking readings the furnace resistance was adjusted at intervals, and observations made when the pyrometer indicator and also the indicator connected to the metals under test were both stationary. The results obtained with a number of metals are appended, and refer to a cold-junction emperature of 25 deg.

Lead.—In the case of lead, it was found that no abrupt change is produced on melting, all the curves obtained by plotting E.M.F. against temperature being quite smooth in this region. Up to about 300°C. all these curves were approximately parabolic, but the continuations above this temperature departed considerably from this shape. Fig. 3 represents the values obtained with a german-silver-lead couple. There is no discontinuity at 327 deg., the melting point of lead, but from about 300 deg. upwards the temperature —E.M.F. relation becomes linear. The representation of this couple on a thermo-electric diagram would, therefore, consist of a sloping line up to 300 deg., and afterwards of a horizontal line parallel to the lead axis. Consequently extrapolation of the sloping lines obtained from low-temperature observations leads to serious errors. As an example, it is specifically stated in some books that the neutral point of iron and lead is 350°C., beyond which the E.M.F. diminishes; whereas direct observation shows that no such neutral point exists, and that the E.M.F., which is 2·6 mv. at 350 deg., rise continuously to a value of 4·2 mv. at 900 deg.

Tin.—As the high boiling point of tin renders it feasible for use as one of the members of a liquid junction, many experiments have been made with this end in view. In no instance was any discontinuity noticed at the melting point (232°C.), as indicated in Fig. 4 (iron-tin). This curve also illustrates the dangers of extrapolation. The steepness diminishes considerably after passing the neutral point and between 700 deg. and 850 deg. shows a flexure, after which the steepness again increases.

Cadmium, Zinc and Aluminium.—In the case of these three metals it was also noticed that the act of melting produced no change in the E.M.F. The temperature of inversion of zinc and iron was observed to be about 470 deg., which is about 50 deg. above the melting point, and had any change resulted from fusion it would have been detected readily with this couple. Aluminium and constantan show a linear relation between E.M.F. and temperature, which is not interrupted by fusion at 657 deg.

Antimony.—Special interest was attached to the experiments with antimony, owing to the general resemblances between this metal and bismuth. It was found that, as in the case of bismuth, an abrupt change in thermo-electric properties occurred at the

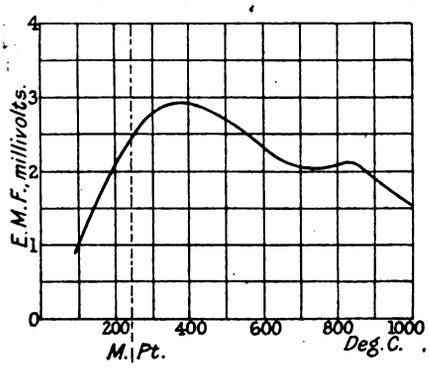

FIG. 4.

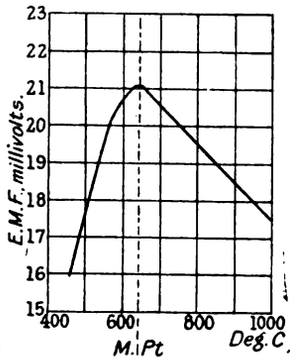

FIG. 5.

melting point, 632 deg. A typical case is shown in Fig. 5, which shows the behaviou of an antimony-copper couple between 400 deg. and 1,000 deg., the change in shape due to fusion being most pronounced. A similar result was obtained with an antimony-iron couple, and hence antimony acts in the same manner as bismuth in this respect.

Conclusions.—So far as it is possible to generalise on the results obtained, it would appear that the thermo-electric properties of metals are usually unaffected by change of state from the solid to the liquid phase or *vice versa*. The exceptional behaviour of bismuth and antimony may be due to the formation of allotropic modifications on melting, in support of which view may be adduced the fact that both of these metals expand upon solidification, and are thus exceptions to the ordinary rule. Further, as shown in the case of iron, an allotropic change is accompanied by an alteration in thermo-electric properties, and it is possible that the one change is always accompanied by the other. Experiments are now in progress with metals of still higher melting points, which may confirm or otherwise the view expressed above. The success of the main object of the research—the production of a high-reading pyrometer—entails the condition that mere change of state has no effect on the thermo-electric properties of the metals used.

It is possible that molecular changes occurring in molten alloys may be detected by experimental methods similar to those described in the present communication. A suitable metal to couple with the alloy under test could be found by trial, and it is probable that the change in E.M.F. accompanying a m lecular transformation would in some cases be detected with greater certainty than a small temperature halt. This is a matter which it is hoped to investigate later, as opportunities permit. Experiments are also desirable in which both metals forming the couple undergo liquefaction, which it is also hoped to conduct at some future time.

* Abstract of a Paper read before the Physical Society of London.

† "Proc.," Phys. Soc. Vol. XXIX., Part I.

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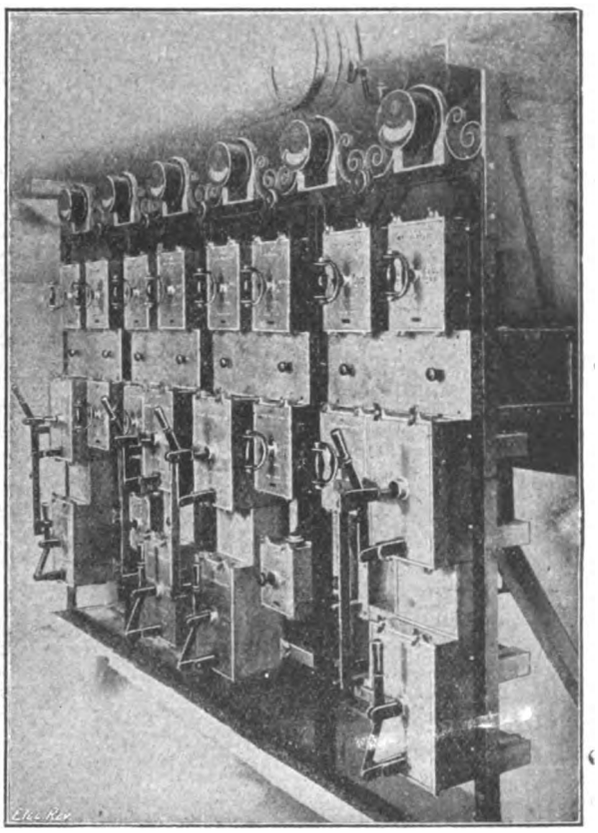
Ironsafe Power Switchboards.

Twenty years ago, the Ironclad Medium Pressure type of switchboard was unknown. To-day it is to be found controlling the electric power and lighting of every modern factory, workshop, mill, mine and dockyard. We all remember the highly polished slate and marble panels, so beautiful without, oft-time so full of elusive veins of metal within, surmounted with richly emblazoned lacquered brass and copper instruments and switches, but these have now given way to something more robust. The exposure of "live parts" in open boards, which, in the interests of the life risks, necessitated the provision of wasteful gangways and clumsy barricades, have all succumbed to the self-contained totally enclosed ironsafe fool-proof type. The accompanying illustration shows a switchboard of this type by Messrs. Berry, Skinner & Co., to whom is largely due the development of this kind of plant.



IRONSAFE SWITCHBOARD BY BERRY, SKINNER & CO.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W.1.
Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.
Orders for the Week.

Officer for the Week.—Capt. E. G. Fleming.

Next for Duty.—Capt. W. Hynam.

Monday, May 27.—No. 3 Company, 6.30–8.30. Recruits' Drill, 6.30–8.30. Signalling Section, 6.30–8.30.

Tuesday, May 28.—Lecture on Demolitions, 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, May 29.—No. 1 Company Entrenchments, &c., 6.30–8.30. Recruits' Drill, 6.30.

Thursday, May 30.—No. 2 Company Entrenchments, &c., 6.0–8.0. Recruits' Drill, 6.30. Signalling Section, 6.30–8.30. Ambulance Section, 6.30–8.30. Band Practice, 7.0.

Friday, May 31.—Musketry for the whole Corps, 5.30–8.0.

Saturday, June 1.—Knotting, lashing, &c., for the whole Corps, 2.45–4.45. Musketry, 2.45–4.45.

SPECIAL NOTICES.—All drills will take place at headquarters unless otherwise stated.

The Medical Officer will attend for the examination of recruits on Thursday evening at 6.0.

SUMMER CAMP.—Arrangements are now being made for this Camp to start August 3.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1917 SPECIFICATIONS.

155 ELECTRIC & ORDNANCE ACCESSORIES CO. & ETCHELLS, J. Electromagnetic regulating and switching devices. (3/1/17.) 114,320.
1555 KLEINSCHMIDT, E. E. Telegraphic printers. (11/1/17.) 114,636.
1,539 HUNT, W. Electric attachment plugs. (26/1/18.) 115,008.
2,018 NAAMLOOZE VENNOOTSCHAP DE NEDERLANDSCHE THERMO-TELEPHONE MAATSCHAPPIJ. Thermic telephones and microphones. (27/3/17.) 114,418.
2,838 BONDRA, M. Primary electric batteries. (26/2/17.) 114,323.
3,274 LANCASHIRE DYNAMO & MOTOR CO. & MASON, G. E. Dynamo-electric machinery (6/3/17.) 114,638.
3,419 GREEN, H. Electric signalling systems. (8/3/17.) 114,325.
3,937 STIRK, G., STIRK, E., STIRK, R., & STIRK, J. G. Power traverse in electrically driven lathes, boring mills, and other machine tools. (19/3/17.) 114,868.
4,196 HARRIS, H. K. Electrical transmitting apparatus applicable to controlling advertising and other devices from a distance. (3/23/17.) (Addition to 10,627/16.) 114,646.
4,228 STONE & CO., J., & DARKER, A. H. Electric generating and battery charging installations for railway and other vehicles. (25/3/17.) 114,332.
4,356 BERRY, A.F. Electric incandescent lamps and reflectors used therewith. 26/3/17 114,336.
4,808 BEAVER, C. J., & CLAREMONT, E. A. Manufacture of electric cables. (3/4/17.) 114,872.
5,224 BRUSCHKE, G. I. Telephone meters. (13/4/17.) 114,876.
5,410 CAMPBELL, D. J. Electric heating of metallic bodies for forging or other purposes. (17/4/17.) 114,835.
5,442 FOLEY, C. B. Electric induction furnaces. (13/4/16.) 114,853.
5,503 GREVILLE, E. E. X-ray apparatus for surgical and medical use. (19/4/17.) 114,893.
5,878 HOPE, V. Fuse or cutouts for electric circuits. (26/4/17.) 114,906.
6,053 JOHN, W. J., & JOHN, J. Working of signals by electric currents. (30/4/17.) 114,910.
6,279 AKT. GES. BROWN, BOVERI ET CIE. System of electric regulation for variable speed dynamos with parallel connected storage batteries. (11/11/16.) 111,772.
6,461 CONNER, M. S. Electric starters for internal-combustion engines. (7/5/17) 114,690.
6,631 SAINT, G. Momentary contact electric switches for cancelling mining visual signals. (10/5/17.) 114,693.
7,122 FOREST, L. DE, & LOGWOOD, C. V. Radio-signalling systems. (23/5/16.) 107,001.
7,449 KEY, T. H. R. Sparking-plugs for internal-combustion engines. (23/5/17.) 114,703.
7,683 HENLEY'S TELEGRAPH WORKS CO., W. T., & CLEMENTS, W. R. Electric plug couplings. (29/5/17.) 114,363.
7,934 YAMASAKI, M. Hanging-straps for electric cars. (2/6/17.) 114,710.
8,109 QUINN, M. J. Electric switches. (13/6/17.) 114,365.
8,446 SCOTT, A. A. Electric sparking plugs. (13/6/17.) 114,368.
8,467 BRITISH THOMSON-HOUSTON CO. Electric voltage regulators. (12/7/17.) 114,715.
8,579 HARRISON, W., & EYRE, R. E. H. W. Watertight fittings for electric lamps and the like. (15/6/17.) 114,719.
8,627 BATEMAN, W. T. TALLENT. Protective apparatus for dynamo-electric generators. (15/6/17, addition to 1,671/15.) 114,720.
8,738 HARLOW, F. J. X-ray apparatus. (18/6/17.) 114,941.
8,992 BAYLES, E. A., & BRITISH INSULATED & HELSBY CABLES (LTD.). Rubber insulated electric cables or conductors. (22/6/17.) 114,373.
9,111 KOWALSKI, A. Electrical condensers for high-tension and high-frequency currents. (24/6/16.) 108,468.
9,480 PEARCE, H. Protective apparatus for alternating electric current circuits. (30/6/17.) 114,729.
10,191 GILES, G. Electric valves or safety devices for the discharge of excess voltage (13/7/17.) 114,739.
10,627 HARRIS, H. K. Electrical transmitting apparatus applicable to controlling advertising and other devices from a distance. (27/7/16.) 114,633.
10,773 BOWLER, H. S., & FREMMER, F. Method of removing and replacing electric storage battery connectors. (26/7/17.) 114,948.
12,572 PATE, C., & WOOD, A. R. Electric heating and cooking apparatus. (1/9/17.) 114,757.
13,029 SYKES INTERLOCKING SIGNAL CO., W. R., & TARRANT, R. W. Rheostats. (11/9/17.) 114,761.
13,028 OSRAM-ROBERTSON LAMP WORKS & DURDLE, O. Electrodes for ionic tubes for use, more particularly in wireless telegraphy. (11/9/17.) 114,968.
13,303 SIMPSON, F. G. Transmitting apparatus of radio-telegraph stations. (19/9/16.) 114,854.

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

April 17, 1918.

6,517 BELLINGHAM & STANLEY. Rendering absorption by a thermopile of infra-red radiations audible in a telephone.
6,540 BRUSH ELECTRICAL ENGINEERING CO. (Akt. Ljungstroms Angturbind.) Blade rings for turbines.
6,545 MOLAS. Motor and engine starter.

April 18, 1918.

6,562 JENKINS & SMITH. Gas or electric cookers and solid fuel stoves, working in combination or singly.
6,563 WATSON & CO., ETCHELLS & GREAVES. Electric furnaces.
6,571 STICKLEY. Contact-breakers for magnetos.
6,599 B.T.-H. CO. Synchronous dynamo-electric machines.
6,611 TRAMP, CURTIS & CO. & WICKETT. Self-acting electric switch.

April 19, 1918.

6,629 MARSH. Device for locking electric lamps in holders.
6,641 & 6,642 DONOVAN. Electric switches.
6,657 GENESE. Mounting electric batteries so as to prevent escape of liquid.
6,659 B.T.-H. CO. & HASTINGS. Electromagnetic switches.
6,660 & 6,661 LAWTON. Electric furnaces.
6,678 BERRY. Working of electric furnaces and electrode used therein.
6,679 GRANVILLE & SMITH. Electric relays.
6,680 EVERSHED & VIGNOLES. Convergence correctors for directing devices.
6,682 SCHOLEY & WOODROFFE. Electrically-operated drilling apparatus.

April 20, 1918.

6,698 VERITYS LIMITED & LANZ. Electrically-driven hoists.
6,706 MCCOLL. Protective devices for a.c. systems.
6,707 WESTERN ELECTRIC CO. Machine switching telephone exchange systems.
6,717 VANDERVELL & CO. Magnetos.
6,718 MIDGLEY. Magneto-electric machines.
6,725 BRITISH EVER READY CO. Machines for making dry battery parts.
6,727 WHELLER. Glands for electric cables, shafting, &c.

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Commercial Topics.

Bank Amalgamation.

The Treasury Committee, which was recently appointed to consider the question of bank amalgamations, has issued its report, and recommends that future amalgamations shall not be permitted without the sanction of a departmental committee.

The committee thinks that the approval both of the Treasury and the Board of Trade should be obtained to future schemes, and that legislation should be passed requiring these departments to set up a special statutory committee to advise them.

* * * *

Prohibited and Restricted Exports.

An Order made by the Privy Council on May 14 makes the following alterations in the schedule of articles, the exportation of which from the United Kingdom is prohibited or restricted :—

Delete.—(A) boilers, (A) ferro-nickel, (C) oiled cloth and tape and (C) vulcanised fibre (insulating materials), (B) nickel, alloys of nickel and nickel ore, (C) nickel manufactures, not otherwise prohibited, except nickel plated goods, (B) goods made wholly or partly of rubber, gutta percha or balata, (B) X-ray apparatus.

Add.—(A) boilers, including portable boilers and their component parts, (A) oiled insulating cloth, paper, silk and tape, (B) vulcanised fibre, (A) nickel, its ores, alloys and manufactures, except nickel plated goods not otherwise prohibited, (B) goods made wholly or partly of rubber gutta percha or balata, not otherwise specifically prohibited, (A) X-ray apparatus.

* * * *

Capacity of Shareholder Councillors.

A question of some general importance to members of Councils who are also shareholders in local utility companies, recently arose at Derby, and the Corporation took counsel's opinion upon the matter.

There was competition between the Corporation electricity department and the Gas Company for supplying the requirements of the newly-established works of the British Cellulose Co. Some members of the Council including a few who were directors of the Gas Company, were averse to the municipality expending £90,000 upon the extensions necessary to supply electricity to one firm, and the then mayor intimated to Ald. Hart, a director of the Gas Company, that if the point was raised he should not allow him to discuss or vote on the matter as he was interested under the Municipal Corporations Act. The right of the mayor to take this course was challenged, and Mr. A. Macmorran, K.C., was consulted. Counsel's opinion is that councillors who were shareholders in the Gas Company had a pecuniary interest, though of an indirect kind, in the question whether the proposed contract between the Corporation and the Cellulose Co. should be entered into, and that the mayor was correct in so far as he considered such councillors to be disqualified from discussing or voting on the question. Similarly he holds that members who are directors and shareholders or shareholders only, in limited companies which supply goods to the Council, cannot discuss or vote on any question relating to such supply or payment therefor.

* * * *

Alien Enemy Companies.

The Committee appointed to advise the Board of Trade on questions under the Trading with the Enemy Act, 1915, has completed its labours and submitted its report.

The committee held 139 sittings, and dealt with 959 cases. 506 orders to wind up or prohibit trading were made ; in 94 cases orders for the sale of enemy interests to British subjects were made, and 96 were found not to be within the Act. In 11 cases no recommendations have yet been made, owing to one of the war departments having notified that the business meets some of its requirements. For a variety of special reasons no order has been recommended in 174 cases. Seven orders have been issued for cancelling contracts, and in 7 cases recommendations were made for the non-cancellation of contracts. One case was reserved for consultation with the Foreign Trade Department, and one recommendation was made to allow sale, while 10 cases were postponed, and one application to cancel contract was withdrawn.

In the course of the report it is stated that the variety of the trades in which Germans were engaged was a noticeable feature of the committee's work, extending, as it did, from the great chemical and electrical combinations to such businesses as the collection and export of disused cans for the purpose of extracting the tin, or the treatment of offals for the production of sausage skins. In the course of the inquiries the necessity of legislation for the registration of names has been fully demonstrated. Foreign traders have habitually adopted British names for their own purposes or for the purpose of misleading their customers into the belief that they were dealing with British principals instead of aliens. The free choice of titles which joint stock companies enjoy was also shown to enable foreign traders to conceal their nationality and acquire whatever advantage may accrue to a business appearing to be British. The practice of adopting the word " British " to disguise the fact that the business is German is well known. But the extent to which German businesses were conducted through a British staff and by British employees is remarkable. In case after case the committee found that, although the profits mainly belonged to a German proprietor, the business was carried on entirely, or almost entirely, by a British staff or by British employees. Even in the case of the dye industry, the staff of chemists employed in the important service of advising the application of dyes and the stuffs to be dyed were almost entirely British ; and when branches were established in this country for the manufacture of German patented articles they were usually British manned. In many of these cases, by the operation of Sec. 4 of the Act, British managers and employees are now carrying on the business on their own account, and the businesses have become British businesses. The committee find that German producing houses commonly adopted means for avoiding the payment of income tax in Great Britain. This practice was probably not confined to German houses, but the result had been to assist German competition.

Electricity Supply.

General.

Brighton.—Before the Local Bench on Friday, the Brighton & Hove Gas Co. were summoned for supplying gas of a calorific power of less than 500 B.Th.U., and, after hearing evidence, a fine of £85 was inflicted with 50 guineas costs.

Edinburgh.—Last week the Electric Lighting Committee passed resolutions on the arrangements for the generation and distribution of electric power supply in the country.

The resolutions suggest that when the areas for the super-stations were decided upon Edinburgh should be one, and that the power should be supplied from the Portobello station. They also urged the necessity of the erection of the new Portobello station beingproceeded with.

The Council is also recommended to appoint a deputation to go to London and urge upon the authorities the urgency of the matter.

Increased Charges for Electrical Energy.—The charges for current at the following places are being increased :—

Ilford Council has adopted a new scale of charges, including a flat rate for lighting of 6d. per unit (arc lamps 5d.), m.d. charges of 8d. and 3d., and prepayment meter rate of 6½d. per unit. Bulk supplies vary from 4d. per unit for 500 units per quarter to 2½d. per unit for 10,000, heating 2½d. per unit, rates for cinemas, vehicle charging, &c., will be increased 25 per cent., with a minimum charge of 5s. per quarter.

Edinburgh Lighting Committee recommend an increase of prices for private lighting from 3¾d. to 3½d. per unit, and for power from 1½d. plus 10 per cent. to 1½d. plus 25 per cent.

The Charing Cross, West End and City Electricity Supply Co. have notified the City of London Corporation that the war percentage on lighting is to be increased to 25 and on power to 40 per cent.

At Bradford as from April 1 bulk consumers for power purposes are to pay in addition to the former rates 0·015d. per unit for every 6d. or portion of 6d. per ton increase in the price of coal to the electricity works over 9s. a ton, and all consumers not subject to the coal clause are to pay 20 per cent. extra.

Willesden Council has adopted the following rates : Flat rate 4d. per unit m.d. Three units per quarter, at 7d. per unit for each 33 watt lamp simultaneously alight at one time, and 2d. per unit for further consumption. (Picture palaces to have option of flat rate of 3½d. per unit.) Prepayment rate 4d. per unit, plus 10 per cent. Contract rates, either lighting or power, increase 15 per cent. above pre-war charges.

East Ham Council has adopted the following rates with the addition in each case of 33⅓ per cent : Private lighting 4d. per unit, m.d. 5½d. and 2½d. per unit, contractors' rate 2d., power and heating from 1½d. to 1¼d. ; outdoor signs 2½d., special rate for arc lamps, increase ½d. per lamp per hour, other special rates increase ½d. per unit ; traction 1·0625d.

Bexhill Electric Light Committee is increasing its charges for lighting by 10 per cent., making 25 per cent. over pre-war rates, and power rates by 5 per cent., and prepayment meter rents are to be 2s. 6d. instead of 1s. per quarter.

Kensington & Knightsbridge Electric Lighting Co. is increasing its charge to private consumers from July 1 by a further 10 per cent., making 6½d. per unit, compared with 5d. before the war.

Southwark (London) Electricity Committee has decided to increase its charges for lighting and power to the authorised maximum.

Presentation.—On the transference of Mr. W. Chamberlain from the joint managership of the Oldham Corporation Electricity department to the managership of the tramways department he was presented with a silver tea service.

On the occasion of the presentation Mr. F. L. Ogden presided, and among those present were the Mayor (Councillor Wm. Buckley), Ald. Hardman, chairman of the Electricity Committee (who made the presentation), and Messrs. R. Blackmore (consulting engineer) and J. W. Collison (chief clerk).

Scottish Provisional Orders.—The Clyde Valley Electric Power Order has complied with the Standing Orders, but the Edinburgh Corporation Tramways Order, which authorises the Corporation to construct tramways and tramroads, to run railless trolley cars, &c., has been adjourned until June 11.

Stepney (London).—In consideration of the extra work and responsibility thrown upon the resident electrical engineer (Mr. W. Young) and the deputy commercial manager (Mr. A. J. Squire) while Mr. Tapper was assisting the Coal Controller, the Council is

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recommended to give £50 each to Mr. Young and Mr. Squire respectively out of the £535 received from the Treasury for Mr. Tapper's services.

Swansea.—The Chairman and Vice-chairman of the Electricity Committee and the Borough Electrical Engineer have been authorised to visit Sheffield to obtain information regarding arc furnaces for steel making.

£200 is to be spent on a small overhead run-way in connection with the coal handling plant.

Teddington.—The Urban Council has withdrawn its opposition to the application of the Twickenham & Teddington Electric Supply Co. to the Board of Trade for the increase of the maximum rate of charge under the company's provisional order to 8d. per unit.

Wednesbury.—The Board of Trade have issued a provisional order authorising the transfer of the municipal electricity undertaking to the Midland Electric Corporation for Power Distribution, and the Bill confirming the Order has been read a first time in the House of Commons.

Electric Traction.

Belfast.—The Corporation recently decided to terminate by a week's notice the engagements of all tramway employees, numbering about 800.

The Committee on Production awarded the men an advance of 8s. per week on their war wages, but the Corporation refused to carry out the award, and were then summoned before the local Munitions Tribunal. It was contended that the Corporation could not give effect to the award as they were under statutory obligation to make the tramways self-supporting, that the expenditure had been reduced to the minimum and fares raised to the maximum limit. The Corporation, however, gave the men the option of withdrawing the summonses or terminating their engagements.

The Board of Trade has now received authority to sanction any deficit on the tramways being met out of the rates, and thus a solution of the difficulty has been found.

Dunfermline.—The Dunfermline-Rosyth tramway route was officially inspected on Friday and subsequently opened for traffic.

Edinburgh.—Revised estimates of the cost of the proposed new lines from the city to South Queensferry and Port Edgar have been prepared, and the draft of the proposed provisional order has been approved by the Council.

The estimated cost of constructing the new lines (11¾ miles in length) will be £343,849, including £289,035 for track construction, £21,000 for rolling stock, £15,660 road widening, and £18,154 for purchase of lands. The total of the original estimates was £225,000. The new estimates have been prepared on the basis, among other items, of an overhead increase of 50 per cent. on pre-war costs and of a greater mileage of tramway laid along the public road. The electrical equipment is not included as a tramway capital charge, the capital cost being repaid in the charges for the current supplied, and this item being, therefore, reflected in the operating cost for tramway power.

Estimates of the revenue and operating cost, showing a gross surplus in one case of £18,625 and in the other of £19,115. The anticipated revenue is understood to be based on a through fare of 8d., or 1d. per mile for intermediate stages. A previous estimate was based on a through fare of 6d. per single journey. The proposed through fare of 8d. is lower than the present omnibus fare, which is 10d., and than the railway fare, which is now 1s. 2d. It is suggested that the cars should run at 10 to 20 minutes' intervals, although on Saturdays, Sundays and holidays the service would be as frequent as the traffic may require. The operating costs are based on a rate of 9d. per car-mile.

Light Railways.—The Nottingham Colwick Estates Light Railway Order has been submitted to the Board of Trade for confirmation. Objections must be sent to the Railway Department of the Board by June 6.

Liverpool.—The general manager of the Corporation Tramways (Mr. C. W. Mallins) has issued his report on the past year's working.

The service was carried on with very great difficulty owing to the constant demand for additional men for the Army and Navy, together with the ever increasing difficulty of obtaining material and labour. There were 2,700 men employed in the department when war broke out, and of that number 2,200 had joined H.M. Forces. The vacancies had been filled as far as possible either by men incapable of military service or by females, a class of labour which would not, under normal conditions, have been engaged for the purpose, with the result that a very heavy strain had been placed upon those responsible for the operation of the service, as it was found most difficult to enforce discipline in connection with this class of labour. Whilst the service provided was not, by any means, as adequate as could be desired it was the best that could possibly have been given under existing conditions. It was not the curtailment of the service which brought about the present overcrowding and inconvenience. The overcrowding was the result of the enormous increase in the number of passengers who desired to travel by the cars as compared with pre-war times. The increase in the number of passengers who travelled by the system during the year 1917, as compared with pre-war years, amounted to 40,000,000. That enormous increase was brought about by various causes, as, for example: The increase of 50 per cent. on the railway fares; the total abolition of certain local railway services, and the great reduction in others; the diversion of shipping from other ports to Liverpool, the great number of new factories in and around Liverpool, &c.

Plymouth.—Owing to a dispute between two labour organisations—the Dockers' Union and the Municipal Employees' Association, there was a 12-hours' strike of the tramway workers on Saturday.

It appears that 245 out of 259 tramway employees were members of the Dockers' Union, but the remainder, being members of the Municipal Employee's Association, refused to join. Late on Saturday the tramway drivers and conductors resumed work on condition that the Tramway Committee considered the grievances of the men at its next meeting.

Tramway Deficits Placed on the Rates.—An Order in Council was issued on Tuesday amending the Defence of the Real Regulations so as to cover cases of deficit on tramway working.

It is provided that if in the case of any tramway undertaking carried on under statutory powers by a local authority it appears to the Board of Trade to be necessary that the undertaking should be carried on in an efficient manner, but owing to circumstances arising out of the war it cannot be so carried on without either charging tolls, fares and charges in excess of those the local authority is authorised to charge, the Board may (by order) authorise the local authority to charge the local rates funds with any deficiency to an extent and subject to such conditions as may be specified.

By an Order the Board of Trade may modify any provision in any local Act regulating the undertaking to such an extent, and during such period, as appears to be necessary for the efficiency of the service, or to relieve the local authority from the obligation of making allowances for renewals or depreciation.

Tramway Depreciation.—Glasgow Tramways Committee has decided, in accordance with a memorandum by the general manager (Mr. J. Dalrymple), to set aside the following sums for depreciation for the current year:—

Permanent way, £400 per mile of single track (£78,510. 18s. 2d.); power stations and sub-stations plant, 3 per cent. (£13,915. 5s. 9d.); cars and electrical equipment of cars, 5 per cent. (£27,923. 13s. 2d.); other rolling stock, 15 per cent. (£2,829. 17s. 9d.); Clydebank bridges, 5 per cent. (£550); a total of £123,729. 14s. 10d.

Telephony.

Automatic Telephone Exchange at Leeds.—On Saturday last the Postmaster-General (Mr. A. H. Illingworth, M.P.) opened the new automatic telephone exchange.

At 2 p.m. the subscribers connected to the Central Exchange were transferred to the new exchange, and Mr. Illingworth sent a congratulatory message to the "Yorkshire Evening Post." The engineer-in-Chief of the Post Office (Sir William Slingo) said that he looked for an extension of the automatic system on comprehensive lines, trusting that the experience in Leeds would cause subscribers in other large towns to agitate for a similar change in their own areas. He congratulated Leeds upon having the largest automatic telephone system in Europe, and looked forward to the time when Bradford would be linked up with it.

Mr. Dane Sinclair, managing director of the Automatic Telephone Manufacturing Co., of Liverpool (contractors for the equipment of the Exchange), Mr. R. Armitage, M.P., and others also spoke. In the evening a number of Post Office officials and friends were entertained to dinner by the Automatic Telephone Manufacturing Co.

Imperial Notes.

Australasia.—The Commonwealth Postmaster-General (Mr. W. Webster) states in his report on the year 1916-17, that there was for the first time a profit (£17,234) on the State telephones.

Zinc Recovery.—The first annual report of the Mount Read and Rosebery Mines (Ltd.) states that the great trouble of the previous owners of the properties was to discover a method of satisfactorily dealing with refractory ore, but the recent successful introduction of the electrolytic method for the recovery of zinc in ore of the average type of these mines had so materially improved the position that, in the opinion of the general manager (Mr. R. C. Sticht) the present time is opportune for the application of this method with every certainty of commercial success. Mr. C. A. Hansen, electro-metallurgical engineer of the General Electric Co. (New York) has tested the Company's ore, and states that the resulting spelter is of the highest quality, in fact very exceptionally pure. Investigation by two other experts proves that the ore is splendidly adapted for the proposed treatment, with relatively lower power requirements. The successful treatment of the Mount Read and Rosebery ores is dependent upon a full supply of electric power at a reasonable price, but sufficient energy from water power can be made available from the Tasmanian Government's projected King River power undertaking.

The accounts of the Hawthorn (Victoria) Tramways Trust for the year ended Sept. 30 last show a net surplus of £1,082, the gross revenue being £58,020, and expenses (including interest, sinking fund, &c.) £56,938.

A deputation, representing the Municipal Tramways Conference and 27 metropolitan local authorities, recently waited upon the Victorian Minister of Public Works (Mr. John McWhae) to urge that a permanent body representing the municipalities be established by the Government to control the municipal tramways in and around Melbourne. The municipalities propose to pool the revenue and distribute the profits on a car-mile basis. Councillor H. F. Barnet (St. Kilda) said it was

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monstrous that there should be seven tramway trusts as at present in operation in the area. He hoped the new Government would pass a Bill for handing over the tramways to their rightful owners.

In reply, the Minister said he hoped that matter would be settled before the end of the year. The Ministry would try to make an honourable deal for all concerned.

India.—The net profit of the Nagpur Electric Light and Power Co. for 1917 was R. 31,344. R. 5,000 has been placed to depreciation, R, 1,500 to preliminar expenses and R. 2,000 to reserve for repair and renewals. A dividend of 4½ per cent. was declared, and R. 4,243 was carried forward.

Sir Edward Gait, Lieutenant-Governor of Behar and Orissa, recently inaugurated the Loyabad power station. A Calcutta journal states that the scheme is the outcome of the growing necessity for greater economy in the working of the coal mines. The Burrakur Coal Co., the Reliance Coal Co. and the Nowaghur Coal Co. decided to establish a power supply which would be adequate for their joint needs, and the result was the formation of the Sijua (Jherriah) Electric Supply Co. (Ltd.), with a capital of 12 lakhs of rupees (£75,000) and the equipping of the Loyabad power station to supply electric power to the Loyabad, Mudidih, Katras and Choitodih mines. The plant consists of two 2,000 kw. sets, but a third set is to be installed later. Current will be transmitted to the collieries at 6,600 volts by means of overhead lines. The area served by the plant is over 60 square miles. The turbines are by the Westinghouse Co., the generators and motors by the British Thomson-Houston Co., while the mechanical parts of the haulage gears and winders have been made in India. Two of the Babcock & Wilcox boilers are coal-fired, and the third by waste gases from the Loyabad Coke Co.'s plant.

The "Times of India" contains particulars of the Koyna River hydro-electrical project of Messrs. Tata, Sons & Co. It is intended to aid the development on the West coast of India of electro-chemical industries, including the production of aluminium from bauxite or laterite, and the production of nitrogen, iron, steel and alloys. Messrs. Tata do not propose themselves to engage in these industries, but to provide cheap electric power and assist industrial experts to start such industries.

The Electro-Metal Refining Co. (Ltd.) has been established in Ahmedabad. The company will manufacture finished articles from metal scrap.

Johannesburg.—After a strike of a week, during which the town was in darkness and the tramway service suspended, a Committee of the Council has conceded the demand of the electricity works employees for an extra 12s. a week, bringing their wages up to £8. 2s.

South African Railways.—The annual report of the Union of South Africa Railways and Harbour Board for 1917 states that the British firm which was requested to report upon the electrification of the railways in South Africa has sent out an engineer to collect data.

Foreign Notes.

Argentina.—The National Government has authorised Messrs. Etchemaite y Llanos and Carlos Menendez Behety to install and operate electric power plants in Puerto Deseado, Territory of Santa Cruz.

The concessionaires will establish at the outset a power station of 200 kw. capacity. The maximum prices per unit will be $0·40 per unit for lighting business premises or private houses, $0·35 for lighting schools, hospitals and public offices, with rebates of 30 per cent. for public lighting and 50 per cent. for heating, motive power and other industrial uses.

Chili.—The Chilian Government has granted concessions to Senor A. Winkler for electricity supply in Frutillar, and to Senores F. Rudolph H. V. Enriquez and G. S. Elgueta for similar works in San Pablo, Santa Catalina and Puerto Natales respectively.

China.—The following are extracts from a report by the British Consul-General at Yunnanfu on the Province of Yunnan:—

There are two electricity supply companies supplying current. The larger of the two is a Yunnanfu company with hydro-electric plant at Shih Lung Pa, consisting of two 150-kw. turbine driven alternators. Current is generated at 23,000 volts (three-phase, 50 ∿) and transmitted. 30 miles and transformed down at the West Gate of the City to 3,000 volts, and after distribution to various points is further transformed to 110 volts. Current is supplied at 1 dollar per month per 16 c.p. lamp or at 30 cts. per unit if meters are used. The whole of the machinery was supplied by the Siemens-Schuckertwerke, but the contract for supplies required during the war was secured by a British firm. The second undertaking is at Mengtsz, and the plant is of British make and comprises a 80-kw. 6,600 volt alternator (three-phase, 60 ∿) and a steam engine and boiler. In order to supply 1,0 .0 H.P. of energy to the Kotchin tin mines (15 miles from the station) the company will put down a water turbine driven unit of about 1,000 H.P. The prices of current are the same as those of the first mentioned company.

The telephone system at Yunnanfu has an exchange for 100 lines, and the instruments are of Swedish make and are good, but the poles, wires and insulators are not satisfactory. The charge to subscribers is 4 to 5 dollars per month. The Yunnanfu company is about to start constructing a system to connect Mengtsz with Kotchin-chang, Ling-Qu and Amichow.

Guatemala.—In the annual address of President Estrada Cabrera it is stated that the telegraph and telephone services have been extended, there being now 261 telegraph offices and 105 telephone offices working. The total extent of the telegraph system is now 7,000 km., the telephone lines being 860 km.

Miscellaneous.

An Advisory Welfare Committee.—The Minister of Munitions has appointed a Committee

To advise the Minister upon the general principles to be adopted in carrying out the welfare and health work of the Ministry, and to report to the Minister on all matters connected with the same which may be referred to them.

The constitution of the Committee is as follows: Mrs. M. J. Tennant, C.H. (chairman); Mr. G. Bellhouse, C.B.E., Home Office (vice-chairman); Mr. W. H. Allen (Messrs. W. H. Allen, Sons & Co.); Mr. A. F. Butler, O.B.E.; Mrs. Churchill, C.B.E.; Dr. E. L. Collis (Director of Welfare and Health Section Ministry of Munitions); Viscount Dunluce (Welfare and Health Section, Ministry of Munitions); Sir Walter Morley Fletcher, K.B.E., M.D., F.R.S. (Medical Research Committee); Dr. T. M. Legge (Home Office); Miss Mary MacArthur; Mr. J. J. Mallon; Miss Violet Markham, C.H.; Mr. S. Mavor (Messrs. Mavor & Coulson); and Miss Squire, C.B.E. (Director, Women's Welfare (General), Ministry of Munitions). The secretary is Mr. R. H. Crooke, 53, Parliament-street, S.W. 1.

British Industries Fair.—The opening of the British Industries Fair at Glasgow has been fixed for Aug. 19, and it will remain open until Aug. 31.

The Fair will be practically confined to textiles and personal and household requirements, and only British manufacturing firms are permitted to exhibit. Further information can be obtained from Mr. J. M. Freer, 38, Bath-street, Glasgow.

Coal Rationing.—Sir A. Stanley, M.P., announced in the House of Commons last week that during next winter a coal rationing scheme, going further than the existing one, for industrial and domestic consumption, would be applied to the whole of Great Britain. Electricity supply and gas will also be controlled.

Forthcoming Books.—Messrs. Constable & Co. will publish almost immediately a new edition (rewritten and enlarged) of "Industrial Electrical Measuring Instruments," by Mr. Kenelm Edgcumbe, and "The Production and Treatment of Vegetable Oils," by T. W. Chalmers.

Industrial Reconstruction Council.—Application has been made to the Board of Trade for the registration of this Council with limited liability, but without the addition of the word "limited" to its name. Objections to the application should be made to the Companies' Department of the Board, 55, Whitehall, London, S.W. 1, before the 31st inst.

Inquest.—An adjourned inquest was held last week upon a probationary fitter named Lovell, employed by the Avonside Engineering Co., Bristol.

The boy was found dead in a travelling crane, and Dr. H. Grey, who made a post-mortem examination attributed death to collapse following congestion of the lungs, and said there was no indication of electric shock. A subsequent examination revealed a mark which resembled a burn on the right hand, and the jury asked for further medical evidence.

Dr. Grey was still of opinion that death was due to congestion of the lungs. Dr. E. V. Foss said that the mark on the right hand was evidently a burn, but he could not say how it was inflicted. He was unable to give an opinion as to the cause of death, but it was possible that in that case death was due to shock. Dr. J. S. Mather said that it seemed quite possible that the lad received an electric shock, and the position in which the body was found was that in which he would have expected it if there had been contact with the wires.

The jury returned a verdict of "Accidentally electrocuted."

National Employers' Federation.—The Ministry of Labour has requested this Federation to nominate a representative on the Labour Re-settlement Committee.

Good progress is, we are informed, being made by the Federation. Particulars may be obtained from the secretary (Mr. F. Fosdick), 38, Parliament-street, S.W. 1.

Railway Working.—On the 15th inst. the House of Commons considered the Board of Trade estimates.

The President of the Board (Sir A. Stanley), who explained the system of State control, said that recent traffic (goods and passenger) was heavier than it had ever been in the history of the railways. On the general policy of State control, he thought it would be a great pity if all the economies which the war had shown could be effected by unified control were not secured permanently to the traders of the country. Season tickets had been increased in price because the season ticket traffic was being carried on at a loss, and it was necessary to restrict travelling.

Retiring Rank of Naval Electricians.—H.M. in Council on May 7 approved a recommendation that commissioned warrant officers of certain classes who have completed three years service in commissioned warrant rank shall be granted on retirement rank corresponding to that of lieutenant R.N. In the case of electricians the retiring rank will be electrical lieutenant.

Surrender of Patent.—Mr. J. O. Callender and Callender's Cable & Construction Co. have offered to surrender letters patent No. 104,793 for "Improvements in multicore electric cables." Any person who desires to be heard with reference to such surrender should apply to the Comptroller-General of Patents.

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Winding-up Petitions.—Petitions for the winding-up of the Electrical Co. (Ltd.) and the A.E.G. Electrical Co. for South Africa (Ltd.) have been presented by the Board of Trade, and will be heard by Mr. Justice Younger on May 28.

Wireless Operators' Wages.—The Ministry of Labour has been notified that owing to the failure of the National Wages Board of the Ministry of Shipping to deal within a reasonable time with the claims of wireless operators for an increase of salary, the operators represented by the Association of Wireless Operators have given three weeks' notice to cease work.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during March, 1918, and (*b*) the aggregate figures from Jan. 1 to March 31, with increase or decrease compared with corresponding periods of 1917 :—

Electrical machinery, (*a*) £134,618 (decrease £16,909), (*b*) £324,017 decrease (£36,691); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £4,399 (decrease £25,924), (*b*) £35,255 (decrease £26,947); and electrical machinery unenumerated, (*a*) £130,219 (increase £9,015), (*b*) £288,762 (decrease £7,744); telegraph and telephone apparatus, (*a*) £1,776 (decrease £2,247), (*b*) £7,956 (decrease £1,031); other electrical wires and cables, rubber insulated, (*a*) nil (decrease £7,067), (*b*) £602 (decrease £20,989); with other insulations, (*a*) £38 (decrease £398), (*b*) £38 (decrease £2,610); carbons, (*a*) £1,167 (decrease £8,077), (*b*) £8,890 (decrease £13,786); glow lamps, (*a*) £2,907 (decrease £21,449), (*b*) £46,986 (decrease £7,930); parts of arc lamps and searchlights (other than carbons), (*a*) £18,717 (increase £10,149), (*b*) £31,894 (increase £5,057); primary and secondary batteries, (*a*) £10,529 (decrease £14,390), (*b*) £71,875 (decrease £30,528); meters and measuring instruments, (*a*) £302 (decrease £1,829), (*b*) £1,887 (decrease £6,624); switchboards, (*a*) £222, (*b*) £222; electrical goods and apparatus unenumerated, (*a*) £30,690 (decrease £22,351), (*b*) £82,821 (decrease £44,728). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £66,348 (decrease £69,046), (*b*) £253,171 (decrease £161,615.)

Exports.—The exports of electrical machinery, material, &c., (*a*) during March, 1918, and (*b*) from Jan. 1 to March 31, with increase or decrease compared with corresponding periods of 1917 were as follows :—

Electrical machinery, (*a*) £63,475 (decrease £37,340), (*b*) £251,895 (decrease £151,332); including railway and tramway motors, (*a*) £3,062 (increase £1,532), (*b*) £7,995 (decrease £2,288); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £40,486 (decrease £17,868), (*b*) £126,123 (decrease £102,109); and electrical machinery unenumerated, (*a*) £19,927 (decrease £21,004), (*b*) £117,777 (decrease £45,935); telegraph and telephone cables, submarine, (*a*) £3,811 (decrease £10,316), (*b*) £51,167 (decrease £17,857); other than submarine, (*a*) £8,614 (decrease £59,304), (*b*) £45,961 (decrease £175,354); telegraph and telephone apparatus, (*a*) £16,969 (increase £989), (*b*) £54,422 (decrease £3,152); other electrical wires and cables, rubber insulated, (*a*) £5,699 (decrease £21,665), (*b*) £13,082 (decrease £84,754); with other insulation, (*a*) £9,801 (decrease £31,091), (*b*) £23,993 (decrease £108,047); carbons, (*a*) £578 (decrease £1,364), (*b*) £1,492 (decrease £5,682); glow lamps, (*a*) £7,544 (decrease £8,566), (*b*) £22,998 (decrease £17,660); arc lamps and searchlights, (*a*) £1,635 (increase £1,511), (*b*) £4,982 (decrease £5,556); parts of arc lamps and searchlights (other than carbons), (*a*) £933 (decrease £5,847), (*b*) £4,856 (decroase £16,482); primary and secondary batteries, (*a*) £5,256 (decrease £10,815), (*b*) £20,919 (decrease £31,810); meters and measuring implements, (*a*) £5,819 (decrease £6,154), (*b*) £21,730 (decrease £17,114); transformers, (*a*) £1,389 (decrease £10,818), (*b*) £6,526 (decrease £13,750); switchboards, (*a*) £1,914 (decrease £2,941), (*b*) £10,318 (increase £1,840); electrical goods and apparatus unenumerated, (*a*) £41,045 (decrease £26,283), (*b*) £112,790 (decrease £67,181). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £111,007 (decrease £192,764), (*b*) £403,236 (decrease £542,559).

Tenders Invited and Accepted.

Cables.

BELFAST Corporation invite tenders for the supply and laying of cables. Specifications, &c., from the consulting engineers (Messrs. Preece, Cardew, Snell & Rider), 8, Queen Anne's Gate, Westminster, S.W.1, or from the city electrical engineer, Mr. T. W. Bloxam, M.I.E.E. Tenders must be lodged at the Town Clerk's Office, City Hall, Belfast, by the 31st inst. *See also an advertisement.*

MANCHESTER Corporation require tenders by 10 a.m. May 28 for the supply of cable and cable laying work for 12 months. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Water-Tube Boilers, Superheaters, Stokers, &c.

SUNDERLAND Corporation invite tenders for the supply and erection of two water-tube boilers with integral superheaters, mechanical stokers, vertical cast-iron tube economisers, steel plate chimneys, &c. Specification and form of tender from the general manager, Mr. Alfred S. Blackman, and tenders to the Town Clerk, by May 29.

Rotary Converter, Transformers, &c.

ERITH Urban Council require tenders for supply of 500 kw. rotary converter with transformers, switchgear, &c. Particulars from the Electrical Engineer.

Telephone Material.

The Deputy Postmaster-General, Melbourne, requires tenders by 3 p.m. July 2 for g.i. wire and gal. steel stranded wire (schedule 1,436), copper wire (h.d. enamelled covered and twisted pair), copper sleeves (schedule 1,449), and telephones and diaphragms (schedule 1,450) for the AUSTRALIAN COMMONWEALTH. Postmaster-General's Department. Specifications, &c., from the General Post Office, Melbourne, Sydney, Brisbane, Adelaide, Perth and Hobart.

CARDIFF.—The Corporation has accepted the tender of the British Thomson-Houston Co. for the supply of a rotary converter at £4,884.

ILFORD.—The Urban Council has placed an order at £125 with the Fuller Wire & Cable Co. for 150 yds. 61/12 600-volt cable.

LEEDS.—E. Green & Son have secured an order for the erection of an economiser at Crown Point station for £981.

WOLVERHAMPTON.—The Council has accepted the following tenders :—

Mellowes & Co., roof glazing for boiler house, £266; J. Hopkinson & Co., 20 Ferranti valves, £515; Premier Cooler Co., cooling towers, £4,565.

MANCHESTER.—The tender of Edgar Allen & Co. has been accepted for special track work for the Corporation tramways department.

The following tenders have been accepted for supplies for the electricity department: Mather & Platt, 150 B.H.P. three-phase induction motor and switchgear; F. Morton & Co., steelwork for 20,000 kw. turbo-generator; Callender's Cable & Construction Co., supply and laying of 33,000 volt cables; Ferranti (Ltd.), two 3,000 k.v.a. three-phase static transformers; W. T. Glover & Co. and Western Electric Co., cable.

Government Contracts.—The following tenders were accepted by the British Government Departments during April :—

War Office.—F. R. Butt & Co., Cavendish Electrical Co., H. W. Cox & Co., Mica Supply Association, Schall & Son and Watson & Son, X-ray apparatus; Electric Construction Co., dynamos; Robey & Co., electric lighting sets; Brush Electrical Engineering Co., transformers; Austin Motor Co., F. S. Bennett (Ltd.), H. T. Boothroyd (Ltd.), British Westinghouse Electric & Mfg. Co., Buffalo Forge Co., H. Green & Co., J. H. Holmes & Co., R. A. Lister & Co., Lyon & Wrench and New Pelaphone Engine Co., generating sets; British Westinghouse Electric & Mfg. Co., Electric Construction Co. and Phœnix Dynamo Mfg. Co., motors and parts; Dorman & Smith and J. H. Tucker & Co., switchboards; British Insulated & Helsby Cables, India Rubber & Gutta Percha Co., Johnson & Phillips, Siemens Bros. & Co. and A. Terry & Co., insulating tape.

India Office.—Pritchetts & Gold & Co., cells; Lancashire Dynamo, &c., Co., generating sets.

H.M. Office of Works.—Pritchetts & Gold, &c., Co., storage battery for aero-dynamics building at N.P.L.

Post Office.—Automatic Telephone Mfg. Co., India Rubber, Gutta Percha & Telegraph Works Co. and Telegraph Condenser Co., telegraph apparatus; Automatic Telephone Mfg. Co. and British L. M. Ericsson Mfg. Co., telephone apparatus; India Rubber, Gutta Percha & Telegraph Works Co., testing apparatus; Siemens Bros. & Co. and Telegraph Construction & Maintenance Co., submarine cable; British Insulated & Helsby Cables, Craigpark Electric Cable Co., Henley's Telegraph Works Co., Johnson & Phillips, Telegraph Construction & Maintenance Co., Union Cable Co. and Western Electric Cable Co., telegraph and telephone cable; British Insulated & Helsby Cables, Siemens Bros. & Co. and Western Electric Co., telephone cords; Spauldings (Ltd.), plug covers; Bullers (Ltd.), insulators, spindles and stay rods; T. Bolton & Sons, Shropshire Iron Co. and F. Smith & Co. (inc. in London Electric Wire Co. & Smiths), bronze wire; British Insulated & Helsby Cables, insulated bronze wire; Shropshire Iron Co., annealed copper wire; British Insulated & Helsby Cables, Shropshire Iron Co., F. Smith & Co. (inc. in London Electric Wire Co. & Smiths), copper wire strand.

Business Items.

The Tudor Accumulator Co. (Ltd.) has disposed of its business in rail welding to its managing director (Mr. Edwin Jacob), who will continue the business on his own account as the Rail Welding Co.

Mr. Jacob will take over all liabilities in respect of work done and contracts in course of execution. This arrangement involves no change in the management of the Tudor Accumulator Co., of which Mr. Jacob still remains managing director.

Messrs. Hans Renold, Ltd., of Didsbury, Manchester, notify that their works and offices are closed from the 22nd until May 27 inst. for the Whitsun holidays.

The report of the British Chamber of Commerce for Spain for April contains an announcement that a firm in Santander is willing to take up the agency for the whole of Spain of important British manufacturers of electric plant and steam engines. Reference No. 20. The secretary of the Chamber, Plaza Cataluna, 9 pral, Barcelona, will supply further particulars.

The partnership between Miss Taylor and Mr. Moritz I. Bergl, mica merchants, 40, Hatton-garden, London, E.C., has been dissolved. Miss Taylor continues the business under the existing name of Taylor & Co. at the same address.

Advance in Prices.—Messrs. Belling & Co., Derby-road, Edmonton, N.18, notify that, owing to further increases in the cost of labour and material, their list prices will be subject to an advance of 50 per cent., except their fires, which will be subject to 33⅓ per cent. advance only.

Liquidations, &c.

A meeting of creditors of the Elieson Electric Traction Co. (Ltd.) (in liq.) will be held on May 30 at 25, Finsbury-square, London, E.C.

An application for the discharge of Russell Ernest Connold, late electrician of 6A, The Parade, Canterbury, will be heard on June 11 at the Guildhall, Canterbury.

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Municipal Accounts.

Salford.—The electricity departments accounts for the year ended March 31, 1917, show gross capital expenditure £759,621 (increase £24,227).

Revenue was £155,813 (compared with £134,678 in the previous year), working expenses were £77,400 (£65,252) and gross profit was £71,479 (£64,538). Interest required £17,725 (£17,029) and sinking fund (£32,400 (£30,911), leaving a net profit of £21,354 (£16,598), of which £12,000 is to be devoted to relief of rates. Average price received was 1·26d. (1·29d.) per unit, working expenses 0·684d. (0·677d.), and total cost 1·087d. (1·131d.). Units generated were 31,794,640 (29,117,290) and sold 29,572,331 (24,856,435). Maximum load was 10,246 kw. (9,400 kw.) There are 701 (704) motors on hire, of a total capacity of 5,955 (5,839 H.P.

Mr. J. A. Robertson (the chief engineer) says in his report that the three 5,000 kw. sets which were supplied since the outbreak of war, have effected a great reduction in works cost, particularly in fuel. The saving in fuel is £17,000 per annum, and in oil and other stores and repairs not less than £2,500 per annum. The average quality of fuel has fallen off through various causes, and the coal stocked during the summer had to be drawn upon in mid-winter. In addition to the plant in sub-stations there has been installed at Frederick-road 5,500 kw. of converting plant and 400 kw. of transformer plant for lighting. The whole of the energy supplied is now generated as e.h.t. alternating current, of which the bulk is transformed and converted to direct current for power, traction and lighting. The new sub-station at the corner of Blackfriars-road and Greengate which was put in partial operation in February 1917, is equipped with three rotary converters representing 3,750 kw. of converting plant, but the building can accommodate converter plant of 7,000 kw. Within the last three years the output from the works has increased by fully 50 per cent. The scheme for the interconnection of electrical undertakings in Lancashire and Cheshire, if adopted, will lead to the supersession of power stations not favourably situated for cheap generation; the extension of those stations already operating on favourable sites, and the erection of several new large stations built and equipped on the most scientific lines on selected sites. While the Salford power station cannot be regarded as favourably situated, the importance of the district as a manufacturing centre would justify the erection of a new station within, or near to, the Borough boundaries

Companies' Meetings and Reports.

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.)—The gross income for 917 was £99,506, against £93,578; gross profit was £25,617, against £31,598. After payment of tax, interest, &c., and adding £10,000 to renewals fund, the amount available (including £6,838 brought forward) was £16,092. Further dividend of 3 per cent. (less tax), making 6 per cent. for the year; £7,092 is carried forward.

ARGENTINE TRAMWAYS & POWER CO. (LTD.)—The gross tramway receipts for year ended Sept. 30 last were $m/n355,351, a decrease of $m/n14,741, of which $m/n6,400 arose during the strikes, and the balance was more than covered by economies effected. Gross receipts of the light and power department were $m/n124,998, an increase of $m/n18,344. Net revenue from operation was £13,959, against £12,256. Adding interest, &c., the total is £15,142. After charging interest and sinking fund on debenture stock and London expenses, and providing £2,000 as reserve for renewals, there remains £423 to be carried forward.

CANADIAN GENERAL ELECTRIC CO. (LTD.)—The accounts for 1917 show a net profit (after reserving $524,318 for depreciation, and $383,694 for amortisation of munitions plant and equipment) of $1,133,596. Quarterly dividends amounting to 8 per cent. have been paid, and $500,000 transferred to reserve, $466,293 being carried forward.

CRAIGPARK ELECTRIC CABLE CO. (LTD.)—For the year ended March 31 the net profit was £11,297 (after making provision for excess profits tax), which, with £716 brought forward, makes £12,013. The directors recommend that £2,000 be appropriated to depreciation of buildings and machinery and £3,000 to reserve, that the dividend on the 6 per cent. preference shares for the half-year ended March 31 be paid, and a dividend at 6 per cent. be paid on the ordinary shares for the 12 months, leaving £1,913 to be carried forward.

ELECTRIC CONSTRUCTION CO. (LTD.)—The net profit for the year ended March 31, 1918, after providing £6,558. 11s. for debenture interest and £10,000 for depreciation is £66,825. 15s. 6d. Adding £31,442. 6s. 7d. from last year and deducting excess profits duties for two years ended March 31, 1917 (£30,240. 9s. 7d.), the total is £68,027. 12s. 6d. The interim dividends paid in November of 7 per cent. per annum on the preference and 6 per cent. on the ordinary shares absorbed £8,923. 6s., leaving £59,104. 6s. 6d. The directors recommend final dividends at rate of 7 per cent. per annum on the preference shares and at rate of 9 per cent. per annum on the ordinary shares (making 7½ per cent. for the year), and a bonus of 2½ per cent. on the ordinary shares (all less tax). The sum of £9,326. 7s. 6d. has been transferred to general reserve, leaving to be carried forward £31,886. 13s. Operations have been conducted during the past year under abnormal conditions, but, notwithstanding, a large measure of success has been achieved which is indicated by a substantial increase both in turnover and net profit.

GREAT NORTHERN TELEGRAPH CO. (LTD.) (OF DENMARK).—At the company's general meeting, which it has been found necessary to postpone until June 29, the directors will propose for the year 1917 the distribution of a total dividend and bonus of 22 per cent., including the 5 per cent. already paid, and to set aside the following amounts—viz., £55,555.11s.1d. to reserve and renewal fund, £11,111. 2s. 3d. to the pension fund, and £111,111. 2s. 4d. to extraordinary taxes.

KIDDERMINSTER & DISTRICT ELECTRIC LIGHTING & TRACTION CO. (LTD.)—The net receipts of the lighting undertaking during 1917 were £2,904, and with £3,120 for dividends and interest received in respect of investments and £499 brought forward, the total is £6,524. After deducting administration and general expenses, interest on temporary loans and debenture stock and providing £500 for renewals, the balance is £2,045. The directors propose to appropriate £500 to reserve, and to pay the dividend on the cumulative preference shares for the year, carrying forward £45. The profit on the tramway company (after providing for renewals) was £2,879, which, with £256 brought forward, leaves £3,135. Of this amount £943 has been placed to reserve; and a dividend at rate of 3½ per cent. on 5,720 shares absorbed £2,002, leaving to be carried forward £190.

LEWES & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The revenue for 1917 amounted to £3,649 and working expenses to £2,405, leaving £1,244. After providing for debenture interest and adding amount brought forward, there remains £1,488. The directors propose to place to renewals fund £600, reserve fund £200, and to carry forward £688.

MERTHYR ELECTRIC TRACTION & LIGHTING CO. (LTD.)—The revenue for 1917 was £28,978, compared with £27,179 in 1916. After deducting expenses, providing £2,000 for renewals and £1,000 for deferred maintenance, there remains £5,060, and with £508 brought forward, £5,568 is available. The directors, after providing for preference dividend, propose to place to reserve £1,000, pay a dividend at rate of 6 per cent. per annum on the ordinary shares and to carry forward £668. The gross revenue of the electricity supply undertaking amounted to £13,084, against £13,023. The number of units sold for lighting and power was 695,568, against 759,744. The number of consumers is 1,425, compared with 1,388. The gross revenue of the light railways amounted to £15,799, an increase of £1,770.

METROPOLITAN CARRIAGE, WAGON & FINANCE CO. (LTD.)—At the meeting on the 30th inst., the following dividends will be recommended: On the "A" preference shares at rate of 2½ per cent. (less tax) for half-year ended March 31, making 5 per cent. for the year; on the "B" preference shares at rate of 3 per cent. (less tax) for the half-year, making 6 per cent. for the year; and on the ordinary shares at rate of 1s. per share for the half-year, and a bonus of 1s. per share.

NORTHERN GENERAL TRANSPORT CO. (LTD.)—The report for 1917 states that the traffic receipts (less working expenses), dividends and other revenues amounted to £37,555, compared with £35,756 for 1916. After providing for administration expenses, deducting £4,077. 10s. for loan and debenture interest, and providing £5,871 for renewals, the balance is £22,569. With £5,689 brought forward, the divisible surplus is £28,258. The directors recommend that £1,484 be placed to a sinking fund for redemption of debenture stock and that dividends at rate of 6 per cent. for the year on the preference and ordinary shares be paid, leaving to be carried forward £6,624. 6s. 1d.

NORTH OF SCOTLAND ELECTRIC LIGHT & POWER CO. (LTD.)—The report for 1917 states that the connections increased from 1,091 kw. to 1,173 kw. in Brechin from 815 kw. to 837 kw., and in Inverness from 1,597 kw. to 1,784 kw., making a total of 3,794 kw. Gross profit is £6,642, against £7,550, and after meeting interest on debentures and loans and adding £2,177 brought forward, £6,200 is available. The directors recommend a dividend at rate of 3 per cent. for the year, placing £2,000 to renewal reserve and £1,000 to general reserve, carrying forward £1,700.

POTTERIES ELECTRIC TRACTION CO. (LTD.)—The revenue for the year 1917 amounted to £176,745. The traffic and parcel receipts (£160,060) exceed those of 1916 by £24,941. The expenses increased by £24,972, although many repairs and practically all renewals have had to be deferred. After deducting expenses, including £11,025 for debenture interest, and £10,000 for renewals, there remains £34,444, compared with £33,152 for 1916. Adding £7,261 brought forward, the available balance is £41,705. The directors recommend that £12,500 be placed to reserve, that a dividend at rate of 5 per cent. per annum on the preference shares and a dividend of 3½ per cent. per annum on the ordinary shares be paid, leaving £8,380 to be carried forward. Stoke Corporation recently decided not to execute the draft agreement providing for the postponement by the Corporation (until Dec. 22, 1932) of their right to purchase the tramways within the borough. The right of the Corporation to purchase the tramways and light railways does not arise again until 1924 and 1932 respectively. The directors have decided to increase the fares.

RIVER PLATE ELECTRICITY CO. (LTD.)—The net revenue for 1917, after providing for administration expenses, depreciations, &c., is £43,515 and £18,695 was brought forward, making £62,211. The directors recommend a dividend of 7 per cent. on the ordinary stock; £5,000 is set aside as special provision for income-tax, and £25,961 carried forward. Owing to practically all fuel tonnage between the United States and the Argentine having been commandeered, oil fuel has had to be purchased at famine prices. No interest has been received upon the 5 per cent. obligations of the German Trans-Oceanic Electric Co. Interest has been paid on the £66,667 5 per cent. debentures of the Tucuman Tramways Light & Power Co. and a dividend of 4 per cent. on the Company's shareholding in the Argentine Electricity Co.

SHROPSHIRE, WORCESTERSHIRE & STAFFORDSHIRE ELECTRIC POWE CO.—The directors' report for 1917 states that, including £4,665 brough forward, the amount available is £38,302. The directors recommend a dividend of 5 per cent. on the ordinary shares (against 4 per cent. for 1916)

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and propose to transfer £17,000 to reserve, leaving £4,580 to be carried forward. To meet the increased demands of consumers and to enable the company to give a supply of power to new factories, an agreement has been effected with the Ministry of Munitions to make advances to the company up to £200,000, to enable the company to discharge certain commitments in respect of plant installed during the past year, and also towards the cost of plant in course of installation.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—The directors report that the units sold during 1917 amounted to 36,959,049, compared with 30,058,461 in 1916, an increase of 6,900,588 units, or nearly 23 per cent. Negotiations have also been completed for a further substantial increase of output. After payment of all expenses, the credit balance on the past year's working was £24,748. Deducting interest on the prior lien debenture stock and the original debenture stock of the company, and making provision for depreciation of the new plant the balance (£64. 0s. 3d.) has been carried forward

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The directors report for 1917 states that the amount to credit of revenue is £113,644, and the expenses have been £69,344, leaving £44,300, to which is added £3,205 from interest on investments and £2,888 brought forward, making a total of £50,393. From this sum there has been deducted £6,065, the cost of extending the date of maturity of the debentures, leaving £44,328. The interim dividends (paid in November) on the first and second preference and ordinary shares absorbed £13,977. 12s. 6d., and the available balance is £30,350. Of this amount the directors have placed £10,000 to general reserve, and they propose to pay final dividends for the year of 6s. per share on the first and second preference shares, and of 6d. per share and a bonus of 3d. per share (both tax free) on the ordinary shares, carrying forward £5,268. The traffic receipts show an increase over those for 1916.

WEST LONDON & PROVINCIAL ELECTRIC SUPPLY CO. (LTD.)—Mr. H. Kahn, who presided over the meeting last week, said that they had received £628 more from their holding in the Chiswick Company, owing to their dividend having been increased by 1 per cent. (to 6 per cent.) for 1917. The management fees received from the Chiswick Company increased by £575, and the net result was a balance of profit of £3,494 12s. 11d. With the amount brought forward the total was £3,513, and the directors proposed a dividend on the cumulative preference shares of 6 per cent., and the interest in arrears for the year 1912 of 4½ per cent. on the funding certificates, the balance (£61) being carried forward. The Chiswick Corporation supplies Aberystwyth with current as well as Chiswick, but the figures were not kept separate. The sale of current increased by £10,360, due in a great measure to the enhanced supply of power required by certain works. The cost of generation was £3,290 higher, chiefly owing to the much higher price of coal, oil and other stores and the increase in wages. Owing to the increased demand for current, they made an agreement with Hammersmith Borough Council for a supply in bulk, and the arrangement had worked satisfactorily. The Chiswick Company had paid their company £575 more for management. The sum of £1,407 has been written off for depreciation, and the net result was that £10,253 19s. 7d. had been carried to net revenue account, an increase over last year of £2,129. Out of the balance of net revenue the Chiswick Company were declaring a dividend of 6 per cent., against 5 per cent. last year, were placing to depreciation reserve account £1,400, and carrying forward £1,007 17s. 1d. The Chiswick Company were obliged to raise their prices for current in Chiswick by another 10 per cent. at the beginning of the December quarter, making 30 per cent. in all. In Aberystwyth nothing further could be done, as the maximum price was already being charged. The daylight saving had started a month earlier than last year, and that, together with the new lighting restrictions, reducing the use of current by one-sixth, and practically doing away with exterior and window shop-lighting, would not tend to increase the amount of current sold for lighting. On the other hand, there was no reduction in the sale of power units to be apprehended, although those were sold at a lower price than those supplied for lighting.

New Companies.

PARKINSON MOTORS (LTD.) (150,330).—Private company, reg. May 1, capital £25,000 in £1 shares, to carry on the business of electrical and mechanical engineers, manufacturers of and dealers in dynamos, motors, meters, lamps, wires, accumulators, &c. First directors are: F. Parkinson and A. Parkinson (both permanent).

PHŒNIX ARMATURE WORKS (LTD.) (150,290)—Private company. Reg. April 27, capital £2,000 in £1 shares, to take over business of armature winders and repairers carried on by H. A. Parkes as the Phœnix Armature Works, and to carry on the business of repairers and renewers of the windings of electrical generators, motors and machinery, &c. First directors are H. A. Parkes, W. L. Worledge and E. King.

SMALL TOOL SUPPLY CO. (LTD.) (149,993.)—Private company. Reg. March 26, capital £2,000 in £1 shares. Vendors of and dealers in small tools, mechanical and electrical engineers, manufacturers of implements and machinery of all kinds, &c. Governing director E. V. Varley. Reg. office: Avenue Chambers, Southampton-row, W.C. 1.

WIGAN ELECTRO-METALLURGICAL WORKS (LTD.) (150,320)—Private company. Reg. April 30, capital £50,000 in £1 shares, to acquire from W. B. Hamilton, H. A. Blackwell and W. L. Turner their interests in an invention relating to grey cast iron, and to carry on the business of ironmasters, manufacturers of pig iron, white iron, grey iron and electro pig iron from scrap or ore, steel makers, manufacturers of metallic alloys, &c. H. A. Blackwell and W. L. Turner are governing directors.

Companies Registered outside United Kingdom.

HUBERT DAVIES & CO (LTD,) (1,658F).—Particulars filed April 4. 1918, reg. in Transvaal Dec. 20, 1917, to take over a business formerly carried on at Johannesburg, Durban and Cape Town, and at Salisbury, Rhodesia and in London, as "Hubert Davies & Co.," and to carry on the business of electrical engineers and contractors, &c., capital £150,000 in £1 shares. British address: Salisbury House, London, E.C., where S. L. Crouch is authorised to accept service.

WORTHINGTON PUMP & MACHINERY CORPN. (1659 F.).—Particulars filed April 24, 1918. Reg. in Virginia, U.S.A., April 20, 1916. Objects to acquire certain properties formerly owned by the International Steam Pump Co. and to carry on the business of mechanical, electrical and general engineers, &c., capital stock $36,000,000 in shares of $100 each. British address: Queen's House, Kingsway, London, W.C., where E. W. Husted is authorised to accept service.

City Notes.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO. (LTD.—A dividend of 4s. per share (tax free) has been declared on the ordinary shares making 8 per cent. for 1917, and £36,559 has been carried forward.

EASTERN TELEGRAPH CO. (LTD.)—The directors of this Company recommend an additional payment on the ordinary stock equal to 1½ per cent. and a bonus of 2 per cent., making 8 per cent. for the year (tax free).

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD. A fourth dividend of 3s. per share, together with a bonus of 4s. per share, making 8 per cent. (tax free) has been declared for the past year.

MELBOURNE ELECTRIC SUPPLY CO. (LTD.)—An interim dividend at rate of 10 per cent. per annum has been declared for the half-year ended Feb. 28.

NAIROBI ELECTRIC POWER & LIGHTING CO. (LTD.)—A final dividend at rate of 4 per cent. per annum (less tax) has been declared for the year ended Dec. 31 last, making 10 per cent. for the year.

The Round Table.

By "kVA."

A newsagent who chalks up his headlines because there are now no posters hit off the London air raid this week very happily. According to the "Daily Chronicle," he wrote up: "Shakespeare up to date: 'Down to hell, and say we sent you there!' Seven Gothas down."

* * * *

The "Star" Asterisk man remarks: "Now that we can obtain lights without a coupon we need not so much mind the rationing of gas and electricity." It is, however, quite certain that consumers of both will be judged according to their lights.

* * * *

A cheese factory has been started at Cockermouth, according to the "Evening Standard," in an electric power house belonging to Colonel Green-Thompson. Doubtless the product will be very much "alive"!

* * * *

Thus "The Times" on the opening of the Leeds new automatic telephone exchange:—

> "The Postmaster-General by simply pulling a cord changed over the 7,000 manual telephones to the automatic system, and at once there was a simultaneous chattering of instruments all over the building, indicating that there were hundreds of subscribers waiting to get the first call."

The contractors will not like to hear that their instruments have developed the habit of chattering.

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, May 21, 1881.]

OVERHEAD WIRES.—To the other adornments of aerial telegraphy in the City we now notice that cables are being swung across the streets. There are already eight of these suspended high over Cornhill, five of them very thick. They are all the property of private companies, chiefly telephone.

PRICES.—The prices this week as quoted are: For gutta percha, per lb., genuine 4d. to 3s. 3d., reboiled 3d. to 1s. 3d.; india rubber, per lb., Para, fine 3s. 6d., negrohead 2s. 5d., Central American 1s. 11d. to 2s. 6d., Assam and Pegu 1s. 2d. to 1s. 11d., other East Indian 1s. 9d. to 2s. 2d., Madagascar and Mozambique 1s. 6d. to 2s. 4d.

CONSTANCY OF THE LECLANCHE CELL.—A correspondent of "L'Electricité" says that he fitted up an electric bell for a retired invalid army colonel in December, 1876, using three Leclanché cells, and that, with the exception of refreshing each with 25 grammes of ammoniacal salt in 1878, he has not touched them, and that they are working well to this day

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CONTENTS.

NOTES	77
Arrangements for the Week	79
The Control of Large Amounts of Power	80
Power Factor and Its Improvement. By E. W. Dorey. Illustrated.—*Concluded*	81
Leeds Automatic Exchange. By J. Hedley. Illustrated	84
Trade Parliaments and Their Work. By E. J. P. Benn	87
INDUSTRIAL PEACE	88
REVIEWS	88
Some Transient Phenomena in Electrical Supply Systems. By Prof. E. W. Marchant, D.Sc. Illustrated.—*Concluded*	89
CORRESPONDENCE	91
Proposed Engineers' Club for the Midlands	92
Volunteer Notices	92
Commercial Topics	92
Electricity Supply	93
Tenders Invited and Accepted	94
Companies' Meetings and Reports	95

Notes.

Capital Charges and Coal Costs.

IN the case of electricity undertakings working at a low load-factor the meeting of capital charges is always a serious matter, and under existing conditions the position is more than usually difficult owing to the fact that in many cases the load has fallen off owing to restrictions in lighting. And now, due to the recent Order, there is to be further curtailment. Coupled with these difficulties there is the increasingly high cost of coal. Many of these stations are comparatively inefficient, and thus we find that the two main costs—the coal and capital charges—have increased very considerably. There are two general methods of meeting these increased costs, one being to raise the tariff—and this has already been done in many cases to a considerable extent—and the other is to meet any deficit by a charge on the rates. The latter is by no means a welcome method at a time when the cost of every commodity has increased, and, for this reason no doubt, the Town Council of Ealing has proposed to the L.G. Board that the required contribution to the sinking fund of these electricity undertakings should be reduced; in other words, that the date of repayment of outstanding loans should be deferred, so that the full annual payment to the sinking fund would not be required until times once more become normal. We think there is a good deal to be said in favour of this proposal, although it is desirable not to carry the principle too far. If this method were applied to any great extent, the tendency would be for undertakings to reach an unsatisfactory financial position, owing to the fact that they would be saddled with a good deal of antiquated plant, the capital expenditure on which should have been repaid. If, however, this aspect of the case is borne in mind, it may very well be that the proposal is the simplest and best way of mitigating a temporary difficulty.

Organising the Engineering Profession.

SOME interesting suggestions were thrown out in the addresses of the various representatives of the chief engineering bodies in the United States on the occasion of the welcome recently extended to the American Society of Civil Engineers to the Engineering Societies' building in New York. Mr. PEGRAM, president of the American Society of Civil Engineers, remarked that the time had come for the whole engineering profession to organise itself with a view to securing adequate recognition of their aims and interests in the States. Two things were necessary for such recognition; first, the public must be informed of their work, and secondly, there must be a responsible body to encourage that recognition. Prof. SWAIN pointed out that there were in the States probably 85,000–100,000 engineers of various kinds. Small bodies of men, by combination, had frequently attained great results. Engineers, properly organised, could do vastly more than at present. Mr. SAUNDERS, past president of the American Institute of Mining Engineers, gave an instructive instance of the neglect by the authorities of the claims of the engineer. In forming the State District Boards to survey recruiting it had been arranged that engineers, as well as famers, the legal profession, business men and labour, should be represented. Engineer members were selected by the organisation of engineers assisting the Naval Consulting Board, and the president sent these lists to the various State Governors for revision. When the lists were returned to the president 90 per cent. of the engineers were struck off to give place to lawyers and others! Such things will continue until the engineering profession as a whole is organised to assert its claims. We think that we, in this country, have a lesson to learn, and that in the future technical men and men of science must abandon their position of aloofness, and, no longer confining themselves to purely technical discussions amongst themselves, find means to rectify the mean opinion of the value of science entertained by the nation as a whole.

Engineers' Clubs.

WE are glad to note that an Engineers' Club is to be formed at Birmingham. The corresponding institution at Manchester has been eminently successful, and if a club on similar lines can be established at Birmingham there is no reason to suppose that it will not be equally a success. Such clubs are not merely social centres which savour of luxury. On the contrary, they may serve a very useful purpose, partly because engineers generally do not meet sufficiently in a social way, and partly because the best way of removing mutual suspicion on the part of trade rivals is for these rivals to meet and get to know something of one another. The present proposal, which is due largely to the initiative of Dr. C. C. GARRARD, is the beginning of a comprehensive scheme for having such clubs in all large manufacturing cities. This would, no doubt, result in the engineers of the country becoming more co-ordinated and better recognised as a power in the community instead of being lost to sight because they are not given to agitation. Such clubs also offer the advantage of very suitable premises for the local meetings of engineering institutions. Anyone who has attended meetings of the Institution of Electrical Engineers at Manchester, will have realised this advantage over meetings held at other centres. Perhaps in due course the movement will spread to London, but here the conditions are unique, and it is not possible to draw sound conclusions as to what would be successful in London merely from provincial experience.

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Royal Society.—Among the Papers read before this Society yesterday was one by Prof. J. Jolly, F.R.S., on "A Method of Avoiding Collision at Sea."

Physical Society.—At the meeting of the Society on June 14 (at 5 p.m.) a discussion will take place on "The Teaching of Physics in Schools." This will be opened by Sir Oliver Lodge, F.R.S., and a number of other contributions have also been promised.

Report of Board of Trade Electric Power Supply Committee.—The report of this Committee has now been published. It is recommended that Electricity Commissioners should be set up to whom the powers of the Board of Trade, L.G. Board, &c., would be transferred. A number of District Electricity Boards would also be set up which would purchase all generating stations, existing undertakers retaining the power of distribution if they so desire. We shall give an abstract of the report in our next issue.

Effect of Cadmium on Alloys of Copper and Zinc.—Mr. H. Le Chatelier recently presented before the Académie des Sciences a note by Mr. L. Guillet on the influence of cadmium on zinc and copper alloys, containing 60 to 70 per cent. of copper and an amount of cadmium in the zinc component, varying up to 4 per cent. A table of the results was presented, from which it appears that cadmium in quantities exceeding 1 per cent. results in a sharp diminution in resilience. Above 2 per cent. the cadmium takes up the form of isolated round nodules in the material, but below 1 per cent. it enters into solution. From the manufacturing standpoint it appears that the presence of cadmium is not objectionable, provided it is not present in quantities exceeding 1 per cent.

Electrical Fires in New York in 1917.—According to the "Electrical Review and Western Electrician," only 152 of the 14,053 fires that occurred in New York in 1917 were attributable to defective electrical installations. The loss involved (about 50,000 dollars) is roughly half that prevailing in the previous year. The committees of the Board of Fire Underwriters investigate all fires that occur, the Committee on Electricity specialising on fires thought to be of electrical origin. Of the 1917 losses about 33,000 dollars was chargeable to electrical equipments or extensions made without the knowledge or approval of the Board. This is significant, as suggesting that the existing loss is largely due to installations which are not made under proper supervision, and where faulty workmanship is to be suspected.

Lubricating Oils.—Some interesting points were raised in a recent Paper by Sir A. E. Dunstan and Mr. F. B. Thole before the Institute of Petroleum Technologists. There is very little available knowledge on the relation between chemical composition and lubricating qualities. Low viscosity and good lubricating qualities are involved in the conversion of "solid" into "liquid" friction, but the mysterious quality of "body," *i.e.*, the power of forming and maintaining a thin film between rubbing surfaces, seems to depend on surface tension rather than on viscosity, and is apparently closely associated with molecular weight. Another important factor is the capacity of the medium to enter into a colloidal state. For lubricating purposes paraffinoid oils are of little value. The polynuclear naphthenes, and their unsaturated components especially confer viscosity and film strength, and, generally speaking, the smaller the hydrogen content the greater the viscosity and durability.

The British Glass Industry.—At the meeting of the Society of Glass Technology on May 15 the future of the British glass industry was discussed from many different aspects. It was recalled that previous to the war only about 20 per cent. of the glass required was manufactured in this country, while many forms of chemical and scientific glassware were not made at all. There were no furnaces, trained men or requisite materials; yet in this direction great progress had been made. Other matters discussed included labour conditions and the future relation to the industry of the Ministry of Munitions. The possibility of applying the conclusions of the Whitley Report to the glass industry was the subject of comment, and it was suggested that after the war the Research Department of the Ministry of Munitions should continue in being to assist development. On behalf of the Department of Scientific and Industrial Research, Sir Frank Heath mentioned that it was proposed to allocate £40,000 to research in glass technology.

The Whitley Report.—We have received from the Engineers' Club, Manchester, a reprint of the contribution to the resumed discussion at the Club on "The Whitley Report" by Mr. F. S. Button, of the Committee on Production. The address falls under five distinct headings, namely, (1) The Works Committee, (2) The Central Works Council, (3) The Local District Council, (4) The National Industrial Council and (5) Arbitration. The functions of the various councils are discussed and the general procedure of each outlined. In conclusion, it is noted that the nature of the problems awaiting Capital and Labour is entering on a new phase. In the past the Trade Union organiser secured recognition only after a struggle. In future, industrial conflicts will rage largely for the control of the industry itself, and Armageddon can only be prevented by granting a real constitution to every industry. Copies of the pamphlet (Price 4d. post free) can be obtained on application to the Hon. Secretary of the Club (Mr. H. Richardson).

Improvements in Magnetite Electrodes.—Some experiments described by Messrs. De Kay Thompson and T. C. Atchison in the "Transactions" of the American Electrochemical Society have for their object the improvement of magnetite electrodes which were formerly widely used in Chile and elsewhere for the electrolysis of acid copper solutions. Chemically, such electrodes resist the oxidising effect of the current extremely well, but they are unfortunately very brittle, and have been almost abandoned on this account. The authors describe a convenient method of making such electrodes, and investigate in some detail the effect of small additions of copper oxide. It was found that in this way the toughness of the anodes could be very materially increased, the improvement being almost proportional to the amount of oxides added. At the same time the resistance to corrosion of anodes containing 5 per cent. copper oxide is distinctly greater than that of pure magnetite, so that the results of the addition of copper appear promising.

Institution of Electrical Engineers.—At the meeting of the Institution on Thursday, May 23, the President, Mr. C. H. Wordingham, announced the result of the ballot for the election of Members to the Council as follows:—

PRESIDENT.
Mr. C. H. Wordingham.

VICE PRESIDENTS.
Mr. W. A. Chamen. Mr. R. A. Chattock.

HON. TREASURER.
Mr. J. E. Kingsbury.

ORDINARY MEMBERS OF COUNCIL.

Mr. H. W. Clothier.	Prof. E. W. Marchant, D.Sc.
Mr. D. N. Dunlop.	Mr. C. C. Paterson, O.B.E.
Sir Robert Hadfield, Bart., F.R.S.	Mr. J. Sayers.

It will be remembered that all the above were nominated by the Council. At the same meeting the President announced that the Council had set up a Committee of all parties interested to watch the situation in regard to the rationing of coal, gas and electrical energy, and had taken steps to put the views of the Committee before the proper authorities.

I.E.E. Students' Section.—The Annual Report of the Students' Section of the Institution of Electrical Engineers for 1917-18 states that there have been eight general meetings during the session, the average attendance being 52, and the highest 185. The opening address was delivered by Sir Oliver Lodge, and the President, Mr. C. H. Wordingham, also addressed the Section on March 22. The Papers read include:—"Recent Applications of Electricity," by Mr. C. E. Webb; "The Evolution of the Thermionic Valve," by Mr. R. L. Smith-Rose; "Magnetos," by Mr. R. W. Corkling; "Works Standardisation of Pyrometers," by Mr. R. Gates; "Electric Arc Furnaces for Steel Refining," by Mr. J. A.

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Broughall; and "Electric Railway Traction," by Mr. G. H. Fletcher. As in the two previous Sessions the Council have decided to award no premiums for Students' papers this year, and visits and other social functions have been suspended. Four general meetings have been held by the Manchester Students' Section. The Committee record with satisfaction a considerable increase in the attendances at general meetings, which is partly due to the fact of meetings being held at the various colleges owing to the occupation of the Institution buildings.

Fees for Engineering Services.—At the recent annual meeting of the Illinois Society of Engineers (U.S.A.) a Paper was read by Mr. E. T. Perkins on fees for engineering services. The author followed the traditional method of making the consulting engineer's fee a prescribed fraction of the total cost of the work, but the fraction progressively declines from 12½ per cent. (for jobs under $5,000) to 4 per cent. (for work over $500,000). The charges are distributed under the heading of Reconnaisance, Preliminaries, Plans and Specifications, Supervision, Superintendence and Alterations. Charges for engineering service on a per diem basis are prescribed as follows, the charge being for each day absent from the office, exclusive of expenses.: Chief engineer, $500 retaining fee and $100 per day; assistant chief engineer, $50 per day; topographical assistant engineer and chief of party, $15 to $25; designer, $12.50; instrument man, draftsman and computer, $7.50; stenographer, chain-man and axeman, $3.50. Attendance at court or expert evidence for any fraction of a day is considered as a full day. A fixed fee for services rendered, or retainers on a yearly basis, are other methods discussed by the author. While to most consulting engineers in this country these questions are of somewhat academic interest at present, we should like to see in the future a better general understanding on the question of professional fees.

Diesel Engine Users' Association.—At the May meeting a large number of applications for election to membership were dealt with.

Mr. GEOFFREY PORTER, A.M.I.C.E., referred to the importance of the great saving in the transport and consumption of coal effected by those electricity undertakings that made use of oil fuel in Diesel engines in place of steam generating plant. When imports of petroleum became restricted, the Association directed its attention to the development of various methods of utilising tar oil. The use of this home product, although obtained from coal, was evidently to be encouraged in the national interest. Not only did it result in an enormous reduction in the tonnage of coal to be transported to various electricity works, but the fuel oil was merely a bye-product in the process of obtaining other products of great value to the country. As the electricity undertakings that had installed Diesel engine plant were already effecting a saving in coal consumption far greater than the proportion aimed at by the Board of Trade in their recent Order, he urged that such undertakings should be exempt from the operation of the Order. He proposed the following resolution, which was seconded by Mr. J. E. Edgecombe, M.I.M.E., M.I.E.E., and unanimously passed:—"That application be made by the Diesel Engine Users' Association to the Gas and Electricity Restriction Committee of the Board of Trade to exempt from the provisions of the Lighting, Power and Heating Order, 1918, all public Electricity Supply Undertakings in which Diesel Oil Engines are utilised." Copies of the resolution were also sent to the Coal Controller and to the Institution of Electrical Engineers.

A Paper by Mr. H. MOORE, M.Sc. (Tech.), A.I.C., F.C.S., on "Tar Oil in Diesel Engines," was read, and followed by a discussion. A Paper by Mr. P. H. SMITH on "Two Essential Conditions for Burning Tar Oil in Diesel Engines," was also presented, and is to be discussed at a later date.

British Supplies of Potash Feldspar.—Some time ago we referred to the progress being made in the treatment of the saline deposits in America for the recovery of potash, a material in the past obtained almost exclusively from the German deposits. The cost of extraction is so high as to render it doubtful if potash extracted from such complex materials can ever compete with the German variety, which is almost pure. In this country we are in an even less favourable position in having apparently no potash-bearing saline deposits, and the most promising source up to the present appears to be the treatment of blast furnace dust and gases. Prof. P. G. H. Boswell has, however, carried out an investigation of various potash-bearing minerals occurring within the British Isles, an account of which is given in the "Journal" of the Society of Glass Technology. Enormous quantities of potash occur scattered throughout the rocks of the world. Potash-feldspar theoretically contains 16·9 per cent. of potash, but in practice few rocks contain more than 13 per cent., and 8-10 per cent. is the usual rule. The extraction, however, is a matter of such difficulty that, as was stated in the discussion, if we had to depend on feldspar the position would be precarious indeed. It is, of course, not impossible that further investigation may reveal more promising natural sources of potash in this country. But the systematic survey so far undertaken does not appear to have yielded very hopeful results.

State Control of Electrical Power in Germany.—"Le Génie Civil" contains an interesting article surveying the progress towards State control of electricity in various countries, special attention being paid to developments in Germany. Even before the war distribution of electricity in Germany had reached an advanced stage. In 1910 it was estimated that only 28 per cent. of the superficial area of Germany was covered by electric networks; at present 74 per cent. of German territory is so covered, and projects are entertained covering another 18 per cent., so that only 8 per cent. will remain to be dealt with. Of the estimated population, at the beginning of the war, of 67 millions, only 17 millions, or about 20 per cent., did not make use of electricity in 1913. While in the smaller confederated States individual action still prevails, the larger States, in particular Prussia, Wurtemberg and Bavaria, have made great progress towards State control and unification. In Bavaria the State has recently succeeded in consolidating a very large number of groups concerned with the use of water-power, and at the beginning of this year initiated two projects on a large scale. One of these, the large central station by the Walchen lake, is essentially a State enterprise, involving a total of 500,000 H.P., the distribution of which will be handed over to companies working under surveilliance. The other big Bayenwerk scheme, the establishment of which is estimated to cost 30 million marks, is not strictly under State control. Negotiations have also been entered into between Wurtemberg and Bavaria for the utilisation jointly of the water-power of the Iller, flowing on the frontier of the two States. Two enterprises mentioned will produce respectively 11,300 H.P. and 15,300 H.P. It is often suggested that the Bavarian State also contemplates a monopoly of distribution, but this has been recently officially denied, though the State control of the use of water-power seems to be determined. Other developments referred to are in Alsace and Lorraine, including a new central station near the Houve mines, intended to utilise inferior coal for efficient distribution at 30,000 volts. In Thuringia long-distance transmission has been in operation for some years and all districts of any importance have a supply. In Prussia distribution networks have been hitherto developed without any State intervention. A great part of the country is already electrified, and in the eastern districts the ravages of the Russian invasion are being repaired. A large central station in Hanover, and the linking up of all the existing networks, both schemes being under State control, are in contemplation.

Personal.

At the request of Lord Rhondda the Leeds Tramways Committee has released Mr. J. B. Hamilton, the tramways manager, in order to take charge of a new department, to be called the General Storage and Inland Transport Department, which will co-ordinate the work of all existing branches of the Ministry of Food dealing with these questions.

Arrangements for the Week.

FRIDAY, June 7th.

ROYAL INSTITUTION.

5.30 p.m. At Albemarle Street, W. Discourse on "The Romance of Petroleum," by Sir Boverton Redwood, Bart., F.R.S.

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The Control of Large Amounts of Power.

The following is an account of a discussion which took place before the Manchester Local Section of the Institution of Electrical Engineers on Mr. E. B. Wedmore's Paper on the above subject. An abstract of the Paper appeared in THE ELECTRICIAN of March 8 :—

Mr. G. A. JUHLIN said that the author, in dealing with short circuit currents, had not made it quite clear whether he had considered a symmetric or an asymmetric short circuit ; if the latter was the case, the values appeared to be too low. Some definite basis should be laid down in giving these values, so as to avoid confusion through the effect of wave form. The author had treated the use of reactances as a protective measure, reducing the stress which might fall on generators or other apparatus. But they also minimised the piling up of voltage on the first few turns of the winding, caused by high frequency surges giving rise to steep wave fronts. So far as stress on the windings was concerned, there was no need for reactance coils in order to protect the generator. Generators of 20,000 k.v.a. capacity 6,600 volts, were being installed without any reactance. The installation of reactance was to be recommended, chiefly for the protection of the end turns from surges. Faults between phases were easily dealt with, but there was no adequate protection for dealing with faults between turns. End connections with an earthed metallic shield would probably be difficult to carry out, and not likely to materially reduce the danger of destruction by fire. A suggestion had recently been made to arrange dampers at the inlet and outlet of a machine, these dampers being automatically tripped by Merz-Price or other protective gear. This would make it possible to shut off the air supply immediately a fault occurred, and so save the machine from total destruction by fire. The influence of synchronous machines feeding into a fault might be very great.

Mr. A. E. MCKENZIE remarked that the author was right in stating that for some time generators of 20,000 and 30,000 kw. capacity would be the limit in this country. Such sizes were contemplated for the new Manchester Station, and it was the intention there to use "step-up" transformers and to do all the switching on the extra-high-tension side. To control 120,000 kw. on the low-tension side would involve very heavy switchgear and was impracticable. In stations of to-day the power load dominated to such an extent that momentary variations in the load were negligible. Machines having coarse regulation and short-circuit currents of comparatively low value were preferred. Automatic voltage regulators were unnecessary, as switchboard attendants could regulate the voltage by hand. Faults to earth were no longer feared. The worst faults were those between phases in proximity to the main generating station. Faults on generators invariably started between turns of the same phase winding, and then went to earth before developing between phases. Every generator should be protected by balanced protective gear, with the addition of a device for short-circuiting the main field immediately the main switch was opened. He did not concede the necessity for automatically closing the air dampers on the outlet and inlet sides of generators. Dampers should be provided, but not automatically operated. The author rightly drew attention to the necessity for centralising distribution systems. This was not an easy matter—particularly when the mains are laid on the ring system. In Manchester they had been fortunate in having mains originally laid radially. He hoped that generator designers in general would look upon the suggestion of earthing the end windings of generators with approval.

Dr. WM. CRAMP said the principles underlying the values given in the paper needed explanation ; apart from impedance coils inserted in divided bus-bars the author considered the protection of long circuits, and the use of selective protective apparatus as well as impedance. The purpose of the impedance was to limit the rise of current until the protective gear had time to act, and thereafter to keep the current down to a safe value for the oil switch to deal with. Maximum currents and instantaneous conditions should therefore be considered instead of R.M.S. currents and steady conditions. Even on the assumption of steady conditions and R.M.S. currents the calculations in the Paper were misleading in some cases where the effects due to capacity, self-induction and leakage of the line were neglected. The author's statements regarding the absolute reliability of oil switches were not borne out in practice owing to lack of attention to detail in design. Regarding ironless chokers, the proportions of the design illustrated did not appear such as would secure maximum reactance with maximum copper.

Mr. J. DENHAM referred to the rupturing capacity of oil switches. What was the k.v.a. actually broken in an oil switch in respect to the k.v.a. produced by the generator ? For instance, when a short occurred and an oil switch cut off the fault, was the k.v.a. broken in the actual switch the same as the instantaneous short circuit k.v.a. delivered from the generating plant to the fault ? The speaker illustrated this point by an actual example, where the maximum k.v.a at the switch contacts would be of the order of one-fourth of the short circuit k.v.a. of the generator at the time of rupture. If resistance or additional reactance were present the instantaneous short circuit k.v.a. would be even less than this. In view of the large difference in price and size of switches of, say, 10,000 k.v.a. as against 40,000 k.v.a. breaking capacity, the matter deserved attention. Mr. Wedmore had explained that the designer's data were still largely empirical.

Mr. S. FERGUSON considered that reactances were destined to play a very important part in the large schemes now contemplated. A combination of generator, feeder and bus-bar reactances might be the ultimate scheme in large stations. In one 6,600 volt three-phase plant, it was proposed to divide the 60,000 kw. into three sections of 20,000 kw., with reactances between sections. The adoption of a 12½ per cent. reactance reduced the initial energy output and the initial short circuit current to about one-half thereby reducing the mechanical stresses, to one quarter. The energy loss in the reactances was about 3 kw. for each single phase unit ; the cost was only 3-4 per cent. of the capital value of the plant, and the space occupied by each coil about 5 ft. diameter by 4 ft. high. This was a very big insurance of plant at comparatively small cost.

Mr. J. L. THOMPSON preferred the ironclad type of reactance. The vital function of a reactance coil was that the voltage choked should be proportional to the current flowing through its windings, and this condition was attained in the ironclad type. Air core types involved heavy stray alternating fields, large floor space and long cable runs, and not very great overload capacity. The ironclad type had no stray field and could be oil insulated and placed in any convenient position. Safety could be secured by earthing the tank, and the overload capacity amounted to 300 per cent. load for half an hour without damage. The factor of safety of the ironclad type reactance was also very high. Generally speaking, the ironclad type was cheaper than the air-core type for bus-bar work, but somewhat more expensive for generator work, while for feeder work the costs were about the same.

Mr. H. A. RATCLIFF said that reactances were often valuable but did not constitute a panacea for all troubles. Generators connected to bus-bars through transformers rendered external reactance less necessary, although a little was desirable in some cases. The best location for reactances was probably between the bus-bar sections, They were a positive disadvantage when placed in the feeders. Regarding sectionalising the bus-bars, the author said the system would require to be sectionalised as well. The first step towards making really effective use of reactances was, therefore, to raise the power factor of the system as a whole. The speaker proceeded to discuss two methods of sectionalising the bus-bars, the "Tie-bus" or "Star" system and the "Ring" system. Referring to concrete supported coils, might not the high negative temperature coefficient of the pyro-electric conductor, causing the resistance to be lowered, be responsible for breakdown ? The speaker agreed with the author regarding the ironless form of construction. The design and construction of current transformers, which were subjected to enormous strains, both electrical and mechanical, required consideration.

Mr. A. G. ELLIS referred to the question of intermediate switchgear between generators and step-up transformers. Such gear was cumbersome, having to deal with 2,000 or 3,000 amperes at about 5,000 or 6,000 volts. Was it the usual practice to put isolating switches or links between generators and step-up transformers ? In large modern stations the reactance of the whole plant was generally such that the steady short circuit current would be from two to three times normal. The instantaneous short was the thing to guard against. From the point of view of transformers, external reactance was preferable, as it resulted in lower stresses in the transformer, but it was usual to build transformers with internal reactance as high as 5, 6 or 7 per cent. This, with the inherent reactance of the generator, was usually sufficient to obviate the necessity of external reactance. Both air-core and iron-clad types of reactances had been extensively used on the Continent. One of the chief gains in the iron-clad type was that there was no stray field. Where the current limitation was not too high, say up to ten times normal, the ironclad type could be run normally at a higher induction density and could compete in cost with the air-core type. Some large reactances of the air-core type required forced air blast cooling. Core losses in ironclad reactances were of no importance.

Mr. H. PEARCE showed a diagram emphasising the importance of sectionalising, distributing centres or sub-stations being fed radially from a power house having four bus-bar sections, and the sub-stations connected by means of interconnectors, so that they formed a complete ring main. The speaker discussed the operation of the scheme in various eventualities, and enumerated the advantages to be secured. The principle of sectionalising would prove of great importance in the future.

Mr. W. A. COATES remarked that selective action was obtainable by means of fixed time limit relays, but such instruments did not take account of the intensity of the short circuit currents. The ordinary inverse time limit relay had a curve of operation such that on large overloads the instrument acted practically instantaneously, and thus selective action was impossible. Some four years ago a relay was patented in this country combining the advantages of the inverse time limit relay with that of the fixed time limit relay (Coates & Ferranti, Ltd., No. 29,861, 1913). The Westinghouse Co. in America had produced an instrument having similar characteristics, but of the induction motor pattern, fitted with a very small compensating transformer, so designed and connected as to set up an opposing field to that caused by the current in the series coil. The method of controlling the speed of the relay disc was so delicate that time differences between the settings of one relay and those of another could be reduced to 0·04 second, well within the period needed in practice.

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Power Factor and Its Improvement.

By E. W. DOREY.

(*Concluded from p.* 63.)

Summary.—The author discusses the causes of low power factor, and whether the cost of its improvement should be borne by the consumer or by the supply authority. It appears reasonable that the consumer should pay for this improvement, and, in order that he should have some inducement to do so, a special tariff is suggested for power consumers. Finally, the means available for improving power factor are considered, and examples are given showing the financial results obtained.

3. What are the Best Means of Raising the Power Factors?

The improvement in power factor should be effected at the point of consumption and not at the point of generation.

With an induction motor load the consumer's power factor cannot be raised above a certain limit without resorting to the installation of plant to improve the power factor. The three chief methods of effecting power factor improvement are :

1. The installation of rotary converters or synchronous motor-generators in place of induction motor-generators.
2. The installation of synchronous motors in place of induction motors where possible.
3. The installation of some form of power factor rectifier or condenser.

The capital expenditure incurred in effecting power factor improvement by methods (1) and (2) would in many cases, where the consumer is charged on kilovolt-ampere demand, quickly be recovered if the machine were designed to run with leading power factor, and so dispose of a considerable portion of the wattless current of the remaining load.

Dealing now with the third method, this may take the form of :—

(*a*) A phase advancer operating in conjunction with a slip-ring induction motor.

(*b*) A static condenser.

(*c*) A specially constructed synchronous motor running light on the mains at approximately zero power factor leading known as a rotary condenser.

(*a*) *Phase Advancers.*—These are of two kinds, both of which can be employed for working in conjunction with asynchronous motors with wound slip-ring rotors as follow :—

1. A " Kapp " phase advancer built by the G.E. Co.
2. A rotary apparatus built by the British Westinghouse Co.

The " Kapp " phase advancer has many very excellent features, is robust, and efficient and is illustrated in Fig. 4.

The " Kapp " phase advancer depends for its action upon the principle that a conductor carrying alternating current situated in a continuous-current field tends to move, and in so doing has induced in at an E.M.F. which leads the current in the conductor by 90 deg. If the rotor current of an induction motor, therefore, be passed along a conductor situated in the continuous-current field, it will commence to oscillate with a frequency depending on the slip of the motor, which may be from one to three cycles per second. A leading E.M.F. will then be generated in the conductor which will supply the magnetising current of the motor. The stator will therefore take no magnetising (wattless) lagging current from the mains, and the motors will work at unity power factor over a wide range of load. As the magnetising current required by the motor is practically independent of the load no adjustment of the phase advancer is required during operation. Once adjusted for unity power factor at full load the motor will run at unity power factor from about one-third load to 25 per cent. overload. The phase advancer can be designed to draw a leading current from the mains up to the maximum heating capacity of the motor.

The three rotor leads of the induction motor are connected to the three-phase advancer armatures each of which is situated in a two-pole field magnet, and oscillates with the frequency of slip of the induction motor. The rotor leads are connected direct to the armatures, and the armatures themselves are mesh connected. Separate excitation for the phase advancer is necessary, but the excitation energy is very small, being normally about 0·5 per cent. of the output of the motor.

The Westinghouse phase advancer may be regarded as an exciter connected in circuit with the rotor winding of an induction motor, and is driven by a belt or other suitable means from the motor shaft. It generates magnetising current alternating at the frequency of slip, the value of which, if great enough to create the magnetic flux in the motor, will enable the motor to run at unity power factor. By increasing the excitation a leading current may be drawn from the mains within the heating capacity of the motor. The apparatus is self-exciting, and the rotor leads are connected direct to the armature of the phase advancer through suitable brush gear. In order that the current in the rotor may be made to exercise the necessary magnetising effect it must lead in phase on the E.M.F. generated by the rotor slip, and to obtain

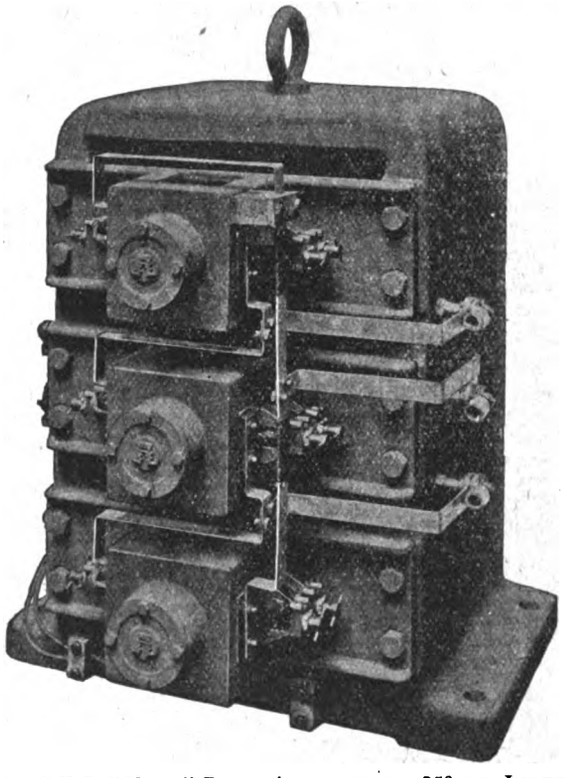

Fig. 4.—G.E.C. " Kapp " Phase Advancer for 350 h.p. Induction Motor.

this a leading current is necessary ; this is effected by the armature, similar to a direct-current armature, which revolves in a magnetic field excited by a leading current. The leading exciting current is obtained by using the current in one phase to excite the field coils and produce flux which generates E.M.F. in another phase.

Owing to the somewhat high cost of both types of phase advancers their use is practically confined to large motors. Provided the motor is capable of taking a leading current, which is generally the case, it is possible by means of the phase advancer to arrange for the motor to correct for other motors forming part of the total load. As an example, if a consumer's total load amounts to 800 kw., consisting of one large motor having an input of 500 k.v.a. at power factor 90 per cent. lagging and 500 k.v.a. of small motors with an average power factor of 70 per cent. lagging, the average power factor of the total load being about 81 per cent., it is possible by running the large motor with a leading power factor of 95 per

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cent. to bring the power factor of the whole load up to about 96·8 per cent.

If the consumer pays for energy on the basis of a fixed quarterly or annual charge per kilovolt-ampere of demand, the cost of the phase advancer would in a short space of time be recovered from the saving in the cost of energy.

(*b*) *Static Condensers.*—The principal makers of the static condensers are the British Insulated & Helsby Cables (Ltd.),

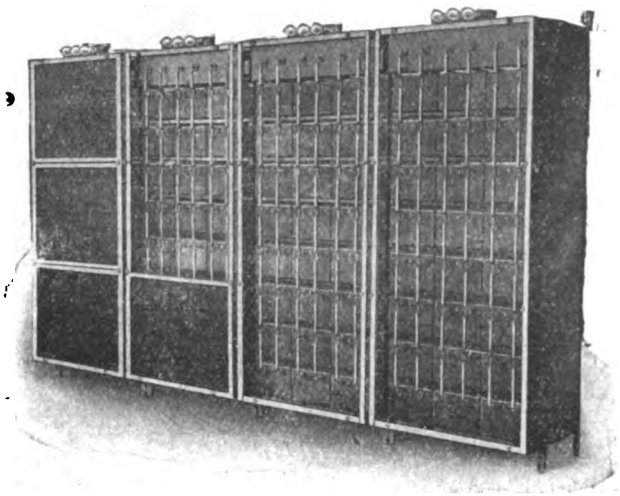

FIG. 5.

who have as a result of many years' experience developed a condenser of the oil immersed self-sealing type. The condensers are manufactured in units of about 1 mfd., the units being assembled in sealed cases in such numbers as may be required.

The efficiency of the condenser is very high, being about 99·5 per cent., and the temperature rise does not usually exceed about 20°F. A great advantage of this form of condenser lies in the fact that there are no moving parts, but, on the other hand, a serious disadvantage is that the capacity is constant unless means are provided for switching the condenser in and out, section by section, in which case attendance is necessary.

Fig. 5 illustrates a B.I. & H. static condenser.

To be really effective the static condenser should be installed at the point of consumption, in order to relieve the wattless current from service and distributing mains, sub-station, &c., and right back to the power station. Although the installation of large static condensers may be found economical, in some cases, a far wider field of use should be found in dealing with smaller consumers on supply mains of, say, 10 to 100 k.v.a. If the consumer pays on the basis of a fixed charge per kilovolt-ampere he will naturally have a strong inducement to install a static condenser, but even if the supply authority is not fortunate enough to have such terms it would undoubtedly in many cases be a paying proposition for a condenser to be installed on the consumer's premises, at the cost of the supply authority, which would correct not only for the consumer's low power factor, but possibly for other loads of low power factor in the immediate neighbourhood, and thus avoid the cost of laying additional distributing cables, and possibly the provision of additional transformer capacity in the sub-station. Taking as an example a load of 75 kw. at 75 per cent. power factor it would be possible to raise the power factor to 95 per cent. by installing a static condenser having a capacity of 750 mfd., the overall dimensions of which would be 3 ft. 3 in. wide by 3 ft. 9 in. high by 2 ft. deep. The demand would be reduced from 100 k.v.a. to 79 k.v.a., the equivalent of a saving of 21 k.v.a., and assuming the consumer pays a fixed charge of £3 per kilovolt-ampere per annum this would be the equivalent of a saving of £63 per annum, and should enable the consumer to recover the capital expenditure in about 2½ to 3 years.

(*c*) *Rotary Condensers.*—Where, however, the consumer's load consists of a number of comparatively small induction motors, it is necessary to resort to the installation of a power factor rectifier (*c*). Such a machine, known as a rotary condenser, is a specially designed synchronous motor running light on the sub-station 'bus bars, and over-excited to give its normal full-load output in kilovolt-amperes at approximately zero power factor leading; a direct coupled exciter is necessary where separate excitation is not available and for starting a starting motor or other starting device as for the ordinary synchronous motor. Fig. 6 illustrates a B.T.-H. rotary condenser of the type described.

The energy consumption of the machine would be that due to losses in excitation, windage, friction, &c., and when running at full-load would amount to approximately :—

500 k.v.a. input	27 kw.
750 k.v.a. input	35 kw
1,000 k.v.a. input	50 kw

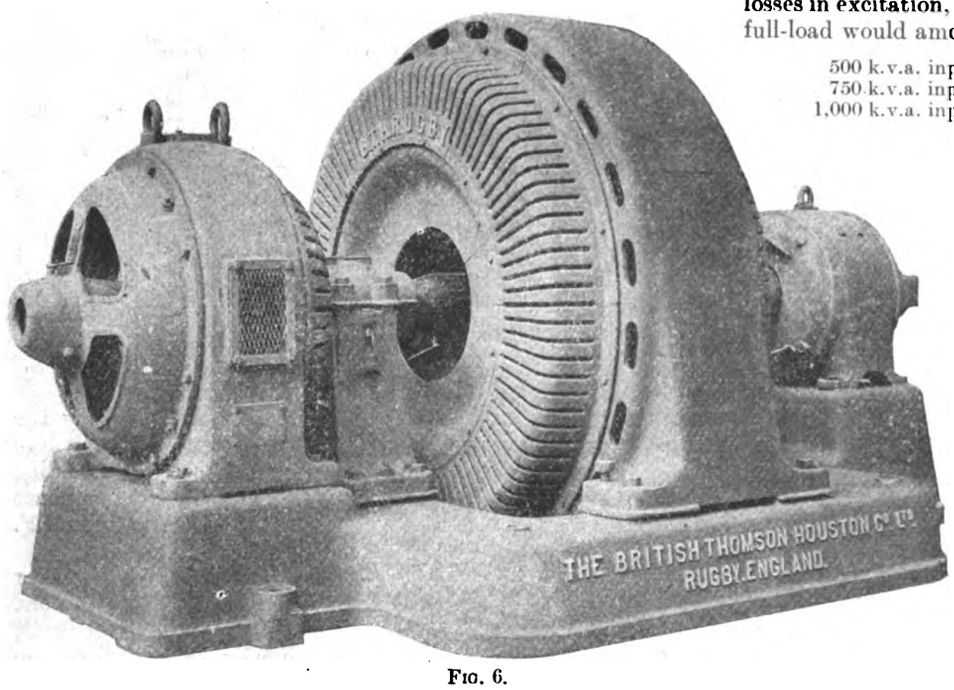

FIG. 6.

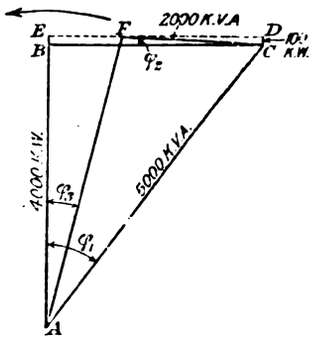

FIG 7

As I have previously mentioned, the onus of installing a power factor rectifier should rest on the consumer, and in order to show that from the consumer's point of view it would be a sound proposition to install such plant, let us consider an example based on the installation of a rotary condenser.

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EFFECT UPON CONSUMER.

Consumer's Load 4,000 *kw. at* 80 *per cent. Power Factor.*—The installation of two 1,000 k.v.a. rotary condensers would raise the power factor as follows :—

AB=Load in kilowatts, 4,000.
AC=Load in kilovolt-amperes, 5,000.
φ_1=Angle of lag=$\cos^{-1}$ 0·80=37 deg.
CD=Losses in phase advancers at unity P.F.=100 kw.
CF=Total input of phase advancers 2,000 k.v.a.

$$\varphi_2=\mathrm{Sin}^{-1}\left(\frac{100}{2{,}000}\right)=\cos^{-1}0\,05=2°\,50'.$$

DF=Cos 2°50′×2,000=1,997·6.
$DE=BC$=tan φ_1×4,000=3,014·4.
$EF=DE-DF$=3,014·4 − 1,997·6=1,016·8.
φ_3=Angle of lag with phase advancers in operation

$$=\tan^{-1}\left(\frac{1{,}016\cdot8}{4{,}100}\right)=\tan^{-1}0\cdot248=14°.$$

Power factor=cos 14°=0·9703, say, 97 per cent.

The power factor of the consumer's load would therefore be increased from 80 to 97 per cent.

Assuming M.D. rates as set out in the foregoing schedule, the saving to the consumer would be :—

		Per quarter.
4,000 kw. at 80% P.F.=5,000 k.v.a. at 16s.	£4,000 0 0	
4,000 kw. at 97% P.F.=4,125 k.v.a. at 14s.	2,887 10 0	
Difference		£1,112 10 0
Less—		
Losses in each machine equal 50 kw., therefore consumer's maximum demand Would be increased by 100 kw., which is chargeable at 14s. per kilowatt per quarter =	£70 0 0	
Losses energy 100 kw.×12 hours per day ×300 days×0·35d. per unit =	525 0 0	
		595 0 0
Saving		£517 10 0

A consumer with a load of 4,000 kw. would, under average conditions, consume, say, 4,000,000 to 5,000,000 units per annum, and with a running charge on a sliding scale basis the energy losses of the rotary condensers would be chargeable at a very low rate ; the figure of 0·35d. per unit should therefore be well within reach.

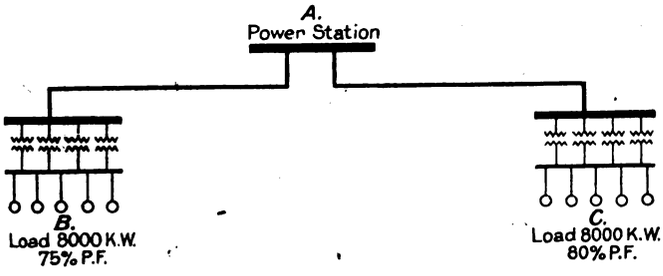

FIG. 8.

The saving would therefore be £517. 10s. per quarter, equivalent to £2,070 per annum.

The cost of two 1,000 k.v.a. rotary condensers complete with L.P. switchgear for, say, 400 to 500 volts, three-phase 50-cycle supply, would at the present day amount to about £3,200 to £3,500 ; adding to this sum other attendant costs the total expenditure would be, say, £4,000. The consumer would, therefore, recover 50 to 55 per cent. of the capital expenditure during the first 12 months.

Consumer's Load 1,000 *kw. at* 75 *per cent Power Factor.*—The installation of a 750 k.v.a. rotary condenser would raise the power factor to approximately 99·15 per cent., and working on the same basis as before, but losses (35 kw.) energy at 0·45d. per unit, the saving to the consumer would amount to approximately £620 per annum : the cost of a 750 k.v.a. plant for L.P. supply as before would at the present day involve an expenditure of about £1,800 to £1,900.

EFFECT OF POWER FACTOR ON THE POWER STATION AND DISTRIBUTION SYSTEM.

The effect of the improvement of power factor on the supply authority's generating and distributing plant is best illustrated by considering an example (*see* Fig. 8) :—

1. *Load on Power Station without Power Factor Rectifiers.*—
Load B=8,000 kw. at 75 per cent. P.F.=10,680 k.v.a.
Load C=8,000 kw. at 80 per cent. P.F.=10,000 k.v.a.
Combined, 16,000 kw. at 77·53 per cent. P.F.=20,640 k.v.a.

2. *Load on Power Station with Power Factor Rectifiers.*—By installing at point C four 1,000 k.v.a. rotary condensers, the power factor would be raised to 97 per cent., and losses energy, *i.e.*, increases, in demand, 200 kw.
Load B 8,000 kw. at 75 per cent. P.F.=say, 10,680 k.v.a.
Load C 8,200 kw. at 97 per cent. P.F.=say, 8,450 k.v.a.
Combined, 16,200 kw. at 87·2 per cent. P.F.=say, 18,600 k.v.a.

It has been assumed that the installation of power factor rectifiers at point "B" is not possible.

The installation of the four 1,000 k.v.a. rotary condensers at "C" would, therefore, reduce the wattless load in the power station by 20,640−18,600=2,040 k.v.a., and provided the prime movers and boiler plant are able to deal with the load this 2,040 k.v.a. capacity would be available for other consumers.

Other important points are the following :—

(*a*) The losses in the mains connecting A to C vary inversely as the square of the power factor.

(*b*) To deal with load C without power factor rectifiers would involve the installation of sub-station transforming plant, having a capacity of 10,000 k.v.a. as compared with 8,450 k.v.a. in case (2).

The foregoing should serve to show that in many instances, both from the consumer's and the supply authority's point of view, the installation of power factor rectifiers by the consumer is a practical and sound proposition.

APPENDIX.

Rotary Condensers in the U.S.A.—Since writing the foregoing, the author has received from the American Westinghouse Electric & Mfg. Co. a copy of their treatise on "Power Factor Correction," by Nicholas Stahl, and dated August, 1917. A description is given of numerous very large rotary condensers, including two each of 15,000 k.v.a., designed to run at zero power factor leading or lagging, and speed 375 revs. per min. ; these machines are installed, not primarily for the purpose of power factor regulation or control for a particular load, but rather for the maintenance of voltage of a transmission line. To anyone seriously interested in the question of power factor improvement, a study of this Westinghouse treatise will be found of great interest.

The Ultra-Violet Spectrum of the Tungsten Arc.—In a contribution to the "Journal" of the Franklin Institute, Mr. M. Luckiesh remarks that there is not available a light-source giving a continuous spectrum between 200μ and 400$\mu\mu$. Moreover, some arc-sources which yield useful spectra are not sufficiently steady for all work. A tungsten arc can, however, be made to work very steadily in certain gases, and the author describes some experiments on such an arc enclosed in a vessel with a plane glass window. Commercial argon, containing 20 per cent. of nitrogen, was used for the inert gas. Spectrograms were made for currents from 0·3 up to 5 amperes. For the lower currents the ultra-violet spectrum between 200$\mu\mu$ and 300$\mu\mu$ is relatively weak, but for currents from 1 ampere upwards better results were obtained. Photographs of the spectrum for this range of currents are presented. The spectrum between 300$\mu\mu$ and 400$\mu\mu$ is practically continuous, although short exposures show that it is somewhat fluted in character. Above 300$\mu\mu$ it consists of closely adjacent lines. The arc-voltage varied from 28 to 16 volts, the consumption being 5 to 80 watts. The arc is quite steady and appears well adapted to the study of many physical and chemical problems.

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Leeds Automatic Exchange.

By J. HEDLEY.

The above exchange was brought into service at 2.0 p.m. on May 18, and as the equipment embodies the latest developments in automatic telephone exchange working, and is the largest in this country, a brief description will probably be of interest. The plant is housed in a new building of fireproof construction in Basinghall-street. This building comprises five floors, including the basement. The superintending engineer and the district manager's staff occupy the basement, 1st, 2nd and a portion of the 3rd floor. The automatic plant is fitted on the 4th floor, and a portion of the 3rd floor is reserved for growth.

The equipment provided is as follows :—

(*a*) 6,800 primary line switches, fitted on 68 units, with floor capacity for accommodating 15,000 lines.

(*b*) 900 secondary line switches arranged in 45 divisions of 20 switches each.

(*c*) 840 1st selectors fitted on 5 boards.

(*d*) 810 2nd selectors fitted on 5 boards.

one secondary line switch in divisions 31 to 40, thus enabling each 100 subscribers to have a choice of 100 1st selectors. The 900 secondary line switches have access therefore to 450 1st selectors, the remaining 390 1st selectors are directly associated with junctions from Leeds manual board and distant exchanges, for the completion of calls direct by means of dials associated with the cord circuits at these exchanges.

From each of the 840 1st selectors the 10 levels have outlets to deal with the following classes of traffic :—

Level 0.—Calls to Leeds manual board for trunk and junction calls from subscribers and distant exchanges.

Level 9.—To 2nd selectors for calls to inquiry and for test and official calls.

Levels 8, 7, 6, 5, 4, 3 and 1. Dead Levels.—Reserved for growth at Leeds and for subscribers' circuits at Roundhay, Stanningley, Chapeltown, Morley, Headingley, and other sub-exchanges in the Leeds local area—when automatic working is extended thereto.

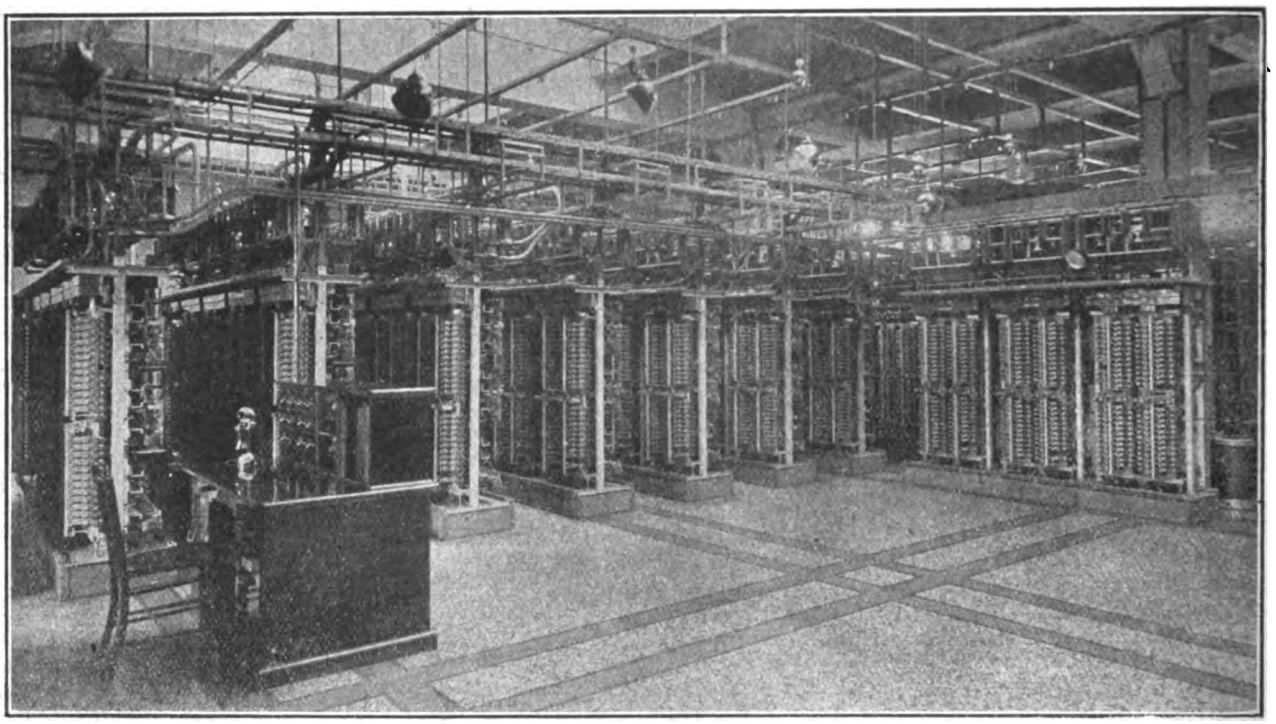

Photo by Stewart Bale, Liverpool.

FIG. 1.—PRIMARY LINE SWITCHBOARDS, WITH DOORS REMOVED, TO SHOW 100 PRIMARY LINE SWITCHES ON EACH UNIT. THE CONNECTORS ARE FITTED ON THE OTHER SIDE OF THESE SWITCHBOARDS.

(*e*) 730 3rd selectors fitted on 5 boards.

(*f*) 740 connectors fitted on 68 units shown under (A).

(*g*) 290 repeater circuits for calls to manual board from subscribers.

(*h*) 40 repeater circuits for calls to manual board from distant exchanges dialling in.

(*i*) 20 repeater circuits to Leeds telegraphs for phonogram calls.

(*j*) 100 repeater circuits for calls incoming from distant exchanges dialling in on high resistance circuits.

(*k*) 2 charging sets, motor 220 volt 50 cycles two-phase, generator 300 amps. at 65 volts.

(*l*) 2 ringing machines one driven from supply mains, one from 46 volt battery.

(*m*) 2 46 volt batteries each 1,588 ampere hours capacity.

(*n*) 6 test clerks' testing positions.

TRUNKING SCHEME.

Of the 68 primary line switch units, 46 have 10 trunks each, and 22, 20 trunks each, *i.e.*, a total of 900 outgoing trunks. Each of these trunks is cross-connected to a secondary line switch, in a different division, each such division having access to 10 1st selectors. This scheme of distribution spreads the traffic more uniformly over the whole group of 1st selectors ; *e.g.*, the 10 secondary line switch divisions 31 to 40, each fitted with 20 secondary line switches, are associated with the 10 outgoing trunks from 20 primary line switch units of 100 lines each—each one of the 10 trunks being connected to

Level 2.—To 2nd selectors for calls to Leeds subscribers at present numbered 20,000 to 27,299—21,500 to 21,999 and 27,300 to 29,999 at present spare.

The exchange is of the full automatic Strowger type for a five-figure system. Each subscriber's line terminates on a primary line switch circuit which, when energised by the removal of the receiver, extends the subscriber via a secondary line switch to one switch out of a group of selectors. This apparatus receives the impulses from the subscriber's dial for the first digit, and extends the line to a 2nd selector to accept the impulses for the 2nd digit, similarly a 3rd selector deals with the 3rd digit and finally a connector receives the tens and units digits and connects the calling subscriber to the wanted line.

Trunk and junction calls originated by subscribers are obtained by dialling "0," and 200 outlets are available for this service. These lines terminate on manual positions in the Leeds trunk exchange : fitted with a multiple of the junctions and short trunk circuits outgoing to other exchanges, so that, as far as possible, a "no delay" service for such calls will be effected. "Long distance" calls are ticketed and mature from a group of additional positions in the Leeds trunk exchange, each position being fitted with a group of junctions outgoing to the automatic exchange ; 223 junctions to the automatic exchange are available, each terminating on a 1st selector switch. Calls from distant sub-exchanges for Leeds subscribers are dialled direct by the sub-exchange operators ; 144 circuits are operated in this manner, each circuit terminating on a 1st selector

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in the automatic exchange. To obtain trunk and junction calls over these circuits the sub-exchange operator dials "0" and obtains the manual operator in the Leeds trunk exchange; 40 circuits, separate from those used by subscribers, are provided for this purpose. This group of lines is marked to indicate to the Leeds operator that the call is from a sub-exchange and will be controlled at that point.

The manual board in the trunk exchange also deals with calls originated by call office subscribers, so that the necessary fee can be collected. Two 100 line-switch units are set apart for this service, the trunks outgoing from these units being wired so that immediately the receiver is taken off the hook the caller is connected to the manual position. The circuits are therefore dealt with precisely on manual lines for originating calls. Calls incoming to such numbers are, however, dealt with automatically in a similar manner to an ordinary automatic subscriber. Coin-box and party-line subscribers are dealt with on a full automatic basis. The former have access to a separate group of "0" level circuits for trunk and junction calls to indicate to the operator that the coins should be deposited before the connection is established. For calls to automatic subscribers the apparatus at these subscribers' offices is designed to short circuit the transmitter, when the called subscriber replies, until the penny is deposited. The party line subscribers are arranged on a two-party line basis, one subscriber, "X," being

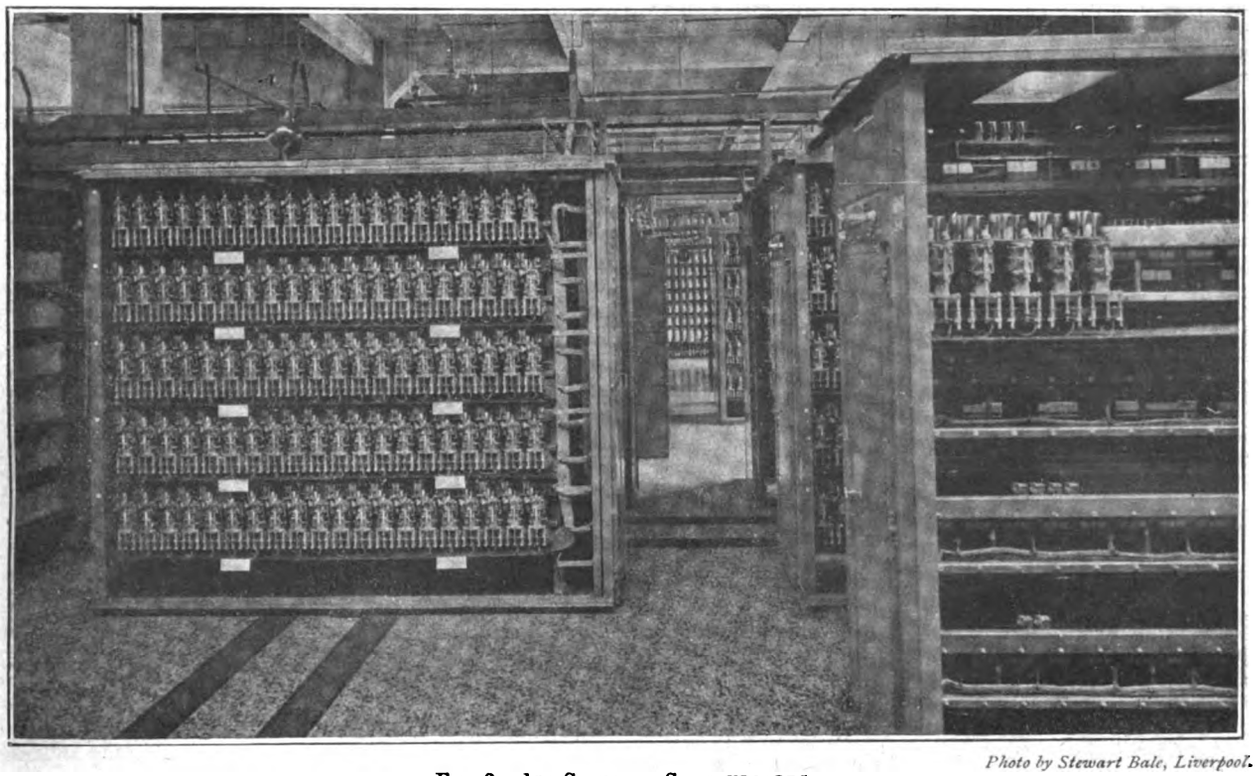

Photo by Stewart Bale, Liverpool.

FIG. 2.—1ST SELECTOR SWITCHBOARDS.

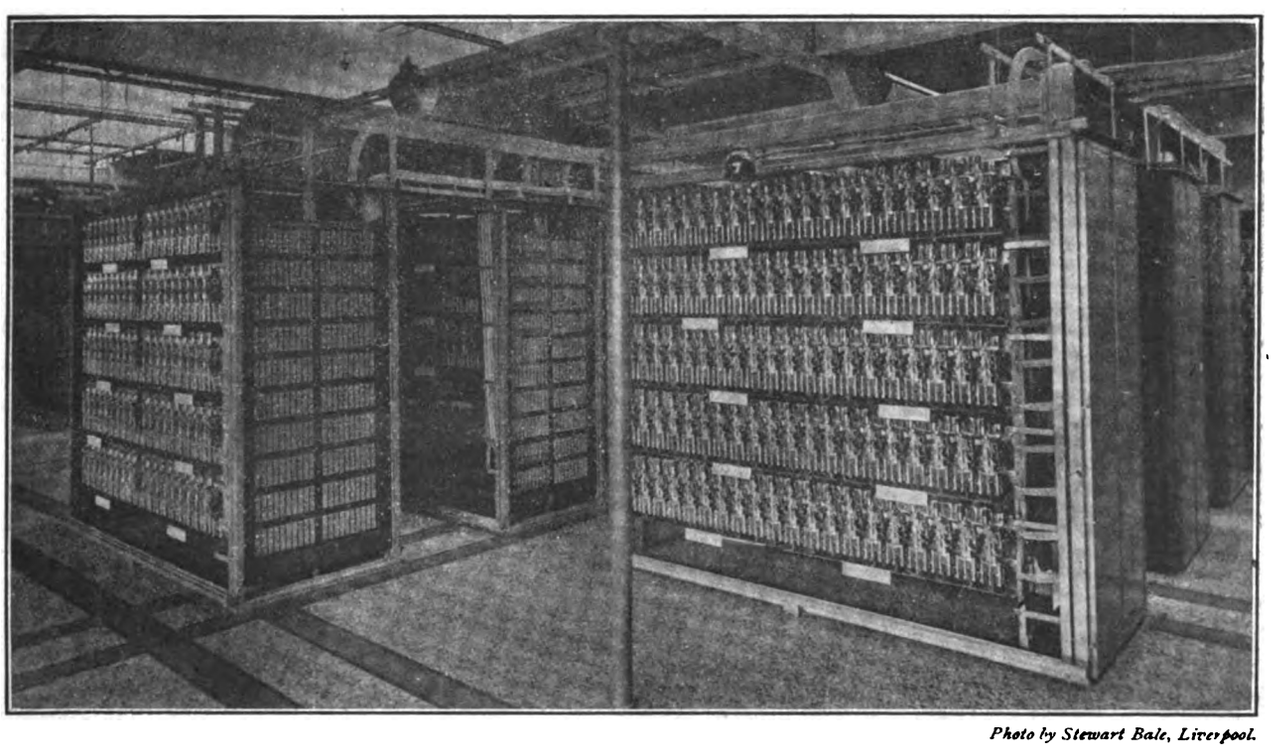

Photo by Stewart Bale, Liverpool.

FIG. 3.—2ND AND 3RD SELECTOR SWITCHBOARDS. THE FORMER ON THE LEFT, AND LATTER ON THE RIGHT.

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rung on the "A" line and the other, "Y," on the "B" line; each subscriber is allotted a separate number in a different hundred group, the connector switches of the "Y" group being arranged to ring on the "B" line instead of on "A" line as for other switches.

Originating calls from party line subscribers are dealt with on a line switch common to the two subscribers and mature similarly to ordinary direct subscribers.

The necessary electrical energy for operating the automatic exchange switches and providing the talking current for the subscribers' instruments is derived from a 46-volt storage battery. This battery is in duplicate so as to eliminate any risk of breakdown, one battery is kept charged whilst the other is in service. The batteries are charged by a motor generator set driven from the electric supply mains.

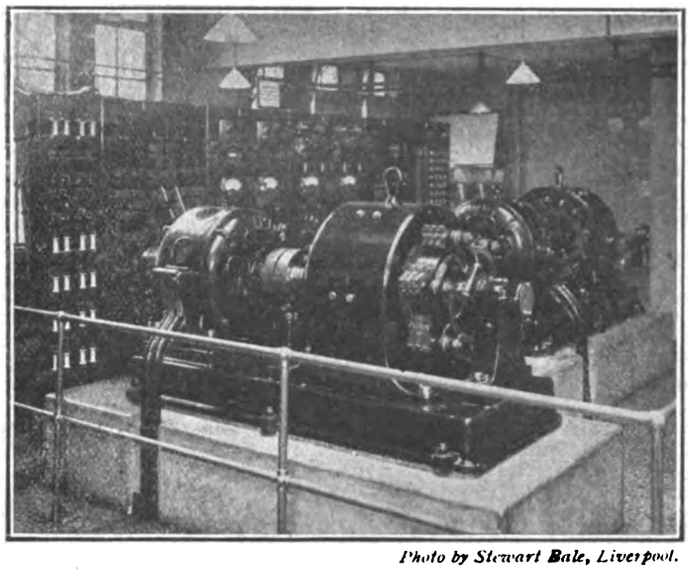

Photo by Stewart Bale, Liverpool.

FIG. 4.—POWER BOARD AND MOTOR GENERATORS.

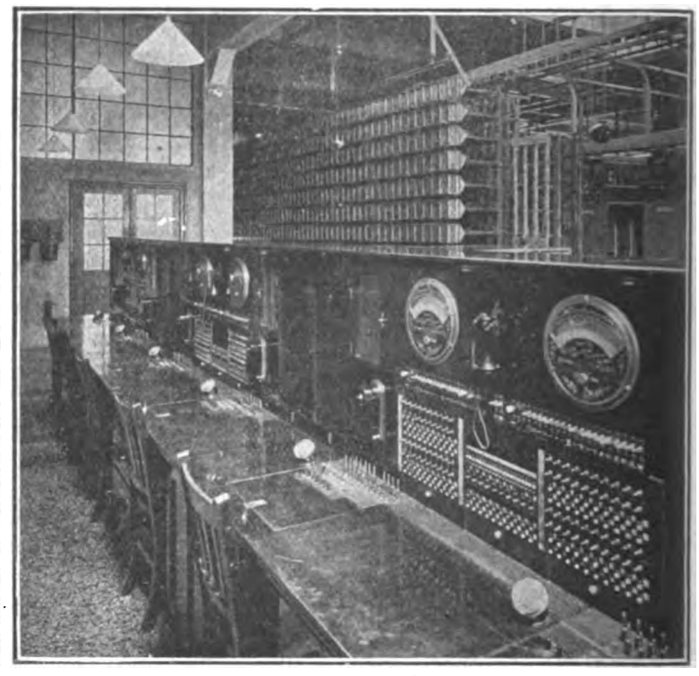

Photo by Stewart Bale, Liverpool.

FIG. 5.—SIX TESTING POSITIONS AND MAIN DISTRIBUTION FRAME.

means for distributing the originating traffic equally throughout the exchange.

2. Secondary line switches are fitted between the primary line switches and 1st selectors, to enable the originating traffic from each group of 100 subscribers to be spread over a larger group of selectors. This scheme provides for the distribution of the traffic more uniformly over the entire exchange, and so affords better traffic conditions.

3. When the called subscriber is engaged, a "busy back" tone is given to the originating subscriber; if the engaged subscriber is called from the manual board, a "busy" flash signal is transmitted to the operator's cord circuit.

4. When a called subscriber replies, the ringing current is tripped immediately.

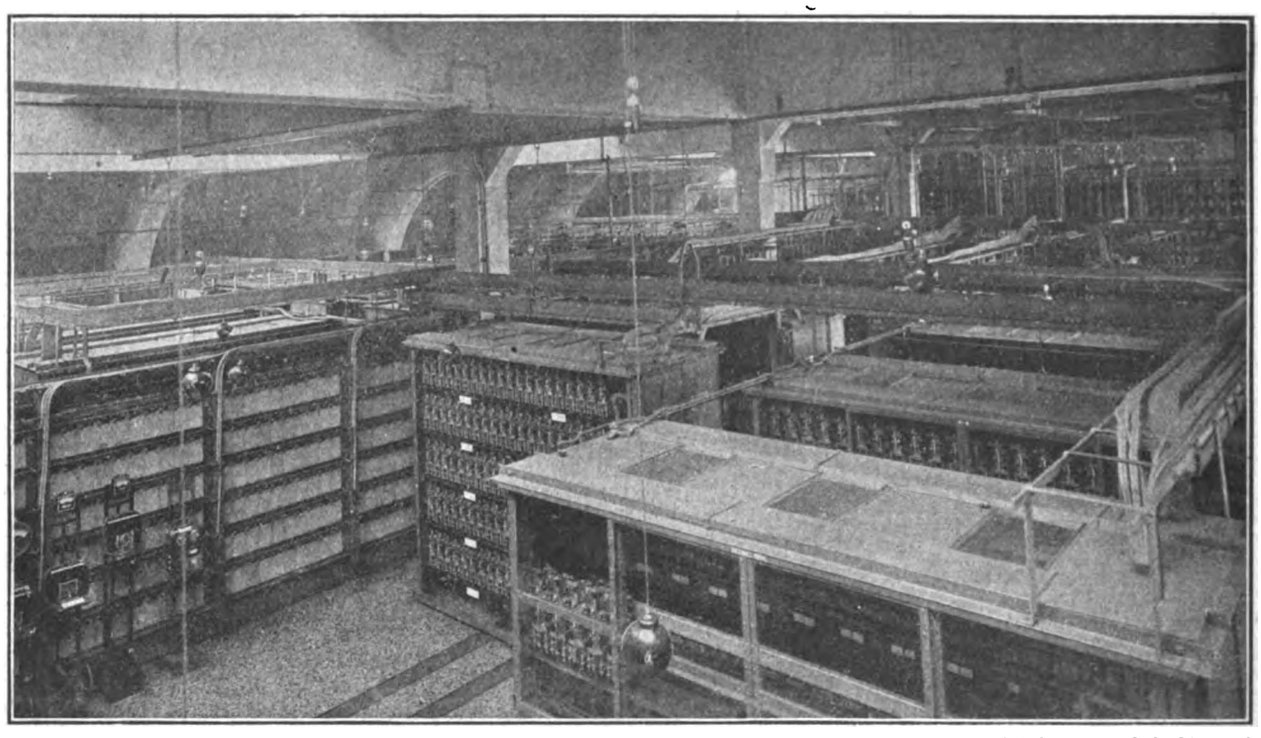

Photo by Stewart Bale, Liverpool.

FIG. 6.—GENERAL VIEW, INDICATING CABLING AND LAY-OUT OF AUTOMATIC PLANT.

The automatic exchange equipment embodies the latest developments in automatic telephone exchange working.

1. Facilities are available on primary line switch units for cross-connecting subscribers' lines to any line switch, thus affording

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5. The number of routes incoming to any unit can be varied without altering the permanent wiring. Increases in load incoming to any unit can thus be dealt with by merely inserting a connector switch on one of the spare multiple banks provided.

6. The meter of the originating subscriber is operated for completed calls between two automatic subscribers only.

7. Each switch, and the outgoing and incoming routes for each switch, are so designated as to enable calls to be traced backwards or forwards to the next switch without difficulty.

8. An alarm circuit is extended to the manual board during the night and on Sundays, when no engineering staff is on duty in the automatic exchange. The alarm is associated only with those circuits which actually affect the working of the exchange such as fuses blown and failure of ringing.

9. The master switch controlling the line switches associated with each primary and secondary switch unit, can be removed without displacing the line switches.

10. Standard positive supervision is afforded on the manual positions in the Leeds trunk exchange on all calls to and from automatic subscribers. Similar facilities are afforded to the sub-exchange operator dialling direct on the automatic exchange.

Fig. 1 shows a view of a portion of the primary line switchboards. It will be seen from the three units on the right, that each unit accommodates 100 primary line switches in four groups of 25 each. Fig. 2 shows a group of 1st selector switchboards; that on the right accommodates 100 1st selectors used by sub-exchanges dialling in direct. Fig. 3 shows 2nd selector switchboards on the left and 3rd selectors on the right. The former shows very clearly the terminal assembly provided at the end of the switchboard, to enable variations in the trunking scheme to be made, to meet the traffic to be carried. The 20 groups of terminals are arranged in two vertical groups of 10 levels. 0, 9, 8, &c., to 1, one group from the levels of the switches on the left of the selector switchboard, and one from the switches on the right. Fig. 4 illustrates the two charging machines and power board. Fig. 5 shows the six testing positions at the front and the fuse side of the main distribution frame and primary line switchboards in the rear. Fig. 6 is a general view of the plant to indicate the cabling scheme and general lay out of the plant.

The whole of the automatic equipment has been manufactured and installed by the Automatic Telephone Manufacturing Co., Liverpool, in accordance with a specification prepared by the engineer-in-chief of the Post Office—Sir William Slingo. In addition to Leeds, automatic exchanges rendering public service now exist at Accrington, Blackburn, Chepstow, Darlington, Dudley, Epsom, Hereford, Newport (Mon.), Paisley and Portsmouth. Much depends on the working of the Leeds equipment, which may be considered as a fair representation of the service conditions to be rendered at other large provincial towns, and its behaviour will be watched with keen interest by all concerned.

Trade Parliaments and Their Work.

By E. J. P. BENN.

VI. Restrictions and Pledges.

As soon as the war was properly started Parliament was asked to pass an enactment known as the Defence of the Realm Act. At that time we were working with a Government machine of a well-known model, and with Departments with whose habits and proceedings the community in general was fairly well familiar. No sooner had the Defence of the Realm Act been put upon the Statute Book than the process began of commandeering hotels and starting new Government Departments. Ever since we have been adding week by week to the army of persons who control us in one way or another. We have almost reached the stage when every commodity has its own office with its own controller, and it is estimated that there are to-day at least 80 authorities having the power to issue regulations under the Defence of the Realm Act. This is the way that we carry on war, and so long as the restrictions and regulations to which we are daily required to conform have for their object the defeating of the enemy no one is entitled to complain. A very large volume indeed would be necessary to catalogue all the regulations that have been issued in the last four years under the name of "DORA."

There are very few men in business who profess to be acquainted with more than a percentage of the rules which have been laid down for their conduct. If a new piece of business is contemplated, the habit now is to turn to the regulations or to inquire of the appropriate Department, in order to make sure that one or other of the intricate orders is not infringed. There are still a number of simple creatures who are comforting themselves with the fond delusion that at the end of the war the repeal of the Defence of the Realm Act is a matter of course, and that the restrictions and regulations which have been made under it will, on one happy morning in the future, suddenly disappear. They think of the glorious days when their liberty will be restored, and when we shall be able to go back to that traditional freedom and independence of action which has always been the leading characteristic of this country. Such views can only be excused on grounds of ignorance. The restrictions under which we suffer so severely have been imposed gradually; the process has been a gentle one, and we must give our rulers credit for having, so far as they were able, considered at every turn the delicate machinery of commerce with which they were dealing. There is nothing so sensitive and nothing so susceptible to shock as trade and commerce, and it is at least arguable that a sudden restoration to the old conditions might prove absolutely disastrous. It is more than likely that upon expert examination it will be found advisable to go through the process of undoing the last four years at a gentle pace and in such a way that the conditions for which we long so earnestly may be given to us only when we are fitted and able to enjoy them.

It will be seen that this question of Government restrictions is intimately mixed up with the question that we have already discussed—Demobilisation and Government Stores—and very little thought will be sufficient to show that great dangers are ahead unless the people who really understand the needs of each of our trades are prepared to apply their minds to the preparation of plans which will give them the maximum opportunity to get back to normal and satisfactory conditions. Each Trade Parliament should prepare a schedule of all the Defence of the Realm Regulations which have any bearing upon the trade it represents, and, working from such a schedule, each Parliament should prepare a detailed statement as to how best these regulations should be removed. It will probably be found convenient and wise to start by the removal of some of them only, but which these may be none but the trade itself can say. It will undoubtedly be found wise to continue for a time some of these restrictions, and here again this is a matter which can only be settled by experts in conference.

Another branch of work very closely akin to war restrictions is that connected with war pledges. War pledges have been given, not only to trade unions but to many other parties, such as bankers and merchants. The Government, on behalf of the nation, has distributed promises lavishly, and these promises, so far as most of them are concerned, will thoroughly justify the old reference to the pie-crust, as very few of them will, in the nature of things, ever be kept. The attitude of the Labour Party is that they recognise the impossibility of redeeming war pledges, but they cling, nevertheless, to those pledges, as they are fully entitled to do, as a basis for bargaining.

All these pledges, to whomever they may have been given, must be studied and plans must be made in advance with regard to them. It is quite unthinkable that we should attempt to face the crisis of peace with this series of problems under present conditions. The crisis of peace, and that is indeed what it must be, will be sufficiently serious from the business man's point of view in any case, and unless pains are taken beforehand to settle such questions as permit of previous consideration the crisis may assume disastrous proportions. It is easy to talk of getting on with the war, and make this the excuse for neglecting to think of questions of reconstruction. On the other hand, those who are prepared to look below the surface in this matter will realise that it is our bounden duty to those who are sacrificing their all to the purposes of the war that we should endeavour to prepare a state of affairs in which they will at least stand some chance of finding a welcome when they come home.

(To be Continued.)

Electric Vehicles in the United States.—The "Electrical Review and Western Electrician" emphasises the possibilities of the electric truck and the need for publicity on this subject. It is estimated that 75 million dollars are spent annually on the delivery of groceries alone in the United States. There are many articles for which the cost of delivery forms a considerable proportoin of the total cost. Thus, the Census Bureau finds that the cost of departmental store deliveries is in several cases 2 per cent. of the total cost, but the corresponding proportion for milk and dairy produce is 12 per cent., for wood and coal 19 per cent., and for ice delivery 45 per cent. It is suggested that for town deliveries electric vehicles might well take a considerable share of the work now being done mainly by petrol motors or horse labour.

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Industrial Peace.

Next to the vigorous prosecution of the war, the industrial and commercial conditions in this country in the near future must be regarded as the most important subject, and one to which immediate attention should be given. The conditions when peace returns will be so very different from those of the past that the methods hitherto used will no longer be applicable. Owing to the huge war loans that have been raised, there will be an unprecedented annual payment for interest which must be met by the country. Taxation, therefore, will be heavy, and it is essential that our industries and commerce should be in such a prosperous condition that they can bring in a large part of the required revenue. In other words, our production must be on an increased scale.

In order that this should be achieved, the amicable working of Capital and Labour is one of the first essentials, and to this subject many writers have recently paid attention. One of the latest is Mr. ALEXANDER RAMSAY, in a book entitled "Terms of Industrial Peace."* Mr. RAMSAY has the advantage that he has not only lived as a workman, but that he has a knowledge of commercial and industrial organisations. He is thus qualified to speak from practical experience on both sides. He does not hesitate to criticise both Capital and Labour, and we are in agreement with him in the view that criticism is merited by both parties. There is no question that many employers are not sufficiently broad-minded, and many do not realise their responsibilities. We think, however, it must be admitted that the most disquieting feature is not in regard to the employers; it is the fear that Labour may make not merely legitimate demands, but demands which are excessive and impossible. This fear is supported by a resolution adopted by trade unionists in 1916. From the workman's point of view, the proposals embodied in this resolution are no doubt excellent and desirable; but from the employer's point of view they are impossible, unless the workers are prepared to offer some compensating advantage.

Mr. RAMSAY points out the futility of making excessive demands. He also refers to many labour questions, and makes criticisms sympathetically, but without hesitation. He deals with such questions as the effect of raising the wages of unskilled men, the education of foremen, the possibility of increasing production by both employers and employees and the mental attitude of Labour. When we come to the question of increasing production, the figures given by the author for the output per man per annum give rise to considerable misgiving. A case is quoted in which the output per man per annum in an American organisation is £805, whereas the corresponding figure in sound British concerns has varied from £250 to £450. The output per man is a figure of vital importance, and if this figure, in a country with which we are in competition, is double our figure, the handicap so placed on the English employer puts him at a terrible disadvantage, and may threaten the very existence of our industries. There is also the important factor that men in the United States have no objection to working under conditions of speeding up, nor to analytical watchfulness, which the workmen of this country would not tolerate for a moment. The result is that, not only do they get through more work, but they earn higher wages.

If there is to be industrial peace after the war, there is no question that the attitude of Labour must be different in the future from what it has been in the past. This fact, we are glad to see, is already recognised by many trade union officials, but what of the rank and file? Will they also be prepared to accept the position? Here it is, we fear, that difficulties will arise. It must, however, be recognised by trade unionists that they form only a section of the State, and, in the words of Mr. RAMSAY, they must cease to act as if they are a body at war with authority.

Mr. RAMSAY makes certain suggestions with a view to stopping strikes. He does not mention Workshop Committees nor Joint Industrial Councils, as suggested in the Whitley Report, which is rather curious considering that the book was published this year. Apart, however, from these important means of avoiding friction, there should undoubtedly be some method of preventing strikes after an agreement has been reached. The suggestion made by Mr. RAMSAY is that trade union funds should be liable to penalty when the men remain on strike—assuming, of course, that an agreement has been reached. We doubt if this suggestion will be acceptable to the trade unions; but it is certainly desirable that the rank and file should not have it in their power to take up an attitude in defiance, not only of their own officials, but of the Government also.

Mr. RAMSAY also makes a suggestion for limiting the profits of companies. This is to the effect that a company with an invested capital of not less than £50,000 should not pay a dividend higher than a specified figure; but that, in the event of a higher dividend being earned, half the excess profit would be paid to the State and half would be left in the hands of the company for the express purpose of extending plant and buildings. There is, no doubt, something to be said in favour of such a suggestion; but it appears to us that limitations of this kind always suffer from the defect that if the State is to limit profits on the one hand they should guarantee minimum profits on the other. Why should many shareholders lose their money, or receive nothing for it, if, when a concern is successful, they are liable to have their profits limited to a certain figure? This is one of the many thorny points with which the questions of Capital and Labour abound, and with which Mr. RAMSAY deals in a practical way. We commend his book to our readers, who should certainly make themselves familiar with these most important problems.

*Constable & Co. 3s. net.

Reviews.

The Lighting Art: Its Practice and Possibilities. By M. LUCKIESH. (London: Hill-Publishing Co.) Pp. ix.+229. 10s. 6d.

This volume adds another to the considerable series that have recently appeared dealing with illuminating engineering. The author aims at discussing lighting problems in a simple manner, dwelling on "common sense" considerations, and artistic principles, rather than on technicalities. Consequently there are relatively few calculations in the book, except a few included under "Computations and Data" (Chapter XXII.)

In the early part of the book he traces the general development of the art of applying light in the service of man, and seeks to show how the expert illuminating engineer may be expected to develop. Chapters are devoted to "The Expressive Possibilities of Light," "Variety in Lighting," and "Distribution of Light." Subsequently the influence of colour in illumination is dealt with, the ground covered under this head being generally similar to that in another recent volume by the same author ("Colour and its Applications").

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In dealing with lighting and architectural effects, the author has some interesting things to say on the use of shadow and contrast; for example, the reversal that occurs when pillars appear dark against a light background by artificial light, instead of the reverse appearance associated with daylight. The design of the portable light is dealt with in some detail, the best height of reading lamps being analysed, and some useful recommendations made. There are other chapters on special aspects of lighting (industrial, stage, public buildings, &c.).

The book is readable, and the author has consistently followed the laudable aim of stating ideas in simple non-technical terms suitable for the general public. There is a need of books of this kind. At the same time parts of the book appear somewhat discursive, and, as we observe that the author has other works still in the Press, we would caution him to avoid undue expansion and repetition.

A Temperature Conversion Table. (Cambridge Scientific Instrument Co.) 6d. post free.

A very useful chart has been issued by the Cambridge Scientific Instrument Co. to facilitate the conversion of degrees of temperature from Fahrenheit to Centigrade, &c. The two scales of temperature are inscribed side by side in red and black ink, and are arranged in an ingenious spiral form, which permits of considerable accuracy and is conducive to economy in space. In addition, the conversion formulæ are stated at the foot of the chart. The remaining space at the sides of the chart are devoted to a number of useful tables of melting and boiling points, melting points for standardisation purposes, specific heats, thermal conductivities, &c. The chart will be useful to all those concerned with temperature measurements, both in laboratories and in metallurgical works where temperature-measurement is now carried on in a much more precise manner than was the case a few years ago.

Lloyd's Diagram for Calculations. By H. G. LLOYD. (London: E. & F. N. Spon, Ltd.) 2s. 6d. net.

This card-calculator, designed by Mr. H. G. Lloyd, is intended to facilitate simple multiplication and division, proportions and the determinations of square and cube roots, &c. It utilises two similar numbered horizontal scales with vertical scales at either end, products of numbers, &c., being obtained by reading on cross lines, which intersect the horizontal and vertical series of lines drawn from corresponding points on the two pairs of scales. For simple calculations this chart would, no doubt, be useful, when a little practice in its application has been attained. It is, of course, on the lines of the slide rule.

Terms of Industrial Peace. By A. RAMSAY. (London: Constable & Co.) Pp. ix.+144. 3s. net.

We deal with this book in our leading article.

Some Transient Phenomena in Electrical Supply Systems.*

By Prof. E. W. MARCHANT, D.Sc.

(*Concluded from p.* 64.)

Summary.—This Paper records a number of oscillograms taken on the Liverpool Corporation electric supply system. In order to explain the results observed on the central station records, a number of tests are included of similar phenomena observed under laboratory conditions, in which the instant of closing circuit has been controlled. The theories of the various transients are discussed.

CURRENT-RUSH ON SWITCHING-IN UNDERGROUND CABLES AND CONDENSERS.

When high-tension transmission lines and cables of great length were first installed the rise in pressure and the rush of current to the cable which was liable to occur when the cable was first switched in, were hardly appreciated. Later on the cable was often connected first through a high resistance, usually a water resistance, and then direct to the line in order to avoid pressure rises. Nowadays a large factor of safety is used in the design of cables and insulators and such devices have become less necessary. In this country long lengths of underground cable are used, which have a comparatively small inductance. An unloaded feeder is usually switched on by connecting it through a transformer to a number of generators. The transformer has considerable inductance due to magnetic leakage and the generator also possesses inductance. The conditions may be represented by an inductive circuit which is suddenly connected to a condenser, and may be readily reproduced in the laboratory.

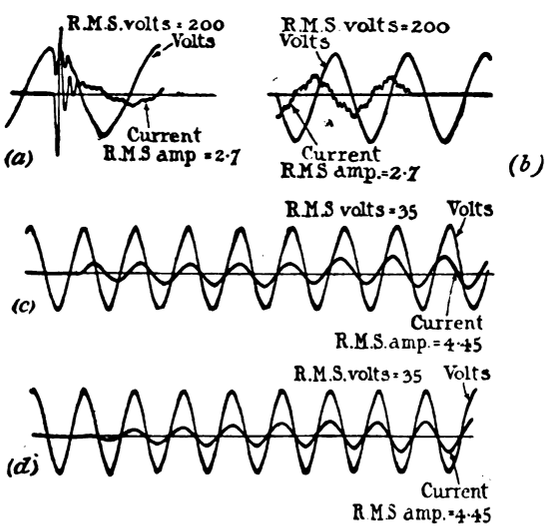

FIG. 4.

In order to demonstrate the effects which may be expected under such conditions, a number of records have been made of the current and P.D. on a condenser at the instant of closing circuit, several of which, referring to a 30 kw. 200-volt 50 ∿ alternator, are reproduced in the original Paper.

There are three possible conditions of circuit which will produce varying results at the instant of closing circuit, namely:—

1. That in which the values of the capacity and inductance are such as correspond to a natural frequency higher than the working frequency.
2. That in which the natural frequency corresponds to the working frequency (the resonant case); and
3. That in which the natural frequency is lower than the working frequency.

There is also a fourth case—*i.e.*, when the resistance of the circuit is so high that the circuit is non-oscillatory.

The only case where there is any serious danger is the first, and the condition of high natural frequency is much the most common. The surge depends upon the instant at which the switch is closed, and rapidly dies away, the decrement being controlled by R/2L the ordinary decrement factor in an oscillatory circuit.

In order to illustrate these effects, tests were made in the laboratory with a condenser of 45 mfd. capacity. In these tests (*see* Fig. 4,*a*) the natural frequency of the condenser and machine was found to be 12 times the frequency of the system. The actual maximum rush in this case is about nine times the maximum value of the steady charging current.

The pressure-rise is marked, being over 30 per cent. above the peak. The circuit was then adjusted by inserting additional inductance until resonance was obtained. Fig. 4 (*c*) shows a switch-in at the maximum point on the wave of P.D., and Fig. 4 (*d*) the corresponding switch-in at the zero point on the wave of P.D. All high-frequency oscillations have disappeared, and the current rises gradually to the full value.

In the feeder-switching experiments, on cables with a length of cable used 3½ miles, the surge was found to be quite small. Tests

* Abstract of a Paper read before the Institution of Electrical Engineers.

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were also made in which the cable was switched off at the sub-station and the pressure at the central station observed. Two records are given in Fig. 5, one corresponding to a switch-in and the other to a switch-off near zero current. There is no appreciable pressure-rise in either case, and little or no evidence of pressure-surge. In a third series of tests made at a sub-station about midway between the ends of the feeder, the author noted a 25 per cent. rise in pressure.

PARALLELING OF ALTERNATORS.

The transient currents which flow when alternators are switched into parallel are well known, and the theory of parallel running has been fully developed. A few oscillograms, however, are given by the author in the original Paper. It has been shown that the reactance of three-phase alternators to currents of triple frequency is very small compared with that offered to the main-frequency current. Consequently, the component of the current circulating between two machines, even when the pressure wave has very small

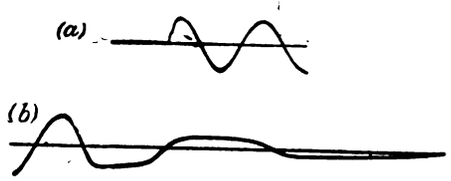

FIG. 5.

harmonics, will be likely to contain a strong third harmonic of current if all neutral points are earthed. A very strong fifth harmonic of current was present. The records presented emphasised the fact that it takes two or three periods to open a circuit with the heavy gear required for controlling 1,500 kw.

The current which flows when the machine is paralleled depends upon two factors—*i.e.*, the phase relationship between the E.M.F. of the incoming machine and the 'bus-bar pressure and the exact relative speed of the machines at the instant of closing circuit. Though paralleling can be effected with certainty, very nearly at the same phase instant, there may be variations of as much as 1/20th of a period in the time of closing circuit. This variation produces considerable difference in the currents which flow between the incoming machine and the 'bus bar, which the author also illustrated showing the limits of variation which may occur under ordinary working conditions with a good switchboard attendant.

In an appendix to the original Paper the equations of Steinmetz, enabling current and pressure rises to be dealt with theoretically, are given, and a bibliography is added.

DISCUSSION.

Prof. J. A. FLEMING said the Paper recalled his experiments of more than a quarter of a century ago. He thought he was the first to describe and explain these current rushes in transformers, such as were observed on the Deptford trunk mains. He gave in his Paper before the I.E.E. 26 years ago what he thought was the reason for these effects—viz., that it was due to the particular phase of the magnetisation in which the transformer was left when it was last switched off. He remembered a curious case of a transformer with an open magnetic circuit—a rather short one—which could not be taken off the circuit when once it was put on, if the secondary circuit was open, without making a powerful arc at the switch circuit. The Paper gave the explanation of that. It was soon seen that the rushes into the mains depended upon the phase and the E.M.F. at which the switch was closed. He gave the elementary theory of that in a book at that time. Since then the Duddell oscillograph had been added to their means of experimenting, and Prof. Marchant had made good use of its beautiful applications. Another instrument which could be used was Braun's cathode ray tube. By examining the movement of a spot of light in a revolving mirror the effects could be seen, and the rushes in the transformer or main were accompanied by increased amplitude. He thought that instrument could be greatly improved, although at the moment it was not so easy to use it for photographic purposes. Further investigation should be made as to what happened at the closing and opening of the switches, and also as to means of controlling the phase. There were switches which enabled one to open the circuit only when the E.M.F. was at zero value. He presumed the oscillograms Prof. Marchant had shown were actual photographs taken with the oscillograph. They showed very beautifully that the current rush took place at the instant the switch was closed when the E.M.F. was at the maximum; but if the switch were closed when the E.M.F. was almost at zero there was no irregularity.

Mr. A. R. EVEREST said the diagrams showed that the potential was taken between two of the lines, while the current wave was the current in the third line. He thought that might be misleading. There might be a pronounced third harmonic or ninth harmonic in the voltage of each individual phase of the machine, while it would not show between lines. Therefore a pressure curve taken between the other two lines was not an indication of the pressure wave in the phase of which the current was being measured. Did Prof. Marchant think the method of connection was undesirable on that account for general use, and what means would he suggest for avoiding the troubles that arose in these switching operations? What procedure would he recommend to avoid leaving the transformer in an undesirable condition? It had been suggested that the combination of transformer and converter should be disconnected bodily from the alternating-current mains, leaving the transformer to die down on its magnetism as the rotary converter died down. What did Prof. Marchant think of the suggestions that had been made with regard to pressure surges on induction motors of having one terminal of the stator winding connected to the line, and, secondly, the suggestion that one phase of the rotor circuit should be left closed before the switching operation took place.

Prof. J. T. MCGREGOR MORRIS said, with regard to the induction motor tests, as far as he could see the rushes that the author had examined were rushes of current. Mr. Everest had drawn attention to the fact that there were pressure rises which were much more dangerous. He had known a fairly large motor to spark between the rotor and stator when switched into circuit, which indicated a rise of pressure. Had the author obtained any results which showed those rises? Prof. Fleming had dealt thoroughly with current rushes in transformers, and he had mentioned several means of detecting them. A simpler method of demonstrating them was shown him (Prof. Morris) by Mr. Clinker at the B.T.-H. Works many years ago. He used a direct-current ammeter having a centre zero. These instruments were more robust now than formerly, and could safely be switched on into an alternating-current circuit, so that the alternating current passed through the shunt of the direct-current instrument. If that were done several times one got occasionally a big direct-current rush which was seen as a big swing in the ammeter; this slowly worked back, the alternating current not being capable of sending enough current through to make the needle do more than the slightest trembling. Sometimes the rush would last 30 seconds with a 50 kw. transformer, but that was 15 years ago. Transformers could now work at higher flux-densities and lower frequencies. Could the author give a quantitative idea of the time these rushes would last? In a big transformer they lasted longer than in a small one.

Mr. H. BRAZIL said he had records taken during the last 14 years on a supply system, and which showed the presence of rises of pressure due to various causes. A simple apparatus which he designed, and Mr. Patchell described in his Paper in 1904, was used. The horn gap arresters of the apparatus were set to work at 50 per cent. above the normal pressure of the system—a 10,000-volt system. Amongst the causes of the oscillations were the following: In running up a generator to speed all the frequencies up to the full frequency were passed through, and at some of them there was resonance. This was so serious in the case he mentioned that they had to stop running up the generators with the cables connected. Another trouble was the linking in of 'bus-bar sections. Mr. Duddell, in his Paper on "Pressure Rises," showed the difference made in the pressure rises by a slight alteration in a piece of cable connecting one piece of 'bus bar with another He helped Mr. Duddell in taking those tests. Substituting about 25 ft. of paper cable for 25 ft. of rubber cable obviated the rise of pressure as indicated by the sparking over of the horn arresters. Instrument transformer breakdowns produced surges which caused damage, and "shorts" in cables were prolific in surges. Short-circuits in machines were another cause, and the inquisitiveness of rats about the edible properties of the cables on the 'bus bars caused arcs. Variation of speed due to governors not working properly was also sufficient to cause the arresters to spark over, due to the rising and falling speed getting into the danger zone of resonance, which he thought was the main cause of most of those troubles. There was a rise of pressure when switching in induction motors, and the arrester horns sparked across. He got over the trouble of breaking down of test coils by putting a choking coil in series with the switch before switching the stator in.

Prof. G. W. O. HOWE said the method of putting a continuous-current ammeter in series with an alternating-current ammeter was sometimes used in the laboratory for demonstration purposes. Even with a 5 kw. transformer the effect seemed to last a minute or two, and sometimes it settled down with a certain amount of symmetry, and afforded a reading for a long time afterwards. The author said "during the third quarter period after switching in the flux changes from negative to positive, and the current required to produce it does the same"; but that would not be at the same moment. On account of hysteresis, that change would occur at a different time. The author also stated that "the iron in this state being in a condition in which it has a very high permeability, it follows that a comparatively small increase in current is required to produce the necessary change of flux through the core." That would be exactly expressed by saying it was not the ratio of B to H that was important, but the large ratio of dB/dH. On coming down to the coercive point, the permeability of the iron was zero. By "skew symmetry" apparently the author meant that two half-waves were not similar, but that what happened at the beginning of one was at the end of the other. That could not be due to hysteresis apart from magnetisation. An even harmonic would not be obtained if the iron were completely demagnetised. The question why the dissymetry died away was an interesting one. He thought it was due to the greater pressure drop in one direction than in the other. The transformer had to deal with a smaller E.M.F. in one direction than the other, and it gradually restored the symmetry. If so, that suggested that a way of getting over the trouble would be to have a resistance at the transformer. It need only be in a minute or two. With regard to switching in the induction motor, the author said that in two instances shown in the Paper the amplitude

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of the current rush was the same, but the duration differed. This was apparently because the copper of the rotor acted as a screen to the flux, and therefore there was the same rush initially whether the rotor was running synchronously or non-synchronously. The numbers attached to harmonics (as in the case of the 30 kw. alternator connected to a 15 mfd. condenser referred to by the author) were a little uncertain. He supposed the number of teeth in the alternator per pole and phase was such that one would expect to have a ripple with a frequency 18 times the frequency of that fundamental, and then, if one measured the time elapsing between two of those ripples, it would be found to be 1/18th of that period. The ripple, like a surge, grew and died away, and if it were analysed it would give a 17th or 19th harmonic, and, though one gave a slightly larger current than the other if it went into a condenser on account of the higher frequency, there was no point in favouring the 19th compared with the 17th.

Mr. F. P. FLETCHER said he had had trouble some years ago with current surges on switching in induction motors, and on switching in feeders, and also with extreme pressure rises. In one case it was so bad that it was impossible to use all the feeders in parallel at one time. To keep the pressure up, the periodicity had to be reduced at the main station and the alternator run with the strongest excitation that could be got. Such matters if discussed now would give operating engineers an idea of a few of the difficulties they had in the past.

Mr. H. W. TAYLOR said the author referred to two alternators in parallel at Lister Drive with a fifth harmonic circulating between them. The wave form was the resulting wave form of the two alternators, and when the switch was opened the wave form was that of the alternator that remained. Mr. Everest and he, when those alternators were being made, eliminated harmonics as far as possible: but there was a fifth harmonic in the older alternator when running by itself. Putting alternators in parallel was the right means of eliminating harmonics from the voltage wave. As a system grew, and its voltage tended towards a sine curve, the harmonics gradually disappeared as more plant was put on the system. A similar point arose with regard to the third harmonic between the line and the neutral. The third harmonic only existed across lines in special circumstances, but was frequent between line and neutral. It was best not to try to eliminate them entirely, but to eliminate them partially by connecting the neutrals through earthing resistances. The means taken to eliminate the stresses in alternators so that they should not be damaged by short-circuits were not applicable to induction motors, as they had to have the minimum amount of internal reactance. The author referred to a low frequency surge which took place in the line after the switch was opened. This was the result of an exchange of electromagnetic and electrostatic energy in the cable. The energy first had one form and then the other, and then gradually disappeared through resistance and dielectric stresses, and finally damped itself out.

The PRESIDENT said he was reminded of an incident of 25 years ago by the author's and Prof. Fleming's references to the early days of the experiments on current rushes. He was on the staff of the London Electric Supply Corpn. at that time, and he first noticed these phenomena in connection with the switching on of transformers, and suggested that it might be due to the state in which the iron was left in switching off. The matter was referred to Prof. Fleming, who was advising the company, with the result that they got a full explanation. He remembered that the rush was so violent that the transformer jumped off the floor.

The AUTHOR, replying to the discussion, said the Paper did not profess to give anything that was very new. He was sorry he had not referred to the original investigations Dr. Fleming had mentioned, and which were recorded in the "Journal" of the Institution 25 years ago. In the bibliography in its complete form he would refer to those experiments. The phenomenon of current rush in transformers was, of course, an old one, but it should be emphasised nowadays, because it was becoming much more important with the low frequencies and large transformers now being used. He hoped it would be possible to make many tests with oscillographs on large oil switches, from which he was sure very valuable results would be obtained. In reference to Mr. Everest's remarks, the chief function of the pressure waves in his curve was the timing function. He had not tried to get any pressure rise, but only investigated the current rush. For the pressure rise the oscillograph should be put between the neutral and the terminals, and so measure the pressure between the neutral and the phase on the coil connections. The suggestion to avoid remanent magnetism in the iron by allowing the transformer and rotary to come down together was a good one, and would prevent the rush reaching such large values as it would if remanent magnetism were left in the iron. Prof. McGregor Morris referred to pressure rises. He had not observed pressure rises of such a value as to cause sparking between the stator and the rotor. The use of a direct-current ammeter for investigating these rushes was a simple way of seeing how long the rush lasted. In tests made with a 100 kw. transformer he got a rush which lasted two minutes or more, and with a 1,500 kw. transformer the rush did not seem to last very much longer: but the evidence one had of the strong hum in the transformer lasting for as much as 30 minutes showed clearly that the effect did last under very unfavourable conditions for a very long time. He hoped they would have Mr. Brazil's information about pressure rises in the "Journal." He agreed with Prof. Howe that dB/dH was the real criterion of the change in the current curve. The curious phenomena shown in Fig. 1 of an actual increase in the current of 15 or 20 periods was due to the continued strong magnetisation actually increasing the magnetisation in the core up to a certain point and then dying away. He thought the magnetisation would die away owing to natural causes if alternating magnetising forces were applied on the iron. He got the number of harmonics by simply counting It was a purely experimental result. The frequencies came out at about 19, but there might have been a 17 as well. Mr. Taylor raised a point with regard to the method of eliminating harmonics by paralleling alternators. Of course that could be done. If two machines with bad wave forms were paralleled on each other a better result was obtained. He thought the pressures he had mentioned as having been recorded at Lister Drive were on the 6,000 kw. machine. None of the pressure curves on any of the machines at that station were bad. It was a surprise, therefore, to find that the synchronising current between those machines was so irregular. A third harmonic would not be obtained on the pressure wave when pressures between the phases were being taken. He did not take the pressure between the neutral and the phase. Having a big capacity across the transformer or induction motor was certainly advantageous. With a large safety factor on the cable it was safe to switch off the transformer with the cable connected, and the cable would tend to keep down the pressure rise. But if the machine was very good and the cable was not, it was better to switch off the transformer independently of the cable.

Correspondence.

ELEMENTARY PRINCIPLES OF CONTINUOUS CURRENT ARMATURE WINDING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am obliged to Mr. Maccall for giving the precise reference to what he thought was my "claim for multiple windings that they simplify the design of brush gear," but I note that the quotation he gives is an abbreviated one. The words he has omitted are essential to the right understanding of the quotation which should have read "[in] a four-pole machine to deliver 4,000 amperes four paths would not be sufficient, since 1,000 amperes per brush is excessive, on account *both of commutation and* of the mechanical difficulty of designing sufficiently rigid brush gear. Eight paths would simplify the design . . ." The words which Mr. Maccall omitted I have put in italics.

My meaning was that the design of the whole machine would be simplified because, as explained in the context, the conditions of commutation would be improved.

In preparing the article for publication in book form I will bear in mind Mr. Maccall's criticism and see if I can improve the wording. I am sure there are many places in which the wording might be improved. Probably also the article contains actual errors. Of these I should like to be informed.—I am, &c.,

London, May 26. F. M. DENTON.

THE EDUCATION OF ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the review of my book "The Education of Engineers" on May 10, you disparage my remark that "for an engineer who has to make his way in life the worst thing he could possibly do is to become educated." Immediately following, in the same article, you yourself expound the difficulties which beset not only engineers but any proposed scheme for the education of engineers. I think, from your article, that we shall agree upon the following conclusion: Under present conditions a man may be an engineer or he may be educated, but, except by a lucky accident, not both; therefore if he means to be an engineer he had better not try to become educated.

I have endeavoured to show in the book that science is the salt and not the food of engineering, and should therefore be administered only when and where required. I submit that you draw an exaggerated conclusion in your remark that a boy should work "without appealing to the aids of science." This is neither stated nor anywhere implied.—I am, &c.,

London, May 22. HERBERT G. TAYLOR.

[We fear that we cannot agree with our correspondent. Although we admit there are difficulties in the education of engineers, this is not the same thing as admitting that engineers should not attempt to become educated. With regard to our correspondent's last paragraph, we have not his book by us at the moment, so that we cannot check his statements, but certainly the impression left on our mind by his book was that given in the article.—ED. *E.*]

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Proposed Engineers' Club for the Midlands.

In our last issue we referred to the project announced at a meeting in Birmingham on May 15, of forming an Engineers' Club for the Midlands. In what follows we give a short account of the proceedings.

In opening the proceedings the chairman, Dr C. C. GARRARD, M.I.E.E., remarked that in the future a great responsibility would rest upon engineers and upon all occupying leading positions in the engineering industry, in connection with the work of reconstruction rendered necessary by the war. It was felt, however, that, as a body, engineers did not have the power corresponding to their abilities. This was no doubt due to their being so scattered and split up into a large number of organisations which had very little contact with each other. It was felt that the first thing to do to get over this state of affairs was for engineers and those associated with them technically to get together and to know each other. The result would inevitably be co-operative action, which would undoubtedly result not only in advantages to engineers themselves, but in great benefit to the country.

Guided by these considerations the idea had arisen to found an Engineers' Club in the Midlands. Many of his hearers no doubt knew that a very successful Engineers' Club on the lines indicated was in existence in Manchester, and that Club had intimated its willingness to render all the assistance possible in the founding of a similar club in Birmingham.

The enthusiasm with which the idea had been greeted by everybody concerned showed that such a club could be undoubtedly formed successfully, but it was very doubtful whether it could be got actually running during the period of the war. Nevertheless, if this be not possible the preparations and preliminary organisations could certainly be carried out.

The idea underlying the organisation of the club was that it should offer all the advantages of a first-class social club combined with facilities for meetings, lectures, &c. It was thus hoped that it would become the meeting place of the various technical societies in the district. Such a common meeting place for these societies had been long desired in Birmingham.

It might be added that the present scheme was part of a larger idea whereby such engineers' clubs would be founded in all the large engineering centres in the country. These it was hoped would eventually become federated together so that members would not only have the practical advantages of the use of the club houses in their travels, but the club would from centres of engineering activities in each locality.

After discussion it was resolved to form a club, and the meeting then proceeded to form two committees on finance and general arrangements and rules and propaganda. Dr. C. C. Garrard, of the General Electric Co., and Mr. J. Fearn, of the Birmingham Small Arms Co., Ltd., were elected provisional chairman and honorary secretary respectively.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W.1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Captain of the Week.—Captain W. Hynam.

Next for Duty.—Captain W. Darley Bentley.

Captain C. Higgins, R.E., T.F., assumed duty as Adjutant May 23, 1918.

Appointment.—Corporal. Smout to be Instructor of Physical Training (6/5/18).

Monday, June 3.—No. 3 Company, 6.30–8.30. Recruits' Drill, 6.30. Signalling Section, 6.30–8.30.

Tuesday, June 4.—Lecture on Demolitions, 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, May 5.—No. 1 Company, Drill, Knotting, &c., 6.30–8.30. Recruits' Drill, 6.30.

Thursday, June 6.—No. 2 Company, Drill, Knotting, &c., 6.0–8.0. Recruits' Drill, 6.30. Signalling Section, 6.30–8.30. Ambulance Section, 6.30–8.30. First Field Dressing Demonstration, 6.0. Band Practice, 7.0.

Friday, June 7.—Musketry for the whole Corps, 5.30–8.0.

Saturday, June 8.—Entrenchments, &c., for the whole Corps, 2.45 4.45.

Sunday, June 9.—Commandant's Parade at Waterloo Station, 8.45 a.m., for work at Esher. Dress: Drill Order with Haversacks and Water bottles, Rifles. Midday and tea rations to be carried.

SPECIAL NOTICES.—All drills will take place at headquarters unless otherwise stated.

The medical officer will attend for the examination of recruits on Thursday evening at 6.0.

Summer Camp.—Arrangements are now being made for this Camp to start on August 3

Commercial Topics.

The Trading Community and War Bonds.

In the issue of the "Financial Times" of the 17th inst., Mr. T. B. Johnston, managing director of the Bristol Pottery, suggests an interesting method by which the trading community could materially increase their holdings of War Bonds, and at the same time introduce a custom which would be of great benefit to the trading community after the war.

The suggestion is to enact legislation making it compulsory to adopt the French system of sending with every invoice or statement an acceptance at, say, three months. In France the acceptance is signed and returned by the customer, either direct or through the bank. The French custom is attracting a good deal of attention in commercial circles in this country and in America. Among the advantages claimed for the system are that the use of trade and bankers' acceptances would be greatly encouraged, rigid open book credits would be replaced by liquid commercial paper, the pernicious practice of deducting unauthorised and unearned discounts would be prevented and it would check the practice of returning merchandise, while it would systematise and regularise our methods of credit; the stamps on the bills would provide a fruitful source of revenue, while—what is important at the present time—it would greatly increase the sale of Government War Bonds, thus mobilising the whole of the ledger accounts throughout the country.

* * * *

Deficits on Electricity Undertakings Due to War Restrictions.

Ealing Town Council has adopted the following recommendation of its Electricity Supply Committee:—

That it is not desirable or expedient to meet the anticipated deficiency on the electric supply undertaking by making any further increase in the price to be charged for the supply of electricity: that it would be a fair and practicable method of enabling the undertaking to meet the annual deficiency until the obstacles as to the supply of coal and other materials, lighting restrictions, &c., have become less formidable, that the deficit for each year should be provided by suspending payment to any sinking or other similar fund of so much as is due to that fund for repayment of principal money raised on loan for the undertaking as is equal in amount to the deficiency for that year, provided, however, that such suspension shall be limited in any year to an amount not exceeding a moiety of the amount due or payable to the said fund for that year.

Copies of the resolution have been sent to the L.G. Board and to the Incorporated Municipal Electrical Association, urging them to take action to bring the suggestion into practical operation without delay.

* * * *

Lead for Vehicle Batteries.

The Electric Vehicle Committee, acting in conjunction with the Accumulator Makers' Section of the British Electrical and Allied Manufacturers' Association, having represented to the Controller of the Priority Department of the Ministry of Munitions the desirability of increasing the amount of new lead allowed to be used in the repair and maintenance of batteries under the special battery permit issued to accumulator manufacturers, where batteries for electric vehicles are concerned, the Controller has now consented to an addition to clause 15 of the special battery permit held by members of the Accumulator Makers' Section of the B.E.A.M.A., to come after the words "Not exceeding 1 cwt." the words, "Or in the case of electric storage batteries used as the motive power for propelling electric vehicles 3 cwt., and provided always, &c."

This addition has been designed to enable accumulator manufacturers who are makers of electric storage batteries for use on electric vehicles to repair and maintain same without the necessity of individual application for permits being made to the Priority Department.

* * * *

Pan-American Trade Marks Union.

The U.S.A. Treasury has appointed a director of the International Bureau for the Registration of Trade Marks at Havana, which is being established to carry out the terms of the convention in regard to an international system of registering trade marks adopted at the Pan-American Conference at Buenos Ayres in 1910. Havana is to be the centre for the countries of North and Central America and the West Indies, and Rio de Janeiro will be the centre for the South American countries. By the payment of $50 a trade mark will be registered in all the countries that have ratified the convention.

* * * *

U.S.A. Copper in 1917.

The production of copper in 1917 was slightly less than in 1916, but the value was higher.

At an average price of about 27 cents a lb., the output for 1917 was valued at $510,000,000, against $475,000,000 for 1916 and $190,000,000 for 1913. The figures showing the smelter production from domestic ores represent the actual output of most of the companies for 11 months and the estimated output for December. A few companies gave no figures for November, but furnished estimates of the combined output of November and December. The production of blister and Lake copper from domestic ores was 1,890,000,000 lb. in 1917, against 1,928,000,000 lb. in 1916 and 1,224,000,000 lb. in 1913. The output of refined copper

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(electrolytic, Lake, casting and pig) from primary sources, domestic and foreign, for 1917, is estimated at 2,362,000,000 lb., compared with 2,259,000,000 lb. for 1916 and 1,615,000,000 lb. for 1913.

The imports of unmanufactured copper of all forms for the first 10 months of 1917 amounted to 460,780,000 lb., against 397,594,000 lb. for the first 10 months of 1916. The imports for 1916 were 462,335,000 lb. The exports of pigs, ingots, bars, plates, sheets, rods, wire and like copper products for the first 10 months of 1917 amounted to 953,876,000 lb., compared with 655,473,000 lb. for the first 10 months of 1916.

Electricity Supply.

Extensions.

Eedford.—The Council has received the sanction of the L.G. Board to borrow £5,713 for the electric supply undertaking.

Newbury.—The Rural Council has approved plans for a new boiler house and electric lighting plant at Douai Abbey.

St. Pancras (London).—The electrical engineer (Mr. S. W. Baynes) recently applied to the Ministry of Munitions for sanction to the installation of two additional 3,000 kw. Ljungstrom turbines at King's-road station, but are only prepared to consider an application for one set.

If one set only is proceeded with, the estimated cost would be £24,800, against £41,900 for the two sets. The Electricity Committee has decided that as soon as the approval of the Ministry of Munitions is received, a contract will be entered into with the Brush Electrical Engineering Co. to provide either one or two Ljungstrom turbines at a cost of £17,900 each.

General.

Armagh.—The Urban Council has refused to allow the local gas company to erect poles and overhead electric cables, as the majority of the councillors are of opinion that the scheme should be a municipal one.

Burton-on-Trent.—The Gas and Electricity Committee has been authorised to purchase a new crane at £1,230.

Dublin.—At the meeting of the Port and Docks Board last week it was reported that the cost of the supply of electric power for the War Department hay pressing installation would be borne by the military authorities.

Ald. BYRNE, M.P., said the Corporation should get the same facilities for supplying the electricity as the tramway company or any other body, and as a member of the Electricity Supply Committee he objected to the action of the Government in pampering companies against a popularly elected body like Dublin Corporation.

The chairman (Ald. MORAN) said that if they could get the converter plant a supply could be given, but it would be a very foolish thing of the Corporation to do, as that was merely a temporary measure.

Mr. FIELD, M.P., opposed, because he thought that all these public utilities should be under the control and jurisdiction of public bodies.

The recommendation of the Engineer was, however, agreed to.

Edinburgh.—Last week the Council decided to appoint a deputation, consisting of the Lord Provost, the Convener of the Electricity Committee, and the resident electrical engineer (Mr. F. A. Newington) to wait upon the Minister of Munitions in order to urge the necessity of provision being made at an early date to meet the needs of their area for an adequate supply of electricity. Leith Corporation will also join in the deputation.

It is suggested that, as the Leith generating station is fully loaded and the Edinburgh stations are practically in the same condition, the Ministry should consent to an instalment of the plant at the new station at Portobello, from which Leith could also be supplied.

Electric Power Supply in Notts and Derbyshire.—A meeting of persons interested in the coal and iron industries met at Mansfield on Saturday in order to learn from Mr. A. B. Gridley the nature of the proposals of the Government in regard to the unification of electricity supply in the Notts and Derbyshire district, and to discuss the advisability of linking up with the South Yorkshire scheme.

Representatives were present from Nottingham Corporation and most of the local colliery companies. Mr. Maurice Deacon (Sheepbridge Coal & Iron Co.) presided over the meeting, which was initiated by Mr. C. P. Markham (Chesterfield), representing the Staveley Coal & Iron Co. It was resolved to form a committee to consider a scheme similar to that adopted by Nottingham Corporation, and that an expert be engaged to present a report upon the best means of providing an electric supply for the district, having regard to the report of the Coal Conservancy Board.

Hackney (London).—The Establishment and General Purposes Committee recommend that the salary of the electrical engineer (Mr. L. L. Robinson) should be increased from £750 to £850 per annum as from April 1, 1918, with annual increments of £50 to £1,000.

Nuneaton.—At the meeting of the Council on Thursday last it was announced that there was a deficit of £2,000 on the past year's working of the electricity undertaking.

Tottenham.—The Engineer reports that 139 arc lamps have been removed and overhauled, and 67 incandescent lamps substituted, the total cost being £182. 5s. When the arc lamps are re-erected an additional charge of £95 will be made.

Weardale.—The Rural Council is recommended to enter into negotiations with Messrs. J. Rogerson & Co. for the supply of electricity for public lighting.

Workhouse Lighting.—Tavistock Guardians have decided in favour of electric lighting for their workhouse.

Houghton Guardians have decided to adopt electric lighting in their board room.

Electric Traction.

Edinburgh-Queensferry Tramway.—The Midlothian County Council will oppose the provisional order for the construction of this tramway in order to secure protective clauses.

Kilmarnock.—The Council has abolished ½d. tramway fares and the other stages have been readjusted and the fares increased.

Liverpool.—The Committee recommend the City Council to authorise a revision of the existing fares.

The Tramways Committee recently obtained priority certificates for certain materials enabling four additional cars to be placed on the Everton and North Docks routes and two cars on the Great Howard-street route.

Potteries Tramways.—The fares on the lines of the Potteries Electric Traction Co. have been revised.

All ordinary fares up to and including 2d. have been increased by ½d., and fares above that value by 1d. Workpeople's and scholars' weekly tickets remain on the basis of half the ordinary fare. Through tickets over more than one route will be discontinued.

Salford.—Owing to the recent revision of fares, the new tramway tickets will contain a number for the various stages instead of as at present the name of the stage.

The new system will enable the tickets to be used on any route, and will prevent a wastage of paper when alteration of stages are decided upon. The number of the stages will be displayed on the tramway standards, and until the public become educated to the new system the conductors will call out the number of the stage as it is reached.

Tramway Transport.—The chairman of the Leeds Tramway Committee (Ald. C. F. Spencer), who is a strong believer in the use of tramways for transport purposes, reports that an experiment recently tried at Leeds had proved the enormous superiority of electric lorries over the old system of horse transport.

The tramway passes a fireclay concern, which supplies about 50,000 tons of fireclay per annum to a factory some eight miles further along the route. It was found that one tramcar could carry as much fireclay as seven horse wagons in about a quarter of the time. Not only does the tramcar economise in time and labour; it also releases horses and reduces the cost of production.

Tramway Upkeep.—A meeting of the Scottish Tramways Advisory Committee was recently held at Edinburgh, Mr. James Dalrymple presiding.

Representatives were present from all municipal and company-owned tramway undertakings in Scotland. The principal business was the grading of the various undertakings into classes, in view of the probable introduction of a priority scheme for the distribution of material for the upkeep of the different systems. The Committee's recommendations on the matter will be submitted to the Board of Trade.

Tramway Workers' Wages.—At a recent conference of local authorities which own tramway undertakings it was decided to ask the Executive Council of the Municipal Tramways Association, with one Corporation representative from each of the nine areas determined by the Tramways (Board of Trade) Committee, to deal with demands which may be made nationally for the application of 12½ per cent. bonus to certain grades of tramway employees.

The new body has already been constituted, and has had to deal with applications from various districts, including one from Dundee and district.

Women Tramcar Drivers.—Walthamstow Urban Council has decided to employ women tramcar drivers.

Imperial Notes.

Australasia.—Ararat and Stawell (Victoria) Councils are discussing a proposal to obtain a supply of electrical energy generated by the water-power from the Grampians.

Prof. J. G. Pickert, of Stockholm University, has suggested that a general scheme of electric power generation in Australia, combining water-power and steam-power plants, would enable electrical energy to be sold at the lowest possible prices for the electro-chemical industry, besides supplying current for other purposes.

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Tunnelling under Sydney Harbour, for laying electric cables from one side to the other, has had to be abandoned, as, owing to a fissure in the rock bed about 200 ft. below water level, an inrush of water took place. A start has been made on a new tunnel.

The Prahran and Malvern Tramways Trust's traffic receipts for the year ended Sept. 30, 1917, were £171,285, compared with £150,444 for the previous year. There was a loss of £2,647 on the Whitehorse-road line, for which Camberwell City Council is responsible. Working expenses (including power, interest and maintenance) were £154,174. Renewals reserve, loan repayment and sinking funds required £15,710; the amount paid to dependants of employees on active service was £2,798; and the balance (£2,271) has been placed to credit of maintenance reserve account.

Mr. Morrison, of the Geological Survey Dept., reports, on the platinum which has been found near Fifield (N.S.W.), that the platinum occurs as alluvial in a lead or placer deposit 1¼ miles from Fifield. As much as 8½ oz. of platinum have been obtained from 16 loads of wash dirt from the prospector's claim. The average yield from 400 loads from 10 claims has been 4 dwts. platinum and ¼ dwt. gold to the load. Most of the platinum won has been disposed of locally at £8 per oz.

Waikutu (N.Z.) Town Council has obtained a 42 years' licence for the erection and maintenance of electric transmission lines. The maximum charges are to be 1s. per unit for lighting and 6d. for power, heating or cooking.

The Victorian Act (No. 2,920, of Oct. 22, 1917), relating to the purchase of goods, machinery or materials for works undertaken by or on behalf of certain local authorities, enacts that all goods, machinery or materials purchased to the amount of £250 or upwards at any one time by any local authority or by any contractor with the local authority for any works undertaken by or on behalf of the local authority shall be manufactured or produced in the Commonwealth, unless the Minister certifies that he is satisfied that such goods, machinery or materials manufactured or produced in the Commonwealth cannot be purchased, or can only be purchased at an unreasonable price or within an unreasonable time or in insufficient quantities or of a quality unsuitable for the works. There is a penalty of £50 for infractions of the Act.

Miscellaneous.

Alien Enemy Companies Wound up.—On Tuesday Mr. Justice Younger made orders for the compulsory winding up of the A.E.G. Electrical Co. of South Africa (Ltd.) and the Electrical Co. (Ltd.), on account of their enemy associations. The petitioners were the Board of Trade under sec. 1 (7) of the Trading with the Enemy Amendment Act, 1916.

City and Guilds of London Institute.—At the annual meeting on Monday Sir Edward Busk stated that a considerable amount of research work had been carried out.

The laboratories and workshops had been made use of by the Government to a great extent, and the facilities for research had been highly appreciated. The report stated that in the department of technology 8,905 candidates were examined, against 10,184 in the preceding year. There were two centres in France for candidates serving in the Army, and one examination was held on board a warship.

Damages for Electric Shock.—At the City of London Court on Monday, Alice Stevens, a coil tester employed by the Telegraph Construction & Maintenance Co., recovered £45 damages for an electric shock.

Fraudulent Use of Electricity.—At Sutton Coldfield George R. Coles, an electrical engineer, was fined £10 for fraudulently consuming electricity, the property of the Corporation, within the last six months.

Evidence was given that the wiring in the pantry connected with the electric meter was so arranged that the current supplied to the premises was not passing through the meter. Several alterations had been made in the electrical fittings of the house which had not been reported to the electrical department.

Magneto Patents.—Last week the Special Patents Court granted the application of Messrs. Bluemel Bros. for a license to use the German patent 26,436 of 1907 for the manufacture of a sparking plug in the Bosch magneto series of patents.

It was stated that the sparking-plug was largely sold in England before the war by the Bosch firm, but it had not since been obtainable.

The Controller of Patents (Mr. TEMPLE FRANKS) said it was clearly in the public interest that that particular plug for internal combustion engines should be again placed upon the market. Manufacturers of motor cars asked for it, and a royalty would be fixed upon the number of plugs sold. It would not, as heretofore, be a percentage upon the cost or sale price, for prices of material had gone up so enormously during the war that those who benefited by the royalty had no right to profit equally, as against the public, upon the enhanced cost of production.

Registration of University Electors.—We are asked to urge graduates of the Universities of Durham, Manchester, Liverpool, Leeds, Sheffield, Birmingham and Bristol to write to the registrars of their respective universities for the forms of application for registration as electors. Relatives of graduates serving with H.M. Forces can obtain the forms of application and forward them to the graduates concerned.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during April, 1918, and (*b*) the aggregate figures from Jan. 1 to April 30, with increase or decrease compared with corresponding periods of 1917:—Electrical machinery, (*a*) £22,519 (decrease £107,289), (*b*) £346,536 (decrease £143,989); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £15,857 (increase £1,834), (*b*) £51,112 (decrease £25,113); and electrical machinery unenumerated, (*a*) £6,662 (decrease £109,123), (*b*) £295,424 (decrease £118,867); telegraph and telephone cables other than submarine, (*a*) £1,846 (increase £724), (*b*) £1,846 (decrease £42,006); telegraph and telephone apparatus, (*a*) £5,280 (increase £2,695), (*b*) £13,236 (increase £1,664); other electrical wires and cables, rubber insulated, (*a*) nil (decrease £1,242), (*b*) £602 (decrease £22,231); with other insulations, (*a*) £417 (decrease £607), (*b*) £455 (decrease £3,217); carbons, (*a*) £5,280 (increase £2,695), (*b*) £13,236 (increase £1,664); glow lamps, (*a*) £440 (decrease £4,234), (*b*) £47,426 (decrease £12,164); parts of arc lamps and searchlights (other than carbons), (*a*) £1,608 (decrease £9,037), (*b*) £33,502 (decrease £3,980); primary and secondary batteries, (*a*) £6,438 (decrease £20,633), (*b*) £78,313 (decrease £51,061); meters and measuring instruments, (*a*) £2,266 (increase £1,664), (*b*) £4,147 (decrease £4,960); switchboards, (*a*) £44 (increase £44), (*b*) £266 (increase £266); electrical goods and apparatus unenumerated, (*a*) £39,509 (decrease £8,581), (*b*) £122,330 (decrease £53,309). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £64,645 (decrease £41,532), (*b*) £317,816 (decrease £207,147).

Exports.—The exports of electrical machinery, material, &c., (*a*) during April, 1918, and (*b*) from Jan. 1 to April 30, with increase or decrease compared with corresponding periods of 1917, were as follows:—

Electrical machinery, (*a*) 110,527 (increase £22,718), (*b*) £362,422 (decrease £127,614); including railway and tramway motors, (*a*) £2,587 (increase £2,227), (*b*) £10,582 (decrease £61); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £84,851 (increase £41,531), (*b*) £210,974 (decrease £60,578); and electrical machinery unenumerated, (*a*) £23,089 (decrease £21,040), (*b*) £140,866 (decrease £66,975); telegraph and telephone cables, submarine, (*a*) £23,714 (decrease £241), (*b*) £77,881 (decrease £18,098); other than submarine, (*a*) £23,453 (decrease £74,101), (*b*) £69,414 (decrease £229,454); telegraph and telephone apparatus, (*a*) £18,298 (increase £6,044), (*b*) £72,720 (increase £2,892); other electrical wires and cables, rubber insulated, (*a*) £5,975 (decrease £966), (*b*) £24,057 (decrease £85,720); with other insulation, (*a*) £5,200 (decrease £6,262), (*b*) £29,193 (decrease £104,309); carbons, (*a*) £420 (decrease £892), (*b*) £1,912 (decrease £6,574); glow lamps, (*a*) £7,605 (decrease £1,238), (*b*) £30,603 (decrease £18,898); arc lamps and searchlights, (*a*) £2,343 (increase £2,333), (*b*) £7,325 (decrease £3,223); parts of arc lamps and searchlights (other than carbons) (*a*) £1,634 (decrease £2,947), (*b*) £6,490 (decrease £9,429); primary and secondary batteries, (*a*) £9,397 (decrease £1,214), (*b*) £30,316 (decrease £33,024); meters and measuring implements, (*a*) £10,627 (increase £4,278), (*b*) £32,357 (decrease £12,836); transformers, (*a*) £1,591 (decrease £880), (*b*) £8,117 (decrease £14,630); switchboards, (*a*) £3,185 (increase £1,397), (*b*) £13,503 (increase £3,237); electrical goods and apparatus unenumerated, (*a*) £31,802 (decrease £20,772), (*b*) £144,592 (decrease £87,953). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £145,244 (decrease £75,461), (*b*) £548,480 (decrease £618,020).

Tenders Invited and Accepted.

Cables.

BELFAST Corporation invite tenders for the supply and laying of cables. Specifications, &c., from the consulting engineers (Messrs. Preece, Cardew, Snell & Rider), 8, Queen Anne's Gate, Westminster, S.W.1, or from the city electrical engineer, Mr. T. W. Bloxam, M.I.E.E. Tenders must be lodged at the Town Clerk's Office, City Hall, Belfast, by June 7. *See also an advertisement.*

Incandescent Lamps.

The SOUTH AFRICAN RAILWAYS AND HARBOURS ADMINISTRATION require tenders by noon June 10 for the supply of 59,500 tungsten filament train lighting lamps, 30,761 other tungsten filament lamps and 3,600 carbon filament lamps during 1919. Specifications from the Secretary to the Tender Board, S.A. Railways, Headquarter Offices, Johannesburg.

Electric Motor.

The Joint Committee of the RICHMOND ASYLUM require tenders for supply of a 30 to 40 H.P. c.c. motor. Tenders to Chief Clerk, Richmond Asylum Offices, Dublin, by June 4.

Telephone Material.

The Deputy Postmaster-General, Melbourne, requires tenders by 3 p.m. July 2 for g.i. wire and gal. steel stranded wire (schedule 1,436), copper wire (h.d. enamelled covered and twisted pair), copper sleeves (schedule 1,449), and telephones and diaphragms (schedule 1,450) for the AUSTRALIAN COMMONWEALTH. Postmaster-General's Department. Specifications, &c., from the General Post Office, Melbourne, Sydney, Brisbane, Adelaide, Perth and Hobart.

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BRADFORD.—The Corporation has accepted the following tenders:—British Insulated & Helsby Cables (Ltd.), cables and insulating wire; General Electric Co., jointing material, tape and solution and 15,000 ft. of casing and cover; Credenda Conduits Co., steel conduits and fittings (three months' supply); Morgan Crucible Co., carbon brushes; G. P. Wall, steel binding wire; Northern Rubber Co., india-rubber channel; R. Young & Co., grease, &c. (three months' supply); Chlorine Electrical Storage Co., maintenance of electric vehicle battery; British Insulated & Helsby Cables, cables (increase of 10 per cent. on existing schedule prices); H. Morris (Ltd.), 5-ton overhead travelling crane; J. Blakeborough & Sons, circulating water valves.

SYDNEY (N.S.W.)—The following tenders were received for the supply of steam turbines and condensers for the Ryde–Pymble pumping plant of the Water Supply and Sewerage Board:—Willans & Robinson (*accepted*), £20,257; Fraser & Chalmers, £19,335; W. Adams & Co., £21,336; Belliss & Morcom, £21,659; Brush Electrical Engineering Co., £24,049; and Gibson, Battle & Co., £24,902.

Appointments Vacant.

A charge engineer (salary £180, plus 12½ per cent.) and a switchboard attendant are required at Derby Corporation electricity works. Applications to borough electrical engineer (Mr. T. P. Wilmshurst), 9, Irongate, Derby. *See also advertisements.*

A controlled firm advertises for a draughtsman for motor control gear.

A staff assistant is wanted for electrical office work in a Government at Portsmouth. *See advertisement.*

A lecturer in physics and electrical engineering (£180, increasing to £200, plus war bonus £25) is required for the Municipal Technical Institute, Belfast. Particulars from the Principal. Applications by June 11.

Holmfirth Urban Council require a working electrical engineer to take charge of their electrical undertaking. Applications to the Clerk by June 3.

An assistant lecturer in engineering is required at the Barrow-in-Furness Technical School. Salary £150, rising to £250 per annum. Particulars from the Director of Education, Town Hall, Barrow-in-Furness. Applications by noon June 8.

Business Items.

The partnership between Richd. St. George Moore, Fredk. W. La Trobe Bateman and John Reginald Fox, carried on under the style of Fox, Moore, Bateman & Fox, consulting engineers, has been dissolved. Debts by Messrs. R. St. G. Moore and F. La T. Bateman, who continue the business.

The Premier Cooler & Engineering Co. (Ltd.) has removed to Station Works, Shalford, near Guildford. Telegrams: "Preecooler Shalford"; telephone: "Shalford 27."

The Millns Electrical Co. and Mr. P. M. Millns have removed to 17, Whitefriars-street, London, E.C.4. Telegrams: "Miltricity Fleet London." Telephone, "City 8363."

Fittings for Industrial Lighting.—A timely and valuable list has been issued by the Lamp and Wiring Supplies Department of the British Thomson-Houston Co., entitled "Fittings for Industrial Lighting." The increasing importance of suitable fittings for industrial lighting work, particularly for use with half-watt type lamps, has led the B.T.-H. Co. to produce this list of a selected line of such fittings. The list includes, among others, the "Lumina" type of semi-indirect fittings, the leading types of the well-known "Mazdalux" reflectors, the "Endura," "Simpla" and "Globa" lanterns, the radial wave reflectors, B.T.-H. inspection lamps, &c.

Accompanying the list is a very complete supplement, giving illumination data for industrial lighting, including a double page size illumination chart. This chart has been specially prepared to assist in the planning of lighting installations. By its use the solution of industrial lighting problems can readily be made for all classes of installations. It has been truly said that there is nothing mankind uses which is so wastefully employed as artificial light, and this waste is a direct consequence of improper methods of use through failure to employ suitable lighting equipment, fittings, &c. The half-watt type of incandescent lamp has made a tremendous advance in lighting economies by doubling the efficiency of previous lamps. Now the notable point is that the efficiency of lighting with half-watt type lamps can again be doubled through the proper use of scientifically designed equipment such as is described in this new list of the B.T.-H. Co. In view of the great importance of conservation of coal and power supply at present, the value of scientific lighting equipment is specially emphasised, and therefore we regard the issue of the present list as most timely. Copies of it should be in the hands of every industrial engineer and manufacturing establishment. It provides a practical answer to the question how to secure the most effective lighting in the most economical manner. Copies have been sent to all holders of the Handbook issued by the lamp and wiring supplies department of the B.T.-H. Co. Extra copies may be obtained from the Publication Department of the Company, Mazda House, 77, Upper Thames-street, E.C. 4, and also extra copies of the "Illumination Chart."

Liquidations, &c.

A meeting will be held on June 14 at Friar's House, New Broadstreet, London, E.C., to receive an account of the winding up of Pintsch's Electric Mfg. Co. (Ltd.) (in liquidation).

A first and final dividend of 20s. in the £ is payable at the O.R.'s, 33, Carey-street, Lincoln's Inn, London, W.C., in the winding up of the Bosch Magneto Co. (Ltd.), 5, Philpot-lane, London, E.C.

A meeting will be held on July 1, at Room 381, Salisbury House, London Wall, London, E.C., to receive an account of the winding-up of the Auxiliary Electrical Co. (Ltd.)

A meeting of creditors of the Southport Tramways Co. (in liquidation) will be held at the Manchester Hotel, Aldersgate street, London, E.C. 1, on June 8.

Companies' Meetings and Reports.

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.)—The chairman (Mr. H Allen) explained at the meeting last week that in 1917 they had connected fewer subscribers than for many years past owing to inability to get equipment from this country or America. There were difficulties in obtaining manufacturing permits and tonnage, and finally, when they got their goods on to the high seas, they were more than once sent to the bottom. They had hundreds of new subscribers on their "waiting list" owing to lack of materials, and he saw little prospect of surmounting their difficulties in the near future. The number of calls made through their exchanges last year was 34¾ millions, the average cost being about ½d. per message. The public was so appreciative of the services of their operating staff on the occasion of the last disturbances at Lisbon that a subscription on their behalf was started in the newspapers and over £1,000 subscribed in next to no time. The operating and other expenses increased by £11,649, against an increase of £5,928 in gross income, but in the expenses is included a loss of £21,597 on exchange. The ratio of expenses to receipts was higher than they could wish, and there had been an immense rise in the price of telephone plant and stores, and there was also the increased cost of labour to be taken into account. In return for the increased wages the company had been permitted to increase the tariff by 15 per cent., but should it be found that that advance was more than sufficient to meet the increased wages, the Government will pocket the surplus.

ALBY UNITED CARBIDE FACTORIES (LTD.)—Mr. A. E. Barton, who presided over the annual meeting last week, referred to the completion of the company's electrode factory in England, and said that up to the outbreak of war practically the whole of the European consumption of electrodes was supplied by Germany and Austria. The establishment of the works was, therefore, another step in the all-important direction of rendering Great Britain independent of enemy products, and would be of great assistance in the expansion of the electric steel industry. Electrodes were essential to the production of electric steel, which was destined to take an important place among our industries, and as it expanded must necessitate a corresponding increase in the demand for electrodes. There was reason to believe that, unless unforeseen circumstances arose, their next financial period would disclose an entirely different position and justify the payment of a dividend.

BRITISH INSULATED & HELSBY CABLES (LTD.)—At an extraordinary meeting at Liverpool on Monday a resolution was passed providing for alterations in the articles of association to enable the directors to capitalise the undivided profits and distribute them amongst the shareholders in the form of ordinary shares.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—During the past year 26,596,827 units of electrical energy were sold, compared with 23,575,211 units in 1916. The number of houses connected is 9,741, against 9,461 in 1916. The gross revenue was £259,397 (against £237,353), and the profits were £173,948. 12s. 11d., which, with balance from 1916 and interest on deposit money, makes a total of £241,069. 11s. 4d. After deducting the interim dividend of 3½ per cent. (actual) on the ordinary shares, the dividends on the preference shares, £39,552 placed to credit of depreciation and renewals account, the excess profits duty for 1915 and 1916, and an estimated sum of £15,000 for 1917, &c., there remains £81,511. 14s. 4d. The directors recommend that £2,500 be added to reserve, £4,000 to insurance fund, and that a final dividend be paid on the ordinary shares for the second half year, of 6½ per cent. actual, making 10 per cent. for the year, which will leave about £45,964 to be carried forward, after providing for the directors' additional remuneration of £3,000. The directors have decided to establish a pension fund for the benefit of the staff. The expenditure on capital account last year was £23,910. 0s. 10d., the total outlay to Dec. 31 last being £1,391,432.

KIDDERMINSTER & DISTRICT ELECTRIC LIGHTING & TRACTION CO. (LTD.)—The capital expenditure during 1917 was £1,273, making a total of £58,653. Net receipts of lighting undertaking were £2,905, and with £3,121 dividends and interest and £499 brought forward the total was £6,525. Deducting expenses, interest and £500 for renewals, there remains £2,046. A sum of £600 has been placed to reserve, and the year's cumulative preference dividend absorbed £1,500, leaving £46 to carry forward. The Kidderminster & Stourport Electric Tramways Co.'s profit (after providing renewals) was £2,880. With £256 brought forward, the available amount was £3,136. A sum of £943 has been placed to reserve, dividend at 3½ per cent. required £2,002, and £191 was carried forward.

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LONDON & SUBURBAN TRACTION CO. (LTD.)—The report for 1917 states that there is a substantial reduction in the return upon the company's investments as compared with previous years. The net revenues of the tramway and omnibus companies in which the company has so large an interest have in nearly every case been adversely affected by the war, the increase of the tramway receipts being more than balanced by the increased expenses of operation due to the further rise in the cost of labour and materials. The revenue, consisting almost entirely of dividends and interest receivable from subsidiary companies, amounted to £81,519, a reduction of £39,067. After deducting all expenses (including debenture and loan interest and providing for the sinking fund charges upon the 5 per cent. debenture stock) there remains £39,037, making with £4,684 brought forward a total of £43,721. The directors recommend payment of a dividend on the preference shares at the rate of 2½ per cent. for the year (£40,086), leaving to be carried forward £3,635. With the concurrence of the debenture holders' committee, the London United Tramways (Ltd.) is promoting a Bill for an extension of the company's tenure of the tramways and an increase of fares, &c. Subject to the passing of the Bill and to certain conditions relating to the future working of the tramways, a scheme for the reorganisation of the capital of the London Company has been provisionally agreed, under the terms of which funds will be forthcoming for reconstruction of permanent way and renewal of rolling stock and other equipment.

METROPOLITAN CARRIAGE, WAGON & FINANCE CO. (LTD.)—The profit for the year ended March 31 was £589,968 (against £398,536 in 1917), and a dividend of 15 per cent. has been declared. It is proposed to increase the nominal capital to £10,000,000.

SIMPLEX CONDUITS (LTD.)—The accounts for 1917 show a net profit of £21,949 (against £8,689), and with £7,372 brought forward, the total is £29,321. The directors propose a dividend of 10 per cent. and a bonus of 10 per cent., both tax free (the same as in 1916), to place £2,000 to reserve (making £30,000), leaving £17,071 to be carried forward, subject to excess profits duty.

SUBMARINE CABLES' TRUST.—The net profits for the year ended April 15, including £67 brought forward, were £25,988. It is proposed to appropriate £14,802 for payment of coupons, adding £11,093 to the redemption fund and carrying forward £93.

YORKSHIRE (WOOLLEN DISTRICT) ELECTRIC TRAMWAYS (LTD.)—The revenue during 1917 was £84,584, increase of £8,444. After placing to reserve £5,614 (against £5,500), a dividend of 6 per cent. per annum has been declared on the ordinary shares, £5,129 being carried forward.

New Companies, Mortgages and Charges, &c.

BATTERIES (LTD.) (150,403).—Private company. Reg. May 10, capital £100,000 in £1 shares, to acquire from the Svenska Ackumulator Aktiebolaget Jungner (inc. in Sweden) all or any part of its patent and similar rights, &c., for the U.K. and British Empire in relation to the manufacture of storage batteries or other apparatus. &c. First directors are W. L. W. Brodie and W. H. Bonham-Carter. Reg. office: 19, Coleman-street, E.C.

BRITISH ENGINEERING STANDARDS ASSOCIATION (Word limited omitted from title by licence of Board of Trade). (150,504)—Reg. May 23 as a company limited by guarantee (not formed for purpose of profit), with an unlimited number of members, each liable for £1 in the event of winding up, to co-ordinate the efforts of producers and users for the improvement and standardisation of engineering materials; for this purpose to take over the work which has been carried on since 1901 by the Engineering Standards Committee, to register in the name of the Association the mark which was originally registered for the said Committee in 1903, to prove and affix or licence the affixing of such mark or other proof, letter or device to certain engineering materials, &c. The first "Main Committee" is to consist of such of the following as consent to act—viz., Sir John Wolfe Barry, K.C.B. (chairman), Sir Maurice Fitzmaurice, C.M.G. (vice-chairman), Sir Douglas Fox, Sir Wm. Matthews, K.C.M.G., K. Elliott-Cooper, A. Ross and Dr. W. C. Unwin (nominated by the Institution of Civil Engineers); H. V. Ivatt, M. Longridge and Dr. W. H. Maw (nominated by the Institution of Mechanical Engineers); G. Ainsworth, Dr. A. Cooper and I. Williams (nominated by the Iron and Steel Institute); Sir Archibald Denny, Sir W. E. Smith, C.B., and Sir Thos. Bell, A.B.E. (nominated by the Institution of Naval Architects); Col. R. E. B. Crompton, C.B., Sir J. Snell and C. P. Sparks (nominated by the Institution of Electrical Engineers); F. C. Gilbertson and F. R. Davenport (co-opted by the nominated members to represent the Federation of British Industries); the Hon. Sir Chas. Parsons, K.C.B., Sir Richard T. Glazebrook, C.B., and Sir Robert Hadfield, Bt. (co-opted by the nominated members).

Hon. secretary, J. H. T. Tudsbery, D.Sc. The first secretary of the Main Committee and of the Association is Mr. C. Le Maistre, A.M.Inst.C., M.I.E.E.

CRYPTO ELECTRICAL CO. (LTD.) (150,466)—Private company. Reg. May 17, capital £50,000 in £1 shares (10,000 preference), to take over the business of electrical engineers formerly carried on by J. G. Shaw and C. R. Shaw as the Crypton Electrical Co. First directors are J. G. Shaw and C. R. Shaw, each of whom may retain office while holding 10,000 shares of either class. Reg. office: Crypto Works, Acton-lane, Willesden.

J. H. NOTT & SONS (LTD.) (150,365.)—Private company. Reg. May 4, capital £10,000 in £1 shares (3,000 preference and 7,000 ordinary), to acquire the business formerly carried on by the late John Henry Nott, as J. H. Nott & Sons, and to carry on the business of lighting, heating, mechanical, electrical and general engineers, electricians, iron founders, &c. First directors are G. Nott and W. D. Hughes.

Mortgages and Charges.

E. S. CO. (LTD.)—Particulars of £6,000 1st mortgage debentures created May 10, 1918 (including £2,000 previously issued) have been filed, amount of present issue being £4,000. Property charged: Company's undertaking and property, present and future. No trustees. Payment of £2,000 debentures issued in 1915 has been postponed from 1922 to 1928, and interest raised from 5 to 6 per cent.

HILL BROS. (MAGNETOS (LTD.)—Equitable charge on properties at Bedminster, to secure all moneys due or to become due from company to National Provincial and Union Bank of England.

KINGOLITE CO (LTD.)—Issue on May 1, 1918, of £400 debentures, part of a series of which particulars have already been filed.

MAXIM LAMP WORKS (LTD.)—Agreement to issue debentures, charged on certain leaseholds and trust deed for £1,000, dated March 21, 1918. Debentures to be charged on Company's undertaking and property, present and future. Holder: J. F. Poynter.

City Notes.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The directors recommend the dividend on the 6 per cent. cumulative participating preference stock and a dividend at the rate of 3 per cent. upon the ordinary stock, the same as last year. In addition about £20,000 is placed to reserve.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—The directors recommend, subject to audit, a dividend of 6 per cent. on the ordinary stock for each of the years 1916 and 1917.

CASTNER-KELLNER ALKALI CO. (LTD.)—An interim dividend of 9 per cent. has been declared.

COMPANIES STRUCK OFF THE REGISTER.—The following were struck off the Register of Joint Stock Companies on May 7:—Bakelite Co., British Graetzin Light, Eclipse Electric Sign Co., Magneto & Taximeter Co.

INDIAN ELECTRIC SUPPLY & TRACTION CO. (LTD.)—The net profit for 1917 was £12,072, and after meeting interest charges, &c., a final dividend of 5 per cent. is proposed (making 7½ per cent. for the year) and carrying forward £685.

PROVINCIAL TRAMWAYS CO.—An interim dividend of 8d. per share (less tax) has been declared on the ordinary shares.

SHANGHAI ELECTRIC CONSTRUCTION CO. (LTD.)—A dividend of 5 per cent. (10s. per share), less tax, has been declared on the ordinary shares (making 10 per cent. for the past year) and bonus of 2½ per cent. tax free: £10,000 has been placed to reserve for renewals and £5,000 written off preliminary expenses.

The Round Table.

By "kVA."

Problem for the I.M.E.A. Convention: Will Watson Bury the hatchet?

* * * *

In a letter to the Press Mr. Harry Allcock says:—

"In a recently issued report by the Committee on Commercial and Industrial Policy after the War the statement is made that if we now adopted the metric system we should be required to work on two systems *for a generation*; but, even assuming this were true, it appears to me much less appalling than our alternative of employing two systems *for all time*."

Mr. Allcock is an optimist; he refuses to consider the prospect for all eternity!

* * * *

We both make and receive many excuses for delays and other things, but the following strikes me as distinctly neat: "We regret delay, but owing to military demands we have some trouble in our arrangements." This did not seem quite good enough, so the writer added "at the moment"!

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, May 28, 1881.]

ELECTRIC LIGHT AT CHATHAM.—The authorities have at last decided to use the Brush light to illuminate the large fitter's shop at Chatham Dockyard. There are 17 lamps in all, said to be of 2,000 candles each. They are worked by an engine of 14 H.P.

GERMAN WIRE TRADE.—The Osnabruck wire industry is reported to be very actively employed at present. Firms in the town have just received large orders for wire for South America, 800,000 lb. of steel wire for the new Anglo-American cable, and 2,000,000 lb. for the United States.

THE TELEPHONE AND THE FAIR SEX.—The introduction of the telephone by the Viceroy of Egypt into his palaces and harems has struck terror to the hearts of the fair occupants. They imagine that this is a dodge of his serenity to keep himself acquainted with all their tittle-tattle and doings.

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CONTENTS.

NOTES	97
Arrangements for the Week	99
Report of the Board of Trade Electric Power Supply Committee..	100
A Study of Group and Individual Motor Drives. By C. E. Clewell. Illustrated	102
Trade Parliaments and Their Work. By E. J. P. Benn	103
Institution of Electrical Engineers	104
Wave Velocity and Capacity of Horizontal Helices in Wireless Telegraphy and Transmission Line Protective Apparatus. By A. Press. Illustrated	106
Some Transient Phenomena in Electrical Supply Systems	107
THE REPORT ON ELECTRIC POWER SUPPLY	108
Progress of British Dyes (Ltd.)	109
CORRESPONDENCE	110
A Power Supply Engineers' Association	111
Patent Record	112
Volunteer Notices	112
Commercial Topics	112
Electricity Supply	113
Tenders Invited and Accepted	114
Companies' Meetings and Reports	115

Notes.

The I.E.E. and Its Work.

LAST week the Institution of Electrical Engineers held its annual general meeting, and thus brought to a close the work of another session. Upon looking over the work of the past six months, what is appearent on the surface is that a certain number of Papers were read in London or before the Local Sections. Most of these were of an engineering character, and it is certainly very desirable that this side of the Institution's activities should be maintained as far as possible. Several of the Papers, however, were of a more topical kind. In this category we may mention the Papers by Mr. L. ANDREWS, on "Overseas Distribution of Engineering Appliances"; by Capt. W. P. DIGBY, on "Contract Prices During Demobilisation"; by Mr. C. TURNBULL, on "A British Electrical Proving House"; by Mr. L. B. ATKINSON, on "The Pros and Cons of the Metric System"; and by Mr. A. J. STUBBS, also on the Metric System. Although these Papers cannot be described as engineering, they are all of them welcome as dealing with important subjects which have been, or should be, under discussion, and which have a very distinct bearing upon the welfare of the electrical industry.

The Less Apparent Work.

AT the present time, however, the work of the Council which is not so apparent is probably the more important. The extent of this work is indicated in the Report of the Council, according to which we notice that 112 committee meetings were held during the session. These committees deal with a variety of subjects, and among the more immediately important may be mentioned those dealing with Patent Law, the Patents and Designs Bill, Research, Ship Wiring, Fuel Oil, the Metric System and the National Proving House. The subject of the electrical equipment of ships is undoubtedly important, and calls for standardisation, and we are glad to note that the Council have adopted the method in this case of submitting the draft rules to informal meetings of at least two of the Local Sections more immediately concerned with this class of work, so that the benefit of the experience of a large body of members may be obtained before the rules are adopted. An attempt is also being made to standardise the articles used in such installations, and for this purpose the Council has worked in co-operation with the Engineering Standards Committee. Another very important section of work is that dealing with insulating materials and insulating oils. There is a great deal to be done in both these directions. Proper co-operation and co-ordination should lead to the collection of much useful information. Passing to another item, it may be said that at the present moment, when electricity supply engineers are faced with many difficulties in obtaining the fuel necessary for their power stations, the utilisation of tar oils instead of imported oil is of very considerable importance. This subject does not, of course, affect large undertakings; but a great number of the smaller generating stations now depend on prime movers of the Diesel engine type, and we are, therefore, glad to see that the Controller of Munitions (Mineral Oil Production) has taken up a sympathetic attitude in regard to this subject. We think it may be said that the Council have recently adopted a rather more active interest in commercial matters, as is evidenced by action of one kind and nother—for example, in regard to the employment of disabled sailors and soldiers, reserved occupations, patent law, the Non-Ferrous Metals Bill, &c. So long as activity of this kind is restricted to broad questions, rather than matters which are of interest to small sections only of the Institution, we think it is all to the good.

The Financial Position of the Institution.

LASTLY, there is the aspect of finance. Notwithstanding that there must inevitably be a falling off in new members from the younger classes of electrical engineers, we notice that there is a net increase in the total membership. This is certainly a satisfactory feature. When we look a the revenue it is also noticeable that the situation is good; in fact, the margin of revenue over expenditure is actually £5,089. 18s. 11d., as compared with £3,776. 17s. 7d. in 1916. It must be remembered, however, that the circumstances have changed. The Institution now no longer occupies its own home, and consequently its expenditure in certain directions is necessarily less than it is in normal times. Further, in all probability, economies have been effected wherever possible. This does not mean, however, tha the expenditure will not be very much heavier when happier times return. That being the case, we think the Council has done well to place a sum of £3,000 to a contingency fund, so that any abnormal expenditure and reduction in revenue at a later date may be met without calling upon other funds. Altogether, it may be said that the position of the Institution is satisfactory, both from the financial and technical points of view.

The Heat-Treatment of Large Masses.

IN view of the very massive parts now being used in large generators, the effect of mass on heat-treatment is a matter of some importance. With the inertia and high speeds now common inadequate treatment may result in flaws or condi-

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tions of instability as regards molecular strain that might lead to serious accidents. It is therefore of interest to note the instructive paper on "The Effect of Mass on Heat-Treatment," read by Mr. E. F. LAW at the recent annual meeting of the Iron and Steel Institute. The treatment of large masses, it was pointed out, presents peculiar difficulties. Experiments made on small masses may not apply to large ones. Among other questions are—"How long does it take for a mass of steel to become uniformly heated?" "To what depth does the effect of oil-tempering penetrate?" and "To what depth is it possible to harden steel effectively by quenching in water?" A series of experiments on cubes of iron of varying dimensions are described, useful information being obtained from thermo-couples embedded in the material at various depths. On the whole, heat penetrated to the centre of the cubes quickly. After 130 minutes from the time of charging the furnace the centre and half-way through were at the same temperature, but an 18 in. cube required 4½ hours for the heat to become uniformly distributed throughout its mass. Very instructive, too, are the differences in the cooling curves obtained respectively with oil and water-cooling. In both cases there appears to be a period during which the metal in the centre of the cube is cooling more rapidly than metal mid-way between centre and surface. While the effect on these cubes of oil-quenching appears substantially the same at the centre and on the surface, there was a decided variation in the water-cooled cube. Another point of interest is that hardening is only effective when rapid cooling takes place through the lower ranges of cooling below 300° C. Hardened steel can be softened by heating to quite low temperatures, and for this reason the view that hardened steel is always gradually softening at normal temperatures—is, in fact, unstable—has been doubted by some authorities. A fuller knowledge of all these phenomena may prove to have an important bearing on the behaviour of large masses required to undergo rotation at high speeds. In this connection we would refer our readers to a very interesting letter from Mr. B. A. BEHREND, which appears in our correspondence columns this week, and which calls attention to the advantages of the plate form of construction as compared with the solid forging, simply on account of these heat problems.

The Progress of British Dyes (Ltd.)

LAST week we had the pleasure of making a tour of inspection of the old and new works of British Dyes (Ltd.). There were many points of great interest, as is indicated in the short account which appears in another column, and it was instructive to notice the differences in design between the old works and the new. When we say that land to the extent of 500 acres has been secured by the Company for their new works it will be realised that they are on a very extensive scale. So far, only a beginning has been made, but that beginning is very substantial and full of promise. One of the most interesting and important features that we noticed was the works industrial laboratory. By this we do not mean the ordinary laboratory in which every investigation must originate, wherein the apparatus is of the familiar type in glass or porcelain, as is used by every chemist. We refer to the laboratory in which all the operations are carried out in plant which is identical with that used in the ordinary manufacturing operations, the only difference being in point of size. In this particular laboratory the plant is on a scale of one-hundredth of the size of the commercial plant, and the quantities used are thus 1 per cent. By this means it is possible to try out the experimental operations on a very reduced industrial scale. Whether a jump from 1 per cent. to 100 per cent. is rather too much may, perhaps, be open to question, and may possibly require modification. Time will show. The important point, however, is that all operations should go through this laboratory on their way to commercial application. It is neglect of this precaution which has so often led to disaster in chemical processes. Reactions which take place quite easily on a small scale may be very considerably modified on a larger basis; the reaction may take much longer, and owing to the larger masses the reaction may not be uniform, so that the final result is unsatisfactory. Thus research is necessary both in the ordinary laboratory and in the industrial laboratory. In such work as that of British Dyes (Ltd.) it is clear that the supply of research chemists is an important matter, and not merely research chemists but works chemists and engineers who are able to work together. The Chairman, Mr. JAMES FALCONER, M.P., laid stress upon this point of view at a luncheon on the day of our visit, and we were glad to note that there was every appearance of this desirable combination in the new works. If this country is to be more successful in the future than in the past in chemical industry it is essential that the engineer and the chemist should work more closely in unison. Lastly, there is the question of the commercial future. We gather that the efforts of British Dyes (Ltd.) hitherto have been most successful in the face of very considerable difficulties, and that there is no doubt that the Company will be able to supply all the dyes required in this country, and of a quality equal to that of the German dyes upon which this country previously depended. It will be necessary, however, for the Company to have adequate support, both from the Government and from the general public. So far, the Government has given serious financial assistance on the basis of limited dividends, but it will be necessary to go further than this. It will be essential that the Government should render available the necessary raw materials on at least as favourable a basis as that on which foreign competitors will obtain their materials, and it will be necessary for the general public to appreciate the advantage of supporting British industries in the future, rather than adopting the curious attitude which has been so often noticeable of giving preference to a foreign article.

British Science Guild.—The annual meeting of the Guild will be held at the Mansion House, London, on Wednesday, June 19, at 4 p.m. The chair will be taken by the Lord Mayor, and Lord Sydenham (the president) will give an address on "Education, Science and Leadership."

Firing Bituminous Coals in Large House Heating Boilers. A Technical Paper (No. 180) by Mr. S. B. Flagg on the above subject has been issued by the Bureau of Mines (Washington). Some sound general recommendations are made on the burning of bituminous coals economically, and the differences in the firing of heating and power boilers are explained. The author also enters into an explanation of the ways in which boilers receive heat. In conclusion, the results of a series of tests are given, of special interest being a series of curves showing density of smoke emission, plotted against time, with various forms of Pittsburgh and Illinois coal and different conditions of firing.

British Engineering Standards Association.—As announced in our last issue, the Engineering Standards Committee, which was formed in 1901 by the leading engineering institutions, has now been incorporated, the word limited being omitted by license of the Board of Trade.

The Committee, therefore, becomes now a corporate body with a legal entity, and is thus enabled to maintain its position in regard to its brand, which has been largely used in a number of the British standard specifications. The wider use of the brand by manufacturers generally who are working to the British standards should be of material advantage to the British engineering industry throughout the world. The good work that the Committee has done during the past 17 years, which is such a monument to its founder, the late Sir John Wolfe Barry, K.C.B., F.R.S., and its acknowledged position in the engineering world, makes its incorporation a logical sequence in its development.

Composite Insulating Materials.—A joint committee representing the Institution of Electrical Engineers and the

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B.E.A.M.A., appointed under arrangements with the Department of Scientific and Industrial Research, is considering a draft specification applicable to composite insulating materials. With this object in view, manufacturers are being requested to supply samples of their various moulding materials. Since these must be in a recognised form to give comparable results, a set of moulds is being prepared, and will be placed at the disposal of manufacturers for a limited period. A large number of specimens are required, and the materials are grouped according to the temperatures which they will normally stand.

Birthday Honours.—In the list of Honours conferred by the King on His Majesty's Birthday we notice very few names connected with the engineering industry. Our readers will be gratified, however, to see that the honour of knighthood has been conferred upon Mr. Thomas Octavius Callender, J.P., managing director of Callender's Cable & Construction Co. and a director of several manufacturing and electric supply companies.

The following additional Honours have also been conferred :—

Privy Councillor.—Sir Edward A. Goulding, Bart., M.P., a director of the British Westinghouse Co., and of the Westminster Electric Supply Corpn.

Baronets.—Mr. Guy Calthrop, Controller of Coal Mines, and Sir Charles Petrie, prominently identified with the Liverpool public and civic services, including the municipal tramway and electricity undertakings.

Knights.—In addition to Mr. T. O. Callender, the Honour of Knighthood has been conferred upon Alderman H. T. Hatt, ex-Mayor of Bath and Chairman of the Electricity Committee.

Electric Furnaces for Non-Ferrous Metals.—In a recent Paper before the Philadelphia Foundrymen's Association, Mr. G. H. Clamer draws attention to the need for careful selection of electric furnaces, according to the purpose for which they are intended. For example, not only is the type of furnace required for non-ferrous work quite different from that used for treating iron, but even the conditions requisite for testing melting red brass may be unsuitable for yellow brass and alloys containing a considerable content of zinc. Horizontal open-ring induction furnaces require careful design in order to obtain a reasonably good power factor, owing to the relatively high magnetic leakage between primary and secondary. The Ajax Wyatt furnace, which appears to have several qualifications for such work, will melt 60 : 40 brass without volatilising zinc in the secondary channels, provided cold metal is continually fed into the furnace so as to keep the temperature below that at which zinc tends to vaporise. No water-cooling is needed, the furnace may be sealed to prevent oxidation, and oily turnings and scrap of brass of composition varying from 70 : 30 to 60 : 40 have been treated quite satisfactorily.

British Science Guild Exhibition.—The British Science Guild is organising a comprehensive exhibition of products and appliances of scientific and industrial interest, which, prior to the war were obtained chiefly from enemy countries but are now produced in the United Kingdom.

The King has graciously consented to become Patron of the Exhibition, and the Marquess of Crewe, K.G., is President. Among the Vice-Presidents are : the Prime Minister, Sir Albert Stanley (President of the Board of Trade), Mr. H. A. L. Fisher (President of the Board of Education), Dr. Addison (Minister of Reconstruction), Lord Moulton, Sir J. J. Thomson (President of the Royal Society), and other distinguished public men.

The Exhibition, which will be held at King's College from about the first week in August until the first week in September, will show in the first place products chiefly imported from Germany before the war, but now made in this country ; but it will also illustrate the remarkable developments that have taken place generally in our scientific industries. In many of these, as a matter of fact, Great Britain always excelled, and it is only our national quality of self-depreciation which has prevented the public from appreciating the fact that we were able to export to Germany apparatus and products embodying the highest scientific knowledge and technical skill. The exhibits will include : chemical products, thermal, electrical and optical appliances, glass, quartz and refractory materials, photographic apparatus, surgical and medical appliances, &c. It is believed that the effect of the Exhibition will be to have a most stimulating influence upon scientific and industrial research, and the demonstrations and lectures that will be given in order to explain the exhibits will undoubtedly bring home to manufacturers, as well as to the general public, the great and growing part that science plays in industry. Further particulars may be obtained from the Organising Secretary (Mr. F. S. Spiers), 82, Victoria-street, London, S.W.1.

Road Transport.—At a luncheon meeting of the Commercial Motor Users' Association on Friday last, Col. R. E. B. Crompton, C.B., the first president of the Association, delivered his presidential address on "The Future of Heavy Motor Traffic."

Col. Crompton said the war had clearly shown that comfort, convenience and health greatly depended on cheap and rapid transport. It ranked with the two great national industries, shipping and railways. All re-housing schemes depended on cheap road transport. The supply of liquid fuel was so restricted by war conditions that for some time to come they must look for other means of obtaining driving power. The use of gas for traction purposes was steadily extending. Later on, when war conditions permitted of the maintenance and supply of cylinders and compressing plant, the use of the gas-propelled vehicle would be greatly helped, and would become permanent for all the lighter classes of vehicles.

The next available source of power was by electrical means. We already had accumulators for town work, and their use and radius of action were growing. It was practically certain that further developments of accumulators would take place in the near future which would increase their usefulness and durability and reduce the dead-weight carried. The trolley system, so long used to take power from wires at the roadside, was certain to be improved. Tesla's idea of obtaining electrical power by induction from a charged wire at the roadside was capable of solution.

Obituary.

MRS. A. H. E. PADLEY.—We much regret to announce the death of Mrs. A. H. E. Padley, late chief lady demonstrator of the St. Marylebone Electric Supply Kitchen, which took place at Loughborough on Thursday last. Mrs. Padley, who was well known in electric cooking circles, relinquished her demonstrating work (much of which was of a pioneer character) three years ago owing to failing health. For some years Mrs. Padley co-operated with Mr. F. S. Grogan in popularising electric cooking in this country, and much of the progress made is due to their united labours. In addition to demonstrating, Mrs. Padley contributed many valuable articles on electric cooking to "The Unit," and made a number of useful suggestions upon the design of cooking apparatus.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service are reported :—

Lieut.-Col. Douglas H. Hyde Thomson, aged 27, was killed while flying over Kent on May 21. He joined the Royal Naval Air Service in 1914. Latterly he had devoted his energies chiefly to wireless telegraphy and other electrical matters, and his loss in this branch of service will be greatly felt.

Capt. Douglas Walton Mellor (King's African Rifles), aged 25, who was wounded in November last and died of fever on the 26th ult., was a former student of the City and Guilds Engineering College.

Sergt. Jas. H. Bell (Warwickshire Regt.), formerly employed by the General Electric Co., has been killed.

Gunner T. Ross (R.F.A.), formerly employed in the India Rubber Co.'s cable department, died of wounds on May 1.

Gunner D. H. Mather (R.F.A.), formerly employed in the Preston tramways department, has died in action.

Driver Norman Gripper, driver of the Friend's Ambulance Unit of the British Red Cross with the French Army, formerly engaged in the Blackburn electricity department, has been killed in action.

Personal.

WAR CASUALTIES.—The following casualties are reported :—

Pte. W. Bunnage (Wilts Regt.), formerly in the India Rubber Co.'s general office, is a prisoner of war.

Pte. W. R. Robinson (Royal Lancaster Regt.), aged 19, formerly employed on the Burnley tramcars, is a prisoner of war.

Pte. P. A. Storr (M.G.C.), also a former Burnley tramwayman, is reported missing.

L.-Corp. John Gillett (Royal Lancaster Regt.), aged 19, formerly employed in the Blackpool Corporation tramways department, has been wounded.

Arrangements for the Week.

TUESDAY, June 11th.

JUNIOR INSTITUTION OF ENGINEERS, NORTH-EASTERN SECTION.

7.15 p.m. At the Mining Institute, Neville-street, Newcastle-on-Tyne. Paper on "The Applications of the Static Transformer," by Mr. S. A. Stigant.

FRIDAY, June 14th

PHYSICAL SOCIETY.

5.0 p.m. At the Imperial College of Science, South Kensington, S.W. Discussion on "The Teaching of Physics in Schools." To be opened by Sir Oliver J. Lodge, F.R.S. Contributions are also expected from Prof. T. P. Nunn, Prof. R. A. Gregory, Prof. F. Womack and Messrs. C. E. Ashford, T. J. Baker, C. L. Bryant, G. F. Daniell, J. Nicol, F. W. Sanderson, A. T. Simmons and E. Smith.

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Report of the Board of Trade Electric Power Supply Committee.

As announced briefly in our last issue the report of this Committee has now been published. The Committee was appointed in the early part of last year and was finally constituted as follows: Sir Archibald Williamson, Bart., M.P. (Chairman), Mr. Harry Booth, O.B.E., Dr. J. F. Crowley, Mr. James Devonshire, Mr. Harold Dickinson, Mr. James Falconer, M.P., Mr. G. H. Hume, Mr. John Kemp, Mr. E. F. Vesey Knox, K.C., Mr. H. H. Law, C.B., Mr. C. H. Merz, the Hon. Sir Charles Parsons, K.C.B., F.R.S., Mr. William B. Smith, O.B.E., Sir John Snell, Alderman C. F. Spencer, and Mr. A. J. Walter, K.C., with Mr. M. J. Collins as Secretary. The report is signed by all the members.

Witnesses were heard representing 25 bodies interested in the subject.

In what follows we give an abstract of the more important parts of the report.

National Aspect.—We recognised that it was our duty to consider the terms of reference from a national point of view so that our recommendations might lead to a practical scheme for providing the vital requirement of cheap power throughout the country. The supply of such power is now seen to be virtually as essential as labour and materials in so far as it affects economical production. We have necessarily had to take into account any seeming conflict of national and local interests.

Progress hitherto has been hampered by legislation, by Parliamentary procedure, by limited areas of supply, by uncertainty whether local authorities will exert the right of purchase and the terms thereof, by the right of veto by local authorities, by the chaos of different systems used by neighbouring bodies, coupled with reluctance on the part of manufacturers and railway companies to take power from a public supply, efficiency of the gas industry and unsound projects on the part of some electricity companies.

To sum up as regards the present position, the evidence given before us was unanimous in declaring it to be unsatisfactory, and the opinion of practically every witness was that something must be done and as speedily as possible. Our investigation confirms fully the opinion of the Coal Conservation Sub-Committee and the Electrical Trades Committee regarding prevailing conditions, and leads us unanimously to the conclusion that the present state of affairs is contrary to the national interest, wasteful of fuel resources, deprives industries of the advantage which a well devised system of generation and distribution of electricity would give, and thereby handicaps them in competition with other countries.

Future Outlook.—It should be fully recognised that cheap electrical power is a matter of first-class importance, and will in the future be essential to the industrial progress of this country. Concentration of larger generating units in larger and fewer power stations, wherever practicable, is urgently required in order to reduce the cost of industrial power to a minimum, and to conserve coal and get the fullest value from every ton consumed.

There are to-day about 600 bodies generating electricity for public purposes, apart from the large number of manufacturers, collieries and others generating their own power. We have no doubt that these separate stations can be reduced to a relatively small number in the course of time, and that the country will greatly benefit thereby.

After the war the position of delayed extensions of generating plant and mains throughout the country will require immediate attention, especially as the greater number of stations are now working without spare plant. There is also an accumulation of new business requiring a supply, but not yet connected to the distributing mains, while the rapid development of electrical furnaces is overtaxing some existing stations. Unless on the termination of the war there is the necessary organisation ready and prepared for developments on right lines, there will be a perpetuation of present disadvantageous conditions. The evil will grow until it is beyond remedy. Thus the matter is urgent, and it may well be that our industrial future depends greatly upon a wise and far-seeing decision at this time.

Our land is not favoured by immense available water power as in Canada, the United States, Norway, and elsewhere, but, having in view the volume and comparative concentration of our industries, which will enable losses in transmission of electricity to be minimised, there is every reason to believe that with well situated modern generating stations based upon coal as fuel, and by the pooling and centralisation of electrical generation, we shall be able to compete with many places where water power is used, and at least to equal in cheapness of power most of our foreign manufacturing competitors.

We have been impressed by the evidence placed before us in regard to the North-East coast system. The costs of the electricity delivered over this wide area bear out in practice the contention as to the advantages to be gained by centralisation of the control of generation and main transmission over large areas. We cannot emphasise too strongly our opinion that it is necessary to take a comprehensive view of the situation, and that it is of paramount importance that a cheap and plentiful supply of electricity should be available over the widest areas possible.

A Central Authority.

Electricity Commissioners.—The general concensus of the evidence given before us was that the need for the creation of one central authority to regulate generation and distribution of electricity in Great Britain and Ireland is urgent, and that in the national interest steps should immediately be taken to establish it. With this view we are in complete agreement. This new authority, we suggest, should be known as "The Electricity Commissioners." The powers connected with the generation and supply of electricity, at present exercised by the Board of Trade, Local Government Board, Local Government Board for Ireland, and Scottish Office, should be transferred to the Commissioners. Many of our witnesses were strongly of opinion that the new authority should be independent of any existing Government Department and of Parliament. We cannot entirely concur in that view. Our recommendation is that the Commissioners should be appointed by the President of the Board of Trade, and that they should be in direct communication with him and through him responsible to Parliament. We are of opinion that the Commissioners should be endowed with very full powers. We feel that their duties should not be confined to framing and administering regulations and deciding questions brought before them, but that they should include the *encouragement* of the supply and distribution of electricity.

It is essential that the Commissioners should be men of high standing and ability. Our recommendation is that they should in the first instance be five in number. Three of these Commissioners should be appointed on the terms that they should not hold office beyond the age of 65, that they should have substantial salaries, not less than £3,000 per annum; and that their whole time should be given to the service. They should also have adequate pensions. The ordinary Treasury scale of pensions does not appear to be suitable in this case. The other two Commissioners might be appointed for a short term of years, and neither the age limit of 65, nor the right to a pension need apply to them. Engineering qualifications and business experience of the highest order should be represented in the personnel of the Commission. The staff employed should include a Secretary and such electrical engineers and inspectors as may be necessary. The work falling on the Commissioners at first, and for some years, is likely to be heavy, but it is probable that later three Commissioners will suffice. We think the whole expenses of the Electricity Commissioners might be recovered from the electricity undertakings of the country by a charge levied upon them *pro rata* to revenue.

Organisation in New Areas.—As soon as possible after their appointment the Commissioners should proceed to delimit suitable electrical districts. We do not express an opinion as to any exact number of districts, preferring that the Commissioners should have a free hand; but we are of opinion that they should in most cases be large, and cover ultimately the whole of Great Britain and Ireland.

We do not attempt to decide which areas should be dealt with first as regards re-organisation of the supply. We may, however, point out that the question is evidently very urgent in the Lancashire district, where interconnection of existing generating stations has already been considered, although it has not been possible to carry it out. The same urgency applies to the area around and including Birmingham, and to certain Yorkshire industrial districts. In London the matter has been pressing for a considerable time; indeed ever since 1905, when the question of re-organisation of the supply was raised in Parliament.

While some localities, or the large towns in them, may already be well served by existing undertakers—company or municipality as the case may be—in practically every instance, some important change will be found to be necessary, in order to secure the cheapest possible supply. It is important to remember that the existing business represents but a small proportion of the business yet to be done, and that, in order to obtain this additional business, it is essential to secure the highest economy in production.

Municipalities in some cases have desired power to supply electricity to areas outside the borough boundaries; but the complications involved in extension of areas of municipal supply so as to cover the area of other towns, or other local authorities, are great. We do not think a satisfactory solution of the problem can be found along these lines, viewing the matter from a national standpoint, and in the interests of consumers generally.

District Electricity Boards.

Ownership.—We have given much consideration to the possibility of finding a solution which might unite, without altering, existing undertakings and provide for new generating stations under Joint Boards But the influence of local susceptibilities, the divergence between those whose tenure is permanent and others whose tenure is limited, added to the difficulty of raising new capital in such circumstances, convince us that the most satisfactory scheme must be based upon single ownership in each district of the generating stations and main transmission system.

After full consideration we have come to the conclusion that in the national interest generating stations and main transmission lines ought, as a general rule, to be publicly owned, and for this purpose a District Electricity Board should be set up in each of the districts when consti-

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tuted. to which the generation and main transmission system should be transferred. The Order of the Commissioners which delimits the district should incorporate the District Electricity Board.

We recommend that District Electricity Boards should be established :

(*a*) To acquire all the generating stations and main transmission systems within their districts (excepting stations for private supply).

(*b*) To link up and develop the supply of electricity.

(*c*) To erect new stations as and where necessary.

(*d*) To acquire and utilise wherever practicable surplus electricity and waste gas and heat and other sources of power.

We are of opinion that District Electricity Boards should have power to acquire generating plants of magnitude at present owned by railways, tramways or other public utility concerns, and that the supply to these undertakings should be combined with that to other consumers of power. Main line electrification may not take place immediately, but will undoubtedly come. Meantime, large extensions of the use of electric power for railways in connection with urban, suburban and special goods traffic, are imminent. The importance of combining the supply to railways, tramways and other classes of consumers is beyond doubt, and we believe that each of them will benefit thereby. Combination will also save duplication of capital expenditure on reserve generating plant which would otherwise be necessary. It is not our suggestion that there should be restrictions in regard to ownership or the setting up of private installations, but where new private generating plant is installed it should be subject to regulations of the Commissioners as to type of current, frequency and voltage, in order that it may fit in with the general system.

Operation.—As regards operation in each of the new districts, some witnesses favoured company operation, others public operation. The former pointed to the need of technical knowledge and business acumen : to the temporary or permanent losses which have to be risked in laying down plant and mains to foster, or in anticipation of, demand : to the necessity of differentiation in price, in addition to the usual scale based on load factor, quantity, distance and coal prices. They suggested that company management, based on the expectation of profits, is alone able satisfactorily to undertake such an intricate and difficult business. On the other hand, evidence was given to the effect that the paramount importance of technical knowledge, business ability, and the necessity for taking risks and facing losses inherent in the present stage of the country's electrical development, were equally associated with publicly operated undertakings, and that this was already exemplified in the case of the larger municipalities.

In using the term "operation," we mean it to include the installation and extension of the generating plant and main transmission lines, and the management and working thereof.

There are three methods, we think, under which this generally should be carried out : (1) Operation by the District Electricity Board : (2) operation by a company under lease from the District Electricity Board, such company preferably to be composed largely of consumers within the area affected : (3) operation by an existing power company under lease from the District Electricity Board.

If the first method be adopted, it is essential that the District Electricity Board should make no divisible profit.

Constitution of the Boards.—This part of the problem is difficult and controversial. It may be necessary to finance the Boards in whole or in part by funds raised with Government assistance, or on the other hand, it may be possible to finance the Boards locally without resort to such assistance. Boards might be of three types

(I.) Boards which are nationally financed. These should be composed of representatives of (*a*) local authorities and companies which are at present distributors of electricity, (*b*) large consumers, and (*c*) railways using electricity within the district of the Board.

(II.) Boards which are locally financed. These should be composed of representatives of (*a*) local authorities, whether distributors of electricity or not, (*b*) companies which are at present distributors of electricity, (*c*) large consumers, and (*d*) railways using electricity within the district of the Board.

(III.) Mixed Boards. These should be composed of representatives of the interests mentioned in (I.) or (II.).

In the case of District Electricity Boards which are nationally financed we do not attempt to fix the number of representatives of each class. [Opinions are, however, expressed as to their composition.]

Subject to our general recommendation that there should be one comprehensive system for the generation and main transmission in each district, it may be advisable in an exceptional district, the outstanding feature of which is an undertaking, whether municipal or company, already supplying power on a large scale and over a large area and able and willing to develop that supply at its own risk, that the municipal authority or the company, as the case may be, should continue, subject to conditions laid down by the Commissioners.

Powers of the Boards.

Powers and Duties of District Electricity Boards.—District Electricity Boards should be charged with the folllowing among other duties :—

(*a*) To acquire all generating stations within the district, whether municipal, company, railway, dock or other public utility.

(*b*) In the case of generating stations belonging to local authorities, electric lighting companies and power companies, all should ultimately be taken over by the District Electricity Board—good and bad. We recommend that the terms should generally be payment of the actual amount expended on lands, buildings and plant for generating purposes, less depreciation, reserve funds, renewal funds and sinking funds which have been provided, and which are properly applicable to the generating stations. Exceptional cases may require special treatment.

(*c*) In the case of railways, tramways, docks and other public utility undertakings, the District Electricity Board should have power to take over the generating stations on the basis of the actual amount expended on lands, buildings and plant for generating purposes, less depreciation, reserve funds, renewal funds, and sinking funds which have been provided and which are properly applicable to the generating stations. An undertaking should in such cases be given that electricity will be supplied to them at least as cheaply as they could have produced it themselves in similar circumstances of coal, labour and other costs, including capital charges, with their existing plant and output.

(*d*) The District Electricity Board may realise any generating stations taken over, will acquire new sites, and lay new main transmission lines, subject to the general regulations of the Electricity Commissioners.

(*e*) With regard to distribution systems :—

In the case of the local authorities, the distribution system may be acquired on terms similar to those proposed in respect of generating stations, in cases where distributors wish to discontinue.

In the case of electric lighting companies, distribution should either be transferred to the District Electricity Board on terms fixed by agreement, or should remain in the hands of the company until the earliest date at which the concession may be terminated.

In the case of the power companies, in some instances, it may be suitable also to buy their distribution system by agreement.

In all cases where the distribution system is not acquired, the District Electricity Board must undertake to supply the distributors with electricity at least as cheaply as they could have produced it themselves in similar circumstances of coal, labour and other costs, including capital charges, with their existing plant and output.

(*f*) Except in the case of the transfer of undertakings owned by local authorities, in which case the purchase price should be discharged by a terminable annuity to be used by the local authority in discharging their loan obligations, payments should be made in cash.

(*g*) It is essential that the necessary capital should be raised as cheaply as possible. Any risk of loss by the Government could only arise in respect of nationally financed or mixed Boards, and the risk would, we think, be small.

(*h*) No powers of compulsory purchase by local authorities under the Electric Lighting Act, 1888, or otherwise, should be exercised without the consent of the Electricity Commissioners. The power of purchase should be vested in the District Electricity Boards, as soon as they are created.

(*i*) The District Electricity Boards should have powers of laying main transmission lines throughout their areas, and powers of distribution in all parts of their areas where there is now no public supply.

In order to ensure that the business of the District Electricity Boards is conducted under proper financial safeguards, provision should be made for :—

(*a*) The submission by the District Electricity Board, for the approval of the Electricity Commissioners, of all specific proposals for capital outlay, with estimates and plans, when these proposals exceed a certain sum.

(*b*) The submission by the District Electricity Board to the Electricity Commissioners of an annual budget of income and expenditure on revenue account.

(*c*) The audit of the District Electricity Board's accounts by an auditor appointed by the Electricity Commissioners.

(*d*) The fixing of charges for electricity so as reasonably to ensure financial equilibrium ; and reserving power to the Electricity Commissioners, in certain eventualities, to give directions as to the charges to be made.

(*e*) An annual report to be made to the Electricity Commissioners of the proceedings of the District Electricity Board.

Leases.—In cases where operation by a commercial company may be found preferable the District Electricity Board may lease their undertaking on terms to be approved by the Commissioners. The terms of any lease should provide, *inter alia*, for the regulation of the amount of the distributable profits by the imposition of a sliding scale, a system of rebates to consumers, or otherwise, as may seem best calculated to secure a community of interest between the lessees and consumers.

Distribution.

In present circumstances our view is that distribution, especially in the case of the larger towns, should generally be left in the hands of present distributors, unless they wish to transfer it. The majority of the Committee are of opinion that municipalitjes and other local authorities should distribute electricity without seeking to make a profit for the relief of local rates, and those members of the Committee who do not concur in this view think that such profits might be limited to a small percentage.

Regulation of Price and Facilities.—The power to vary prices has rarely been called into operation, but when it is transferred to the Electricity Commissioners it should be extended and used so to regulate prices from time to time, by means of a sliding scale, rebates, or otherwise, as to secure to consumers a proper proportion of the benefit of the reduction of cost due to the combination of generation.

The distributor, whether a local authority, a company under the Electric Lighting Acts, or a power company, should have the right to a supply from the District Electricity Board on arbitration terms. We also propose that in those areas where the power companies continue to exist as distributors, an authorised undertaker should have the same right as a consumer now has against the power company to require a

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supply on arbitration terms. The distributors must recognise that distribution is as important as generation and requires the same skilled technical direction. It would be a fatal policy if the distributors were to attempt to cut down their engineers' salaries, just when the new and cheaper bulk supply ought to make them busier than ever.

Compensation for Loss of Office.—Although under our proposals and the development which may be expected to flow from them, there should be new and improved openings for engineers and other officials, we think provision should be made by which District Electricity Boards may provide compensation for displaced engineers and other officials in cases of hardship.

Procedure.—We are of opinion that they should have considerable powers to make final Orders, and that new Orders authorising the supply of electricity under the Electric Lighting Acts in areas with a population of less than 5,000 should not require confirmation by Parliament. We suggest, as recommended by the Committee presided over by Sir George Murray, that the Provisional Order need not go through all the stages of legislation. If unopposed, it should become law after the lapse of a fixed time. If opposed, the Order prepared after a full inquiry by the Electricity Commissioners should be referred to a joint committee of the two Houses of Parliament so as to minimise the loss of time and money.

FINANCE.

In 1916 there were 230 companies and 327 local authorities operating undertakings under statutory authority for the supply of electricity to the public. Their capital expenditure had been £36,000,000 by companies and £55,000,000 by local authorities. A large percentage (some 50 per cent.) of this total has been expended on the distribution systems, which in most cases will not be transferred.

Cost of New Developments.—The cost of the developments undertaken during and immediately after the war will be greatly enhanced by the abnormally high cost of materials. It is generally expected that high prices will prevail for some time after the conclusion of peace. The postponement of all developments until a time when prices have receded to what may be considered a normal level would, in our judgment, be most regrettable. The provision of adequate electric power is required for the resuscitation of industry. We therefore recommend that the Government should go a long way in giving financial assistance, so that installations which are shown to be urgently required should not be unduly burdened by charges for interest and amortisation.

Standards.—It should be an important duty of the Electricity Commissioners to fix standards of system, frequency and pressure, for the whole of the United Kingdom. But regard must be had to existing varying conditions, and uniformity in some districts can only be achieved gradually.

Overhead Lines.—We are strongly of opinion that the legislative restrictions with regard to the use of overhead lines should be removed or amended. There are numerous instances where local authorities have attached to their consent very onerous conditions or have absolutely refused to give it. The future development of electricity in many districts will depend largely upon facilities being granted for the use of overhead lines, and it is of vital importance that restrictions which exist at the present time should be removed or amended. We are of opinion that the absolute veto of local authorities on the construction of overhead lines should be abolished.

Wayleaves.—Further facilities should be afforded for the placing of electric lines, either underground or overhead, across private property. Compensation should be assessed by arbitration after the work has been done.

Rating.—The local rating system as applied to electric transmission mains must greatly, and, we think, unjustifiably interfere with the supply of cheap power and enhance its cost. The matter is one which calls for the immediate attention of the Government.

Water Rights.—The importance of water for condensing purposes cannot be over-estimated and facilities should be afforded for the acquisition on equitable terms of rights to use water.

Liability for Nuisance.—We think that the Electricity Commissioners should have power to order that any generating station should be free from liability for nuisance in the absence of proof of negligence.

Necessity for Immediate Legislation.—In view of the fact that the numerous investigations of the Reconstruction Committees, and the proposals made by them, must largely depend for their practical effect upon the supply of cheap power, we would in conclusion emphasise the importance of initiating the necessary legislation with the least possible delay.

A Study of Group and Individual Motor Drives.*

By C. E. CLEWELL.

Summary.—The article analyses the relative advantages of the individual and group methods of machinery drives in factories. Savings which may be effected by the elimination of line shafts and belts, and other more important economies should determine the policy to be followed in any given case.

There is a marked tendency at present among the leading machine-tool plants toward individual-motor drive, particularly for the larger machines, and it is not yet agreed whether the investment for individual motors for small tools is warranted.

The power consumption of a typical machine tool is usually a relatively small item in comparison with the other charges against the machine (Fig. 1). Any saving in the power of consumption will

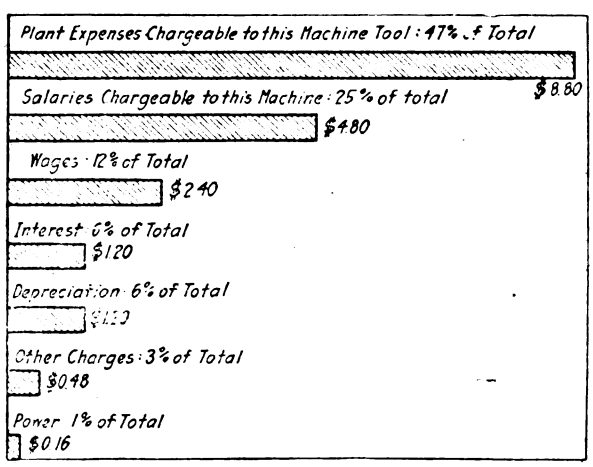

FIG. 1.—RELATIVE AMOUNTS CHARGEABLE TO A GIVEN MACHINE TOOL PER EIGHT-HOUR DAY FOR DIFFERENT ITEMS WHICH MAKE UP TOTAL PRODUCTION COST.

have a relatively small effect on the total cost of production by this tool, whereas any saving in wages brought about by the ability of the operator to perform a given operation in less time will obviously tend to a much greater effect on the cost of production.

The interest and depreciation on a machine tool together may form an item of importance. Fig. 2 indicates that the cost per horse-power* increases rapidly for the smaller sizes of motors; hence the fixed charges on the smaller machine tools when equipped with individual motors are relatively higher than with larger tools.

Table I.—*Frictional Losses in Shafting for various Typical Shop Departments.*

Department.	Per cent. of total transmitted power.	Department.	Per cent. of total transmitted power
Pattern making	17	Chucking	26
Grinding	21	Planing	26
Light drilling	23	Cutter making	27
Lathe	25	Heavy drilling	34
Milling	25	Jig and fixture making...	37
Cam cutting	26	Cutting-off	43

Table I. is of considerable interest because it shows the friction losses connected with the line shafting in various typical shop departments and gives an indication of the economy which may be effected by the substitution of motor drive for any system of mechanical power distribution.

The term "group drive," as here used, relates to cases where one relatively large motor supplies a group of machine tools through line-shafting and counter-shafting. The excessive mechanical losses of the long main-line shafts may be reduced by the electrical distribution up to the group motors, but such losses still occur between the group motor and the machine tools to which it supplies power.

Group drive is usually preferable to individual-motor drive in the following circumstances:—

(*a*) Group of machines operated at constant speed, all machines being in operation simultaneously.

(*b*) Machinery close together and counter-shafts thus short; diversity factor that permits the installation of less gross horse-power with a single group-drive motor than when several individual motors (especially small motors of 2 H.P. or less) are used.

(*c*) Constant-speed machines requiring excessive currents at certain points in the duty cycle and when, owing to such conditions,

* Abstract of an article in the "Electrical World."

* From a discussion by H. R. Johnson, "Trans." A.I.E.E., Vol. XXXIV., p. 757.

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the gross horse-power rating of individual motors would necessarily be higher than the horse-power rating of a single group motor.

(*d*) With groups of relatively very small machines and where the investment in a motor for each machine would be unduly high.

Turning, now, to some of these advantages of individual drive, it is important to note that the increased first cost for individual motors may be offset in a relatively short time by the lower frictional losses brought about by their use.

In a case of group drive the total first cost per floor amounted to \$8,700, proportioned as follows: For the main shaft, 27 per cent.; counter-shafts and pulleys, 57 per cent.; group motor, 5 per cent. The losses due to friction with the group system were estimated at \$2,500 per annum.

The first cost of an individual-motor drive for this same floor was estimated at about \$10,400 per floor, proportioned as follows: For the 136 motors, 83 per cent. of the first cost of the driving system, and for wiring, &c., about 13 per cent. The losses due to friction in this case were estimated at \$700 per annum. In this instance the extra first cost of the individual motors amounts to \$1,700, whereas the saving in frictional or mechanical losses by the use of individual motors amounts to about \$1,800. In such a case, therefore, the increased cost of the individual-motor system would pay for itself through reduced mechanical losses in approximately a year's time.

However, the economy of the individual-motor driven machine rests largely on the increased production it makes possible and on certain other secondary advantages, rather than on savings in power.

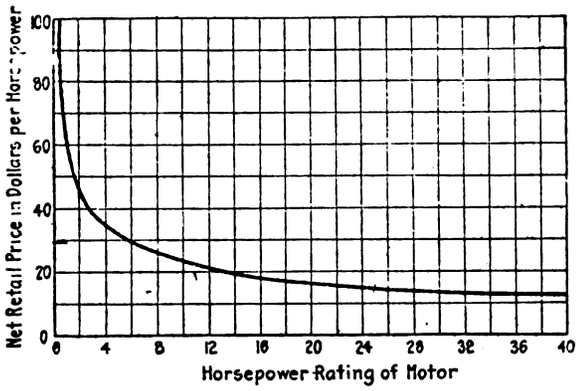

FIG. 2.—APPROXIMATE VARIATION IN COST PER HORSEPOWER FOR DIFFERENT-SIZE MOTORS.

Under the principal advantages are included power savings (already discussed) and increased production. The latter is brought about largely by cutting down the time required to perform some or all of the elements which constitute the cycle of the operation.

Those points which contrast the group and individual-drive methods are summarised here in Table II.

Table II.—*Comparative Factors to Consider.*

GROUP DRIVE.	INDIVIDUAL DRIVE.
Constant friction loss in shafts and belting.	Friction loss in motor and machine when operating only.
Control of speed limited by the number of cone pulley steps.	Control of speed limited only by the number of notches on the controller and by the gear ratios.
Reversing must be accomplished by a clutch or by crossed belts.	Reversing may be accomplished by the handle of a controller.
Difficulty in stopping the machine tool at any given point.	The machine tool can readily be stopped at any desired point.
Speed increments are usually large.	The speed increments may be made as small as desired.
The size of the cut is limited by belt slippage.	The size of the cut is limited only by the mechanical strength of the machine and by the motor torque.
Difficulty is experienced in locating causes of delay in the work.	Delays in the work may easily be detected by the use of the graphic meter.
Changes in the location of machinery difficulty because shafts are fixed in position.	An individually motor-driven machine may be moved readily to suit the convenience of production.

It is generally conceded that the individual motor is the most economical for the larger machine tools, such as milling machines, which require from, say, 10 H.P. to 75 H.P. each, for large lathes and planers and other large machine tools. When smaller machines are concerned the problem requires more consideration.

Trade Parliaments and Their Work.

By E. J. P. BENN.

VII. FINANCIAL FACILITIES.

The Minister of Reconstruction has appointed a Committee, composed chiefly of financial experts, to study the question of financial facilities for trade and industry, and to report as to whether our banking system and bankers' practice is adequate to meet the requirements of our traders when they are once again able to resume normal operations. It is well known that the financial position of a great many of our industries will need the most careful handling when war work is no longer required of them. Such elaborate precautions have been taken during the course of the war to see that these people were not allowed to profit out of the nation's need that in many cases manufacturers will find themselves without the necessary resources to undertake those extensions and developments upon which we shall rely for the employment of the population.

The case of the aircraft industry is, perhaps, the outstanding example of the sort of troubles that I have in mind. There were very few aircraft workers prior to 1914 who were able to show any profits at all, and the industry was carried on by a small group of enthusiasts and in the main at a loss. Then the war broke out and a sudden demand arose for more machines than could be made. Aircraft manufacturers everywhere extended their works, multiplied their machinery, and have by now established one of the biggest industries of the country. They have also provided facilities for an output far in excess of anything that is likely to be required when hostilities come to an end. For this purpose huge sums of money have been sunk in building and plant and the capital of the industry has increased enormously. But in the meantime, income tax and excess profits duty surveyors have been busily at work, and the bulk of the profits of this trade, which has literally saved the nation, has been taken into the Exchequer. They are further, in common with all manufacturers, barred from writing down plant and machinery to the extent which prudence demands. These people will, therefore, find themselves with a huge equipment bought at war prices, with correspondingly large capital, with orders suddenly reduced by half, and with no reserve funds. The position of other manufacturers in other trades, although not so desperate as that of the aircraft manufacturer, is much the same. In these circumstances most of these people will require financial facilities when the war is over if they are to carry on and do their share towards producing the goods that will be required to pay for the war.

This is the justification for the appointment of a Committee at the Ministry of Reconstruction to inquire into this big question, but the Committee should go beyond that. It ought to review the whole system of joint stock banking and report on the need or otherwise for an alteration of the methods and practices of bankers as we know them to-day. But no Government Committee can form really useful conclusions on subjects like this unless they can have for their guidance the trade opinions of the people most affected. This, therefore, is another reason why Trade Parliaments should be brought into being without delay, so that each trade may express its needs in this great question of credit and finance. The need for production in the future will be so great that the powers over industry held by the banking community must be controlled and restricted. We must never again be liable to a situation where orders exist, materials are ready, labourers available, and finance stands in the way. Much of the unemployment in the past has been due to the bank rate, and Labour will require to know that no avoidable restrictions of this kind are to be imposed upon it in the future. Banks have always been ready to help some trades. For instance, the stock and share trade has been carried on entirely with money provided by joint stock banks. Anybody can get without any question 80 or 90 per cent. of the total value of all Stock Exchange securities held by him. People are now beginning to ask why similar facilities cannot be offered to producing trades. It is indeed hard to see why the dealer in Mexican tramway shares can be financed by the joint stock banks while the maker of boots and shoes is denied such facilities. Inquiry into these matters is all the more urgent in face of the present development whereby our leading banks are coming together and amalgamating. We are getting very near to the stage when the banks, like the Press, will be controlled by one or two leading people. In these circumstances it is quite imperative that the leading industries of the country should take counsel together, and say in unmistakable language what sort of banking facilities would suit them best. It should never be forgotten that the banker is merely the accountant of industry; that money is often no more than a book entry, and

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the position of the banker, therefore, in the industrial world should be made to correspond more nearly to that of the accountant in an industrial establishment. When Trade Parliaments look into this question of financial facilities they will probably have something to say of the system which has, hitherto, found most of the money for German trade in London while denying money for British trade in Bradford or Birmingham. There is, in fact, no stronger case for the establishment of Trade Parliaments than the case which may be stated as Financial Facilities, and there is no matter which would give a better opportunity for co-operation between Labour and Capital. The average employer knows no more about the banking system than does the average labourer. Both have been in the past at the mercy of the money magnate, and it is high time that both got together and endeavoured to discover what the real position is.

(To be continued.)

Institution of Electrical Engineers.

ANNUAL GENERAL MEETING.

The annual general meeting of the Institution of Electrical Engineers was held on Thursday, May 30, with the President (Mr. C. H. Wordingham) in the chair.

The PRESIDENT dealt with and moved the adoption of the annual report of the Council (an abstract of which is given later). He remarked that the membership had kept up satisfactorily, there being now 6,667 members, and there could now be no question of the weight the Institution must carry in any action with which it was associated. The roll of honour was a matter of great pride, though also of grief, to the Institution and to the individual members who were afflicted in consequence of these men having given their lives. They had also lost several of their members by death, and those present would doubtless agree in singling out the late Mr. Duddell, one of their most esteemed past-presidents, for special mention. It was a matter of the greatest possible grief that he should have been cut off at so early an age, and that the brilliancy of such a man should be lost to the Institution and to the world in general. Having regard to the fact that the war had been in active progress during the session, it was a matter of satisfaction that they had been able to maintain the meetings fortnightly, and had very excellent Papers and well-attended meetings and in most cases exceedingly good discussions. There was a reference in the report to suggestions received from local sections. The local sections were being developed very rapidly and completely, and he thought this would be beneficial to the Institution. They were being brought into the closest possible connection with the Council, and were about to carry out a large amount of work locally. The general idea underlying the action now being taken was that there were really no local sections, but that the members, whether in London, Manchester, Scotland or elsewhere were the Institution. The suggestions from the local sections with regard to the regulations for the electrical equipment of ships would, he was sure, be of material help to the committee, and he hoped the regulations would be published in the late summer or early autumn. The report of the Board of Trade Committee on electricity supply which had just been issued had thoroughly justified the position the Institution had taken up on the matter, and showed that Mr. Sparks' evidence had been most useful, and that great weight had been given to it. The results of the organisation for the training of disabled sailors and soldiers as sub-station attendants had been very satisfactory, 254 men out of 285 commencing the course, having been actually placed. The action taken in regard to fuel oil, referred to in the report was a valauable piece of work of a commercial nature which the Institution did during the session. A hard-working committee, under the chairmanship of Mr. Mordey, had been considering the Patent Law. It was felt that strong exception could be taken to some of the provisions of the new bill, and the Board of Trade consented to receive the views of the Institution on the matter. The committee would shortly be prepared with a report. With regard to the metric system, the question referred to in the report arose in connection with the Standards Committee. The main committee of the Standards Committee gave permission to the Sectional Electrical Committee to draw up its specifications in terms of metrical measures if the section of the electrical trade affected desired it. He was chairman of one or two of the panels, and he found one panel wanted British measures and another metric measures, and they got into a hopeless tangle. In one instance they had a cable lug, which was supposed to be in metrical dimensions as regarded its shape, but it had two holes through it, both of which had to be in British measures. The point was that merely printing two parallel columns of figures was not all that was necessary; the point at issue was whether the fundamental dimensions to be standardised were going to be in the even round figures of inches or mils. At the conference referred to in the report the discussion was confined to the one narrow issue, and they did not make a pronouncement on the whole question of metric versus British. The conference was unanimously of opinion that this was not the proper time for the Engineering Standards Committee to change its practice in that respect. He thought there would soon be results to show of the work of the Executive Committee of the Engineering Training Organisation. With regard to the Board of Trade Order for Reduced Consumption of Electricity, a deputation representing the Institution, the B.E.A.M.A. and others interested succeeded in convincing the Deputy Coal Controller on most of the points on which they wished him to modify his views, and it seemed that their representations would have the effect of materially improving the position from the point of view of the electrical supply authorities. The Benevolent Fund received very few applications for assistance, and he thought there must be many cases in which help was needed and of which they did not hear. He now formally moved that the Council's report be received and adopted.

Mr. C. P. SPARKS, in seconding the motion, remarked upon the enormous amount of work that had been done by the President.

Mr. H. L. P. BOOT, referring to the fuel oil question, spoke of the peremptory letter the engineers received informing them that if they did not convert their engines to the use of tar oil and have them running by March 31—a little under three weeks—the whole of the oil supply would be practically cut off. It seemed an absolute impossibility to change a Diesel engine over in the space of three weeks. He argued the matter with the department concerned, and they informed him that there was a gear which could be installed in a few days. He experimented with it in a power station for which his firm were engineers, and the experiment was a failure, as he had rather thought it would be. This resulted in considerable expense, as it caused the usual troubles when using tar oil, such as cracked pistons and other things. He could not help thinking somebody advised that Government department to compel other engineers to fit a gear of that description indiscriminately or have their oil supply stopped. In his particular case the department took no responsibility.

The PRESIDENT said the Institution had nothing to do with the recommendation referred to by Mr. Boot. They did not recommend the gear.

Mr. BOOT said, in regard to the Board of Trade Order for the reduction of consumption of electricity, ordering all consumers to reduce their consumption by one-sixth was very hard on those who had been patriotic during the war, and already reduced their consumption to practically the minimum. He hoped that decision would be altered, and that a combination of electricity and gas would be taken, which would work out much fairer. Would the committee consider the question of recommending that the consumption allowed should be based upon the number of rooms and the number of occupants? This had worked extremely well with regard to coal control.

The PRESIDENT said those views had been very strongly put forward by the Institution Committee to the Coal Controller.

Mr. H. ALCOCK said he regretted that the Council dismissed the metric system in such curt language. He feared that opponents of the metric system would charge the Institution with having changed its coat in the matter. He thought that a statement should have been made in the report that the Institution was in favour of the adoption of the metric system, although it would be unreasonable to expect the electrical or any other class of engineers to isolate themselves by agreeing that the fundamental units should be based on the metric system before the system was adopted by the community as a whole.

Mr. E. G. C. BARTON said thay had had a meeting there for confirming or otherwise the previous decision—*i.e.*, adhesion to the metric system or not. The President, in his concluding remarks at that meeting, drew the conclusion that they were an undecided body and very much mixed in their views, but at that meeting there was no opposition worth talking about; nearly everybody who spoke was in favour of the metric system. He thought it was open to the President to add something to-day to give the idea that if it were open to the community to adopt the metric system then the conference would not have recommended that the inch measurements should stand.

The PRESIDENT said the meeting to which Mr. Barton referred discussed the metric system broadly, but the point at issue—whether it was to the benefit of British trade to adopt the system—was only touched on by one speaker. The manufacturers were conspicuous by their absence. The B.E.A.M.A., the Cable Makers' Association, and others must be consulted before making any definite pronouncement as to adopting the system. To him the meeting referred to was an intense disappointment, and it did not justify a pronouncement on the part of the Council on behalf of the electrical industry that the metric system should be adopted now.

Mr. E. T. WILLIAMS said during his connection for about 20 years with the Institution it had grieved him to see standing aloof men who were qualified to join. He thought any qualified electrical engineer was failing in his duty if he did not join the Institution. Individual members might use the power they had in making appointments by making membership of the Institution a qualification of considerable importance. Every member should do his utmost to back the Council.

Mr. G. SEMENZA (local hon. secretary of the Institution in Italy) said the Italian Electrical Association was also working on specifications for the electrical equipment of ships, and he suggested that it might be well to try and put those and this Institution's specifications together in order to have an international agreement on that point. It was desired by everybody in Italy that England should secure the commerce previously held by Germany, and one of the essential things to obtain that was the

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adoption of the metric system. The Italians thought that was of the highest importance.

The PRESIDENT said he was extremely interested to know that the Italian Electrical Society was considering the question of ship wiring rules. The American authorities approached the Institution on the matter, but they did not begin the work, and it was thought best for the Institution Committee to complete their rules, and then send them to the American Institute for their comments. They welcomed the co-operation of the Italians, as they looked forward to the rules becoming to all intents and purposes universal. The Council had set up a small committee which would watch all these questions of international co-operation.

Mr. S. EVERSHED said in past years there was too much of the professorial element in the Institution, but he was one of those who wanted to see the scientific side of the Institution developed much more than it had been. He did not object to the commercial side being developed also, but, as a manufacturer, he realised perhaps more clearly than some members that the English manufacturers wanted boosting on the scientific side.

The PRESIDENT said he agreed with Mr. Evershed. The Council were taking steps to promote that side of the Institution's work for the next session. In connection with research the Council had decided that day to offer a prize of £25 for a Paper on the co-ordination of research in works and laboratories.

Mr. P. M. BAKER suggested that a channel might be provided by which a member could approach a committee dealing with a special subject.

The PRESIDENT said if a member wrote to the secretary giving any suggestions for the consideration of a committee they would certainly be sent on to the committee.

Mr. H. ALCOCK suggested that when a committee was announced in the "Journal" as having been appointed to consider a special subject the announcement should be accompanied by an invitation to members to send suggestions on the matter, and the PRESIDENT said it was a good suggestion, and would receive consideration.

Mr. J. E. KINGSBURY (hon. treasurer) then moved that the accounts be received and adopted. He said the increase in the surplus for the year was due to the fact that the increase in expenditure was small compared with what it would have been if their normal work had been continued. The Council had thought it advisable to look forward to a possible change of an unsatisfactory character, and to make a new departure by putting £3,000 to a reserve fund.

Mr. C. P. SPARKS seconded the motion, and it was carried.

The meeting concluded with a number of votes of thanks.

REPORT OF THE COUNCIL.

In the report of the Council it is stated that the membership shows a net increase of 54, compared with a decrease of 63 in the previous year.

Admission of Shift Engineers as Associate Members.—The Council have adopted a rule that shift engineers seeking election must have had responsibility for two years for the plant and staff in a power station or substation where 12 men (4 per shift) or more are employed, or for a section of the work (such as the boiler house or the engine room) in a station having not less than 2,000 kw. of load. In addition, the candidate must satisfy the regulations as regards training and education as an electrical engineer.

Employment Register.—The Council have decided to set up an Employment Register for assisting members serving in H.M. Forces or engaged on war work in finding suitable employment when demobilisation takes place.

Roll of Honour.—Thirty members have during the year given their lives in the service of their country ("Journal," vol. 55, p. 537; vol. 56, "Institution Notes," No. 1, p. 3: No. 4, p. 15).

Meetings and Papers.—Sixteen ordinary and 3 special general meetings and 22 council meetings have been held. Committee meetings and conferences numbered 112. Of these the benevolent fund, finance, membership, papers, patent law, research, ship electrical equipment, and wiring rules committees held 68 and other committees and conferences dealing with disabled sailors and soldiers, electrical cooking and heating, electricity supply, electric supply employees, enemy submarines, examinations, fuel oil, increase of membership, lead covered conductors, local sections, metric system, model general conditions, national proving house, patents and designs bill, Reserved occupations, "Science Abstracts," &c., held 44. There have been 47 meetings of local sections.

Premiums for Papers.—The following premiums for papers have been awarded by the Council to Mr. E. B. Wedmore, Mr. E. C. McKinnon, Mr. F. G. C. Baldwin, Dr. S. F. Barclay, Dr. C. C. Garrard, Mr. W. A. Gillott, Mr. T. M. Hunter, Mr. C. C. M. Jacobs, Mr. A. E. Moore and Mr. J. H. Shaw. No students' premiums have been awarded, but the papers read will be taken into consideration at the next award of students' premiums.

Local Sections.—The Council have received several valuable suggestions from the committees of the Local Sections for increasing the usefulness of the Institution, and these are being considered.

Wiring Rules.—It is not proposed to undertake a further general revision of the Wiring Rules until after the War, but where the Council are of the opinion that any clauses in the present edition of the Rules require amendments alterations will be made. The rules relating to lead-covered conductors and earthing are receiving attention. The Council have agreed to amend Rule 62 so that it does not apply to meters for currents up to 100 amperes made in accordance with the British Standard Specification for Consumers' Electric Supply Meters (E.S.C. Specification No. 37).

Board of Scientific Societies.—The Institution has made two contributions of £50 each towards the expenses of the Board of Scientific Societies.

Regulations for the Electrical Equipment of Ships.—The Committee engaged in drawing up these regulations have not yet completed their work, but the first draft of the regulations is ready. Informal meetings of the Newcastle and Scottish Local Sections have been held to discuss the draft. Standards will be set up in the regulations for securing uniform conditions and interchangeability in connection with many of the articles now on ship installations, and in every case the standardisation has been referred to the Engineering Standards Committee, who are issuing standard specifications dealing with the respective items. These specifications will be referred to in the regulations, in order to avoid overlapping of work and to ensure that standardisation is effected by the body specially set up for that purpose.

Research.—The Panels set up by the Council to organise researches and draw up standard specifications in connection with porcelain, ebonite, mica and micanite, fibrous materials, insulating varnishes, and composite materials, have made considerable progress, and provisional specifications have been drafted for several of the above materials. In the case of composite materials, arrangements have been made for carrying out researches at a number of universities and technical colleges. Insulating materials for magneto distributors previous to the war were mainly obtained from enemy countries. The British Electrical and Allied Manufacturers' Association are actively co operating with the Institution in this matter, and the specifications are the result of their joint labours. The Department of Scientific and Industrial Research appointed in May 1917 an Electrical Research Committee consisting of three members nominated by the Council of the Institution and three by the Council of the B.E.A.M.A. to be responsible for the researches on insulating materials, and the department has made a grant of £2,050 to the committee. The President (Mr. C. H. Wordingham) is chairman, and Mr. Rowell, secretary.

Further progress has been made with the research on buried cables, but results are not yet available for publication. The research department has provided £750 towards the cost of a special machine at the National Physical Laboratory for the purpose of the tests.

The reports of six investigators who have been carrying out the following tests in insulating oils are nearly ready. The question of publishing the results will depend upon the sanction of the Research Department being obtained. The expenditure on this research during 1917 was £467, of which the Research Department contributed £421.

Electricity Supply.—In March 1917 the Board of Trade appointed a Committee to consider and report what steps should be taken to ensure an adequate and economical supply of electric power for all classes of consumers, particularly industries which depend upon a cheap supply of power for their development. Mr. C. P. Sparks (then President) attended before the committee and gave evidence on behalf of the Council.

Members on Naval or Military Service.—The number of members serving or having served in the Navy or the Army since the outbreak of the war is 1,869.

Employment of Disabled Sailors and Soldiers.—The training of disabled sailors and soldiers as sub-station attendants which had been carried out under the auspices of the Institution at the Northampton Polytechnic Institute, Clerkenwell, E.C., since June 1916 was taken over by the War Pensions Statutory Committee in June last.

Institution Premises.—The portion of the Institution building occupied by the Institution was taken over by H.M. Office of Works on April 6, 1917, and the offices of the Institution were transferred on that date to 1, Albemarle-st., W. 1. The meetings of the Institution have been held at the Institution of Civil Engineers.

Fuel Oils.—A Committee was appointed by the Council on Dec. 13, 1917, to consider the question of the supply and prices of fuel oils to electricity supply undertakings. A deputation of the Committee waited upon the Controller of Munitions Mineral Oil Production, who decided that a Committee of the Diesel Engine Users' Association should arrange for the supply of suitable oils, &c., to electricity undertakings. Messrs. A. H. Dykes, W. Fennell and J. C. Wigham have been nominated by the Council to serve on the Committee. A letter has been addressed by the Controller to users of Diesel engines, advising the adoption of tar oils under licence from the Department.

Legislation.—A private meeting of members of the Institution was held on Feb. 28, 1918, to consider the provisions of the Patents and Designs Bill. The views expressed at the meeting and suggestions for the improvement of British Patent Law (including an automatic moratorium for a period equal to that of the war) are under consideration by a Committee appointed by the Council.

The Council passed, in December last and communicated to the President of the Board of Trade, a resolution that the Council unanimously supports the Non-Ferrous Metals Bill, which is designed to keep control of the supply of non-ferrous metals in British hands.

A conference of representatives of the Institution, the B.E.A.M.A., the Cable Makers' Association, the Tungsten Lamp Association and the Battery Makers' Association on March 25 last passed a resolution in regard to the use of the Metric System by the Engineering Standards Committee, to the effect that all electrical standard publications shall primarily be in inch measurements, and may give in parallel columns or supplementary tables the metrical equivalents; provided that if the,

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manufacturing interests in the trade concerned express a desire for it to be so drawn up, a sub-committee or panel may draw up a standard table either in metric measures alone or in metric measures with inch equivalents in parallel columns, or in metric measures with a supplementary table of inch equivalents.

Engineering Training Organisation.—The Council are taking an active interest in the proceedings of the Engineering Training Organisation and are contributing £100 to its expenses for the current year. In accordance with the terms of a resolution passed at the inaugural meeting of the organisation on Oct. 25, 1917, the committee of the organisation includes representatives of the Board of Education and various associations of engineers and educational associations. The President (Mr. C. H. Wordingham) has been nominated by the Council to be the representative of the Institution on the Organisation, and has been elected Vice-Chairman of the Executive Committee of the Organisation Council.

Electric Cooking and Heating.—A conference of representatives of makers of electric cooking and heating apparatus, of supply undertakings and others, summoned by the Council, was held on Feb. 20 last to consider what steps can be taken to promote the advancement of cooking and heating by electricity. The Council have decided to appoint a Committee to prepare a detailed scheme for an Electrical Cooking and Heating Association, and it is proposed to invite representative Associations to nominate members to serve on the Committee.

Reduced Consumption of Electricity.—In April the Council summoned a conference of representatives of supply undertakings to consider whether the Institution should take any steps in connection with this matter. The conference decided to advise the Council to submit certain observations to the Board of Trade and to urge that the Board when considering cases of excessive consumption under Sections 13 and 14 of their Order in regard to the matter should decide cases on the principle of whether or not the use made of gas or electrictiy subsequently to the promulgation of the Order has in fact assisted in the saving of coal.

Accounts.—The margin to the good on the revenue account, £2,089. 18s. 11d., after providing £3,000 for mortgage redemption and contingencies, compares with £3,776. 17s. 7d. in 1916. Mortgages in the accounts for 1916 stood at £32,719. 4s. 10d., and they now stand at £31,914.

The total of the Life Compositions Fund on Jan. 1, 1917, was £5,526. 15s., and a further amount of £67. 4s. was received in payment of Life Compositions during the year, a total of £5,323. 19s. Out of this £40. 10s. has been transferred to general fund on account of life compositions of members deceased during the year, leaving to the credit of the fund £5,283. 9s.

Since the accounts for 1917 were closed a further £4,000 5 per cent. National War Bonds has been purchased by the Institution.

Benevolent Fund.—On Dec. 31, 1917, the capital account of the Fund stood at £4,642. 3s. and the accumulated income at £2,062. 12s. 2d. The donations and subscriptions in 1917 amounted to £194. 2s. Grants made were 14, amounting to a total of £197. 15s.

Wave Velocity and Capacity of Horizontal Helices in Wireless Telegraphy and Transmission Line Protective Apparatus.

By A. PRESS.

In electric circuits in which horizontally disposed helices are subjected to very high-frequency currents stationary waves of potential and current are produced, which effects go variously under the names of Lecher or Seibt phenomena. Thus, in an experiment mentioned by Dr. J. A. Fleming in his book "Electric Wave Telegraphy" (1916), page 350, reference is made to a coil 210 cms. long having 5,465 closely wound turns with a diameter of 4·78 cms. in which the wave velocity was only about the 1/150th part of the velocity of light. The measured capacity was of the order of 45 micromfds. It is the object of this Paper to show first how to estimate the wave velocity of a horizontally disposed coil, and, secondly, to estimate the actual faradic capacity of the latter.

Dr. Louis Cohen in THE ELECTRICIAN, Feb. 21, 1913, showed how the formula

$$V^2 = 1/LC \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

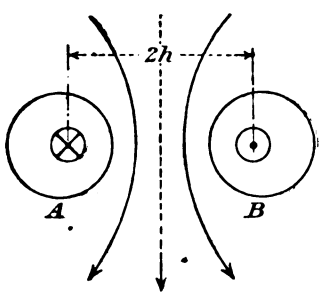
could be used for calculating the capacity of various arrangements of horizontally disposed wires once the inductance was known. The inductances have, as a matter of fact, been fairly amenable to mathematical investigation; not so the capacities. Whereas V^2 in formula (1) is the square of the velocity of light, *i.e.*, 9×10^{20} cms. per second, it is well known that the above formula does not hold for calculating either the capacity or the inductance of spirally arranged wires since the velocity is generally very much less than normal.

A moment's consideration will explain a good deal of the apparent discrepancy. In the cases in which the above formula does hold the magnetic effect of the return path of current is taken into account, so that both the inductance and capacity are considered as functions of the distance separating the go-and-return current paths. Thus, if in the figure we wish to calculate the inductance of the wires *A* and *B*, one has the formula

$$L_s = 4\cdot6 \log [2h\ r]^* \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where $2h$ is the distance between the wire and image whether real or imaginary and L_s is measured in cms. Where an overhead wire has a ground return, h represents the distance from the wire to ground and it is seen that the flux linkages for each wire still remain what they were on the understanding that the image wire is equivalently assumed at a distance h below the earth's surface.

If, then, instead of a straight wire one has a helix, the inductance is still localised to the conductor. To be able to use formula (1), however, it is now necessary to consider an overhead line equal in length to that of the axial length of the helix, but as existing in an electromagnetic medium for which the permeability μ is greater than unity to correspond with the actual increased inductance of the helix per unit length over that of a straight line standard. It should, therefore, follow



that since the straight line circuit has inductance L_s given by formula (2) and the helically wound wire has effective inductance per centimetre axially

$$L_w = \frac{\pi^2 D^2 N^2}{l^2} \text{ (cms.)}\dagger \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

that the permeability of the medium should be taken as

$$\frac{L_w}{L_s} = \frac{\pi^2 D^2 N^2}{l^2 \times 4\cdot6 \log \left(\frac{2h}{r}\right)} = \mu. \quad . \quad . \quad . \quad (4)$$

In other words, since it is well known that the velocity of light in a medium of permeability μ is $V/\sqrt{\mu}$, the actual wave velocity axially ought to be the ordinary light velocity in air reduced by the factor $1/\sqrt{\mu}$.

In the example quoted the inductance in centimetres per centimetre axially by formula (3) worked out to $1\cdot527\times10^5$cms. On the other hand, the Lecher coil was raised horizontally 50 cms. above the earth, so that in the equivalent circuit for which formula (1) holds, the quantity $2h$ is 100 cms. Again, for r one should take the radius of the Lecher coil. That this is so is because the faradic capacity ought to be substantially the same as for a solid metallic cylinder of the same radius as that of the coil with its closely wound turns of copper wire. The radius of the helix is given as 2·39 cms. and the distance h to ground 50 cms., so that $4\cdot6 \log (2h/r) = 7\cdot45$, and thus by (4)

$$\mu = \frac{1\cdot527\times10^5}{7\cdot45}; \quad \frac{1}{\sqrt{\mu}} = \frac{1}{143}.$$

Thus the wave velocity of the coil is 1/143rd part of the velocity of light. This agrees sufficiently well with the estimate made by Dr. Fleming after actually measuring the microscopic faradic capacity of the coil.

An earlier statement above implied that for transmission line reactances when coupled to oscillating circuits to absorb

* *See* "Calculation of Alternating Current Problems," by L. Cohen, p. 68, or "Overhead Transmission," by Still, p. 239.

† Fleming, loc. cit., p. 349.

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the energy of lightning discharge, the faradic capacity per centimetre axially of the wound reactance will be given by the formula

$$C_w = \frac{1}{4{\cdot}6 \log\left(\frac{2h}{r}\right) \times 9 \times 10^5} \text{ mfds per cm.* } \quad . \quad . \quad (5)$$

If, then, the calculation is carried through as above it will be seen that the capacity of the helix under discussion ought to be

$$lC_w = \frac{210}{7{\cdot}45 \times 9 \times 10^5} = 31{\cdot}3 \text{ micro-mfds.}$$

The value by measurement according to Fleming was of the order of 45 micro-mfds. However, in all such high-frequency phenomena not only is the inductance variable per unit of length axially of the coil, but the same thing is true of the capacity. In all the above work "end effects" were totally ignored, yet in a more precise theory dL/dx and dC/dx would be taken into account and instrument integrations whether of capacity or inductance ought only to be used for rough estimation.

Some Transient Phenomena in Electrical Supply Systems.

The following is an account of a discussion on Prof. E. W. Marchant's Paper before the Institution of Electrical Engineers at Manchester. An abstract of the Paper appeared in THE ELECTRICIAN of May 24 :—

Mr. L. B. ATKINSON said that the subject lent itself to mathematical treatment, and gave a series of examples to illustrate the desirability of a clear conception of the combination of simple physical facts which formed the basis of these effects.

Prof. MILES WALKER referring to the author's diagrams for transformers, remarked that the descent of the current curve while the voltage was still of the same sign, had been attributed to the large core-loss current. There appeared some uncertainty about the explanation. Apparently the current curve began to rise at a point where the voltage was nearly zero, and this fixed the position so far as the phase of the voltage was concerned. If three transformers were connected in star, the current had not merely to pass through one leg, but also through the other two legs, and as soon as a sine curve was departed from, an extremely complicated phenomenon was obtained. In tests made by the late W. Duddell at the Deptford power station to ascertain the cause of breakdown of cables, oscillograph curves proved that while the voltage wave of the generator was smooth, with only small ripples, the wave form of the voltage when the generator was connected to a certain number of cables, showed enormously increased ripples due to resonance. The form factor of the wave-form was raised to 1·9. Ripples in the wave-form of generators should be eliminated.

Dr. WM. CRAMP said the four sections into which the author had divided his Paper admitted of classification according to the characteristics of the circuits involved. In the first two sections inductance and resistance only were present, the general ratio, however, being different because of the air gap in the second case. In the third and fourth sections inductance, resistance and capacity were involved. The speaker then proceeded to analyse the conditions applying in these respective cases, showing how the Steinmetz formula and other expressions given in the appendix of the paper could be applied, and in particular the method of determining the relation between the maximum current due to a high frequency oscillation and the maximum steady current. Apart from oscillatory currents the current rush on switching in a transformer, whether iron in the circuit was saturated or unsaturated, had remanent magnetism or none, would appear in a definite form in the transformer secondary P.D. As, apparently, the transformer secondaries were always open on the switch in, confirmatory evidence of the current curves could have been obtained by oscillograph records of the secondary P.D., and the flux curves corresponding to the abnormal currents could have been very approximately deduced. This point was emphasised by Prof. A. Hay in a series of articles in THE ELECTRICIAN 18 years ago.

Mr. G. A. JUHLIN said the question of the current rush in transformers was of considerable importance. Remanent magnetism was nearly always present. Regarding the author's comment on "butt" type transformers, continental transformer builders put air gaps in 25-cycle transformers, one case of a Bergmann transformer showing a 1/32 in. air gap. If saturation were present in the iron there would be a considerable portion of the flux passing in the form of leakage flux, which would give rise to a double frequency wave and ought to show up in the voltage curve. Many instances could be cited when trouble had arisen due to rush in induction motors, particularly squirrel cage motors.

Mr. VERNIER said that the use of cable charging devices appeared quite unnecessary nowadays—even in such unusual cases as 20 miles of 20,000 volt cable. Modern cables had factors of safety varying between 7 and 15 according to voltage, and there was no ground for apprehending trouble. An increase to 60,000 volts and over might cause the return of these devices as the factor of safety on the cable would be reduced. Breakdown might be due to the high frequency of a surge rather than to high voltage, cables in one case breaking down at a right angle bend. Surges had been known to jump across two 6,000 volt bus bars 6 in. apart in air. The piling up of voltage at points where line constants changed had also been encountered in practice, *e.g.*, when an extra high tension overhead line was connected to an underground cable, and a factor of safety of at least five should be specified for insulation at such points.

Mr. F. A. LAWSON referred to some oscillograph records of a slip ring motor starting on light load with the starting resistance in. There was a displacement of the exponential type illustrated in the paper, which was sufficient to disturb the current and push it above the axis by 30 per cent. The greatest disturbance of current flow was obtained at a period when normally the current would be passing its maximum value, and a minimum at a point when normally the current passed through zero. On the stator of this induction motor there was a small coil in the air gap and an oscillograph record was taken, on starting up the motor, of the E.M.F. developed in the coil by the rotating field. The record showed that the field developed to its full value within half a period, the wave being practically a sine wave and of constant slope throughout the record.

Mr. H. A. RATCLIFF considered the momentary excess current value more serious than the pressure value. It was better to switch high tension feeders directly on to the 'bus bars, for with an approximation to a sine wave it was unlikely that the momentary abnormal pressure would ever exceed double the peak value of the wave. If motor generators or charging transformers were employed to run up gradually to full pressure there might be accentuation of harmonics in the pressure wave. Comparatively low values of oscillatory currents might cause damage in auxiliary apparatus owing to the high value of the locally induced voltages. Evidence of the effects of such transients was furnished by high frequency sparks flashing over distances of 4 or 5 in., sparks passing between neighbouring primary turns of current transformers, and the forcing asunder of primary and secondary windings due to mechanical strain.

Mr. S. FERGUSON suggested the establishment of a National Testing Authority to report on breakdowns. Surges might originate in one part of a system but only assume dangerous proportions when entering another part, having different characteristics. Switching operations were largely responsible for surges and it was now general practice to embody charging resistances in oil switches for use with transformers, induction motors, &c., of 500 kw. and upwards. Oil switches could be relied upon to open a circuit at or about zero current, but air-break apparatus occasionally opened a circuit when the current was at a maximum. Air-breaks were still used on some low pressure alternating current systems although some authorities now insisted on oil-breaks for 300 amperes and upwards. In order to prevent surges in overhead transmission lines damaging sub-station gear it was advisable to run a length of underground cable between them. Continental current instrument transformers occasionally had the primaries short-circuited by a non-inductive resistance (sufficiently high not to materially affect the accuracy of the transformer ratio) in order to allow surges to pass without damage to the transformer.

Mr. WM. T. TALLENT BATEMAN referred to supply systems having electric steel furnace connected where there was evidence of heavy surging. A small 33,000 volt system behaved in exemplary fashion until two furnaces were connected when flashing between 'bus bars 5 in. apart took place, due possibly to the natural instability of the arc. The subject deserved thorough investigation on the lines adopted by Prof. Marchant.

Mr. P. H. NELSON suggested that the author's results be summarised as follows :—

1. "Butt" type transformers do not induce the same serious surge when switching on as "Shell" type transformers.

2. The natural frequency of a system should correspond to the working frequency (the resonant case).

3. Reactance coils should be installed to choke down surges.

4. Protective gear should be operated in conjunction with a contact maker which would arrange the closing of the switch at the correct point on the voltage curve.

5. The generator should be insulated to withstand pressure so many times working pressure.

The AUTHOR in reply said there was little opportunity of experimenting on direct current circuits and practically the alternating current circuits were more important. A resonant circuit, as regards switching-in phenomena, was usually the safest, as there were no high frequency ripples. In the data referred to by Prof. Walker the line voltage was recorded because the instrument transformer happened to be so connected. The current recorded was the line current, the current transformers being connected in each line. With higher frequency transformers lower saturations were used than with low frequency, therefore, the surges given with low frequency transformers were much more marked. In most tests the voltage was across the phases, and was very constant. Records of breakdown would be most valuable but the chances of obtaining them were very remote. Cable charging devices, they were not desirable or necessary on present day systems. The author agreed with Mr. Ratcliffe in stating that current transformer breakdowns were due initially to surges.

* *See* Cohen, p. 84 ; Still, p. 26, *loc. cit.*

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The Report on Electric Power Supply.

The long-desired report of the Board of Trade Electric Power Supply Committee is now in the hands of the public. There has been much speculation as to what the conclusions of the Committee would be, more particularly owing to the somewhat recent publication of the report of the Coal Conservation Sub-Committee. The latter gave rise to considerable discussion, partly owing to the view that there should be much wholesale scrapping in favour of the "super-station," and partly due to the suggestion that electricity supply in this country might with advantage be in the hands of private enterprise rather than be controlled by local authorities.

In what follows we can only deal with some of the more salient features of the report; for the details we must refer our readers to another page.

The first important conclusion is that a new body should be set up, called the Electricity Commissioners, to whom should be transferred the existing powers of the Board of Trade, the Local Government Board, the Local Government Board for Ireland and the Scottish Office relating to the supply of electricity, and to which large additional powers would be given for regulating and encouraging the generation and distribution of electricity. That such a step is desirable has been the general feeling for a considerable time. A body of this kind would simplify matters very considerably. It would lead to uniform procedure, instead of having to deal with a number of Government Departments, and would lead to a uniform policy, in place of the old methods of legislation, which have so often been harmful.

The next important conclusion is that the existing system, under which electricity is generated for small areas, should be abolished, and that the Electricity Commissioners should divide up the United Kingdom into districts suitable for the economical generation and distribution of electricity. This may give rise to a certain amount of criticism and opposition on the part of smaller undertakings which claim to generate as efficiently as is possible by means of large stations. We cannot think, however, that this point of view will receive any considerable support. On the other hand, when we come to the question of ownership of the power stations we find a much more difficult subject, owing to the many owners already in the field. The Committee has boldly solved the difficulties by adopting the principal of single ownership in each district, District Electricity Boards being formed for this purpose. The powers of these Boards are to be somewhat larger than has generally been suggested, for not only are they to acquire all the generating stations and transmission systems at present used for public power supply and to erect new stations when and where necessary, but they are to acquire also the power stations of any railways or public utilities. It is proposed that these Boards should be nationally financed or locally financed, as may be found desirable, and that they should be composed of representatives of local authorities, large consumers, railways using electricity, and companies which are at present distributors, according to the special circumstances.

With regard to distribution, it is proposed to leave this in the hands of present distributors, more especially in the case of the larger towns, unless a complete transfer is desired; but there is a stipulation that if the station alone is transferred, then electric energy must be supplied to the distributor on at least as favourable terms as the distributor could have provided it for themselves.

There are two minor points of considerable interest. One is that the majority of the Committee are of the opinion that profits should not be made from electricity undertakings for the relief of local rates, and even the minority are of opinion that such profits should be limited to a small percentage. The other point is that provision should be made by the District Electricity Boards for displaced engineers and other officials in cases of hardship. It is anticipated by the Committee, and we think they are right in this, that there should be new and important openings for engineers through the proposed development; but, even so, it is well to make a provision of this kind so as to disarm certain criticisms which have been heard in this connection.

From the above it will be seen that the Committee do not pledge themselves to any hard and fast policy in regard to the scrapping of existing generating stations. This is a matter for the Commissioners and for the District Electricity Boards. The engineers of economical power stations need not feel that their stations are straightaway to be superseded by "super-stations" on water sites. What may be the fate of such stations in the future, however, will depend on overall efficiencies of alternative schemes. Similarly, in the case of water-side "super-stations." The respective merits of such stations plus transmission as against less economical stations without transmission must be considered in each case. This would be for the District Boards to decide. The important thing is that the electricity supply system of the country should be so developed as to give the best result as a whole. This can only be attained by means of a single authority.

We are glad to see the suggestion that the District Boards should take over the stations which have been laid down by railway companies, dock and other public utility undertakings. This is highly desirable. Owing to the favourable position in which the railway companies find themselves in regard to the purchase of coal, there is a tendency for the companies to erect stations for their own uses alone. From the national point of view this policy is altogether wrong, and it is well that it should be changed. In all cases the purchase, we are glad to see, is to be on equitable terms and not on the "then value."

There is not so much difficulty in accepting Electricity Commissioners as District Electricity Boards, which necessarily conflict with all vested interests. The Committee have decided against Joint Boards, owing to conflicting interests and local susceptibilities. On this point we think their decision is correct, and that single ownership will lead to benefits more quickly than joint ownership. Where there may, we think, be greater differences of opinion is on the question of distribution. It is here that the greatest commercial experience and incentive to a progressive policy is desirable, and it is just in these directions that District Boards, free from the need of earning a profit, may fail unless they are so constituted as to include a preponderating commercial element. For this reason there is much to be said for leaving the distribution in the hands of the present undertakers wherever they have shown themselves fully alive to their responsibilities. This course is still left open, and is even favoured. It would, however, be desirable for the District Board in each case to have the final decision.

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as to laying of mains in new districts. Otherwise, the natural tendency is for the distributor to lay mains only in those parts which are likely to show a reasonably quick return. But this policy is not sufficiently progressive if a national network is to be developed. For example, there is the question of a supply to farmers; this is important nationally, but at the moment it is speculative.

In conclusion, we think we may say that the Committee is to be congratulated on coming to unanimous decisions on an admittedly difficult subject—decisions which will probably prove acceptable to the great majority of electric supply engineers. It now remains for the Government to take action, and to take it without delay.

Progress of British Dyes (Ltd.)

On Last Friday we were privileged to make a tour of inspection of the works of British Dyes (Ltd.). It is now three years since the company began operations, and although there has been a general impression that progress has been made, very little of a definite character has been published as to what has been done.

It will be remembered that the company acquired in the first instance an existing dye works, extensions to which had already been put in hand. This formed a convenient nucleus, and the extensions were completed. Fortunately, it was possible to purchase a large tract of land adjoining these works, and thus new buildings have been erected with perfect freedom of design and arrangement. Many alternative localities were considered, having regard to the special requirements for dye-making, such as a supply of suitable water, supplies of coal and tar products, easy access to ports, and easy distribution of manufactured products. Taking everything into consideration, a site near the existing works appeared to be the most desirable, and thus various estates were purchased having a total area of nearly 500 acres. Plans were prepared and contracts let, and the first ground was cut in November, 1915.

It was very interesting last week to compare the old and the new designs. An inspection of the old works revealed the type of building which is often associated with chemical work, the daylight illumination being by no means good and the plant somewhat crowded. This does not mean, however, that excellent products have not been manufactured at these works. A trip on the works' standard gauge railway, which gives direct connection to a main line railway, brought us to the new works. Here the buildings are of a very different character. They are ample in height, with good top lighting, and are all of a standard size, being 207 ft. long by 90 ft. wide. There is a main avenue 160 ft. wide and subsidiary avenues running parallel to this so as to give easy access. The distance between buildings is also 90 ft. wide, so that such spaces may be roofed over if desired and converted into buildings for plant or other purposes.

PRINCIPLES OF DEVELOPMENT.

The Company, bearing in mind the objects for which it was formed, had cause to examine the reasons for the predominance of the German dyestuff industry and for the apparent decay of the industry in all non-German countries, and, looking at this question from the point of view of factory construction, the following considerations should be re-stated, though they have often been mentioned. Generally speaking, the manufacture of synthetic colouring matters may be divided into three stages: (*a*) The preparation of the pure raw material from the crude coal tar derivative; (*b*) the preparation of a series of chemical compounds known as "intermediate products" from the pure raw materials; and (*c*) the preparation of the finished colouring matter from these intermediate products. It was found that the German manufacturers, either individually or by co-operation, had devoted much study to the question of intermediate products, and had developed large plants for their manufacture, with a consequent cheapening in the cost of production. In fact, they were in a position to offer these compounds to non-German dye manufacturers at such prices as rendered domestic production unprofitable. The manufacturers outside Germany were, therefore, generally content to manufacture finished dyestuffs from imported German intermediate products, and consequently the manufacture of those products in non-German countries declined. It was by holding a virtual monopoly in intermediate product manufacture that the Germans really controlled the dyestuff manufacturing operations of the whole world, and so long as they retain that monopoly no non-German firm will be free from aggression. The company, therefore, adopted the policy of developing as far as possible the manufacture of intermediate products in Great Britain, a scheme which met with the approval of its leading shareholders.

An analysis of such official statistics and other information as are available of the consumption of synthetic dyestuffs in the United Kingdom before the war disclosed the existence of about 100 intermediate products of prime importance. Large plants for the manufacture of these substances have been designed and erected, and the Company is at the moment manufacturing many intermediate products on a commercial scale. Other plants are in course of manufacture and erection, and plans have been prepared for a further extensive programme of intermediate product plant construction, which only awaits official sanction. These plants are large, complicated and expensive, a very long series of processes being frequently necessary for the production of one intermediate product.

It has been estimated that, of the capital to be expended by a dyestuff manufacturing company for plant for dealing with coal tar products only, about 85 per cent. will be represented by intermediate product plant. On the other hand, the dye making plant for converting the intermediate products into finished dyestuffs is less costly and less complicated, and the processes involved are more simple. But the simple plant is useless for achieving the objects of the Company without the associated complicated plant.

A dye making factory requires not only the necessary chemical plant, but also large installations for providing services of high and low-pressure steam, electricity, power gas, compressed air, &c., and in the Company's works are to be found large boiler houses, an electric power station (containing two British Westinghouse turbo-sets of 2,000 kw., three phase, and a smaller Parsons set), a Mond gas plant, &c., together with the necessary conduits and piping for leading these services to all parts of the works. This type of construction has been very difficult to carry out under present conditions, but the provision of such services is essential.

A dye-manufacturing company also requires for its operations large quantities of certain of the heavier chemicals, more particularly mineral acids, and, since the operations of the Company were begun at a time when practically all the available supplies of such acids in the country were required for the manufacture of munitions of war, it was necessary that the Company should erect its own plants for the production of these essential commodities. Consequently the new works contain large plants for the manufacture of oleum and nitric acid. It may be noted that a considerable proportion of the oleum or fuming sulphuric acid used by British dyemakers before the war came from Germany, but the development of war industries in Great Britain has made it certain that dye manufacturers in the future will be supplied from British sources.

Owing to war conditions, construction has been unusually difficult. Steel and copper have not been readily available, and for this reason it has been necessary to give much attention to the question of substitutes, and, in particular, cast iron and home-grown timber are being used in place of steel as much as possible.

RESEARCH.

Difficulty has also been experienced in obtaining a sufficient number of trained chemists for both manufacture and research. Arrangements were made with the University of Leeds for the Company's chemists to attend, at its expense, a course of lectures on a branch of the chemistry of dyemaking. It has also been arranged with a local technical college, to which the Company has given £5,000, that young assistants shall attend part time to receive chemical instruction. A much larger scheme is now being considered by a committee of the board.

It is obvious that in this class of work research is of the utmost importance. For this reason the Company has erected and equipped two large laboratories at its works, where not only can research work of a laboratory character be carried out, but also, in models of actual dye-making plant of convenient size, processes can be thoroughly tested on a semi-manufacturing scale before transfer to the works. These laboratories are almost exclusively devoted to what may be called practical research—that is, research in connection with actual processes and also in connection with plant in course of erection. It has not been possible in the present circumstances for the Company to construct a research laboratory for the development of new fields, and arrangements have accordingly been made with the Universities of Oxford, Leeds and Liverpool for research work of this character to be carried out in those universities by members of the company's staff, under the supervision of the professor of organic chemistry and under the general supervision of the professor of organic chemistry at Oxford University, who is acting as the head of the company's research department. Important research work in connection with the future development of the Company has been allocated to these institutions, and much work has already been accomplished. Contact between the research department and the works is maintained by means of a research council, which meets

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regularly to discuss problems and progress, and which includes the heads of the University Research Colonies and the heads of the technical staff at the works.

The Company has now completed two financial years, and for both years has paid the interest on its debentures and the maximum dividend of 6 per cent. on its ordinary shares permitted by the articles of association. In its first financial year it also wrote off £200,000 for the cost of construction. The decision of the Government departments concerned as to the Company's liabilities under recent financial measures not yet having been received, it is not yet possible to state what sum may be allocated for a like purpose in respect of the second financial year.

At a luncheon at the close of our visit, Mr. James Falconer, M.P., chairman of the Company, called attention to the great importance of training chemists and engineers in this country in such a way that they were capable of working together. This co-operative effort had been secured most successfully by the Company in the development of their works. Mr. J. Turner, J.P., expressed the view that the Company would be able to produce dyestuffs quite equal to, or even superior to, those of the enemy, if the Government would see that the necessary raw materials were available.

Correspondence.

THE IMPROVEMENT OF THE TURBO-ALTERNATOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Dr. S. F. Barclay's interesting and suggestive Paper on turbo-alternator rotors prompts me to say a few words on the subject. Prof. A. B. Field has already spoken in support of the rotor design, consisting of rolled plates without a central hole, held together between forged, flanged shaft ends by the compression of chrome-nickel bolts. No more thoughtful and able designer has ever been associated with the writer in the construction, literally of millions of kilowatts, of electrical machinery. It would, therefore, seem needless for me to take part in the discussion of the subject. Prof. Field very kindly states that the construction which Dr. Barclay criticised was originated by me, but, doubtless out of consideration for me, he omitted to give the poignant reason why we adopted 11 years ago this plate construction. Doubtless Dr. Barclay has still to suffer a similar experience before he will adopt the plates.

Well, 10 years ago, one of the writer's 10,000 k.v.a. generators was completely destroyed during an overspeed test. It was made of nickel-steel forgings, supposedly of the highest quality. It is impossible at this time to enter into the causes of this accident, which the writer discussed at length several years ago before a joint meeting of the American Societies of Civil and of Mechanical Engineers, and of the Institute of Electrical Engineers. Suffice it to say that the prime cause was found in the nickel-steel forgings, and that the plate rotor took its inception from this accident.

Ten years have passed. Single units of 35,000 kw., and units of all kinds and sizes and speeds, have been executed since along similar lines with plate construction, and we have yet to record a failure in this direction. So much for the facts.

But then, there is Dr. Barclay's letter in THE ELECTRICIAN of April 12, in which he is so very hard on the plate construction. This letter contains such strong statements that failure to notice it might be interpreted as tacit agreement with his criticism. The discussion at this time at this great distance, with most of us already overtaxed, must find its warrant in the tremendous importance of the subject, so vital in its bearings upon all industries, and the very life and safety of the nation.

The genesis of a type which marked so radical a step was found in the unreliability and lack of uniformity and ductility of the materials which were obtainable from the great forge shops of the United States in the sizes in which they were required. The stresses in turbo-rotors are primarily tangential and radial stresses. The method of testing adopted by the steel manufacturers consisted in taking test bars from the rotor located in the direction of the axis of the forging. Such tests we pronounced as valueless, and we adhere to this statement.

Radial tests showed a greatly reduced ductility which we considered of prime importance in order to secure approximately uniform distribution of stress throughout the body of the forging. Tangential samples lacked uniformity as well as ductility. It thus became evident that in order to obtain material, ductile, radially and tangentially, it was necessary to shape it in such a manner as to secure work by the forge press in an axial direction. With forgings thus worked, we obtained, even for a thickness of 10 or 12 in., a very fine grain and good ductility both radially and tangentially.

For large turbo-rotors, work by the forge press in the direction of the axis is not feasible. Resort, therefore, was had to steel castings in a number of cases, and some experimental castings were literally honeycombed with test bars in order to establish an idea of the distribution of the ductility throughout the mass. The results were not encouraging.

The automobile industry has clearly demonstrated that forgings made in comparatively small sizes can be obtained with elastic properties of the very highest degree. Experiments carried on 11 years ago in the Armor Plate department of the Carnegie Steel Co., at Homestead, Pennsylvania, showed that it was possible to obtain plates approximately 2½ in. thick, made of nickel-steel, with elastic properties the like of which I have never seen in any other material excepting in extremely small automobile forgings. I think Dr. Barclay would have been interested in inspecting the test pieces, showing really extraordinary cold bends. These experiments, which were carried out on a large scale, involving over 300,000 lb. of steel plate at the outset, gave us so much confidence that Prof. Field and the writer decided to extend the use of steel plates wherever it was difficult to obtain satisfactory forgings and where the conditions of stress were of a serious character. I think Dr. Barclay's references to the answers which the theory of elasticity gives to certain of our problems were considered by us over 20 years ago. We were keen students of Barré de St. Venant's Papers as well as of Lord Kelvin's treatment of the subject. We experimented continually on the effect of hardness, the lack of ductility, the existence of sharp fillets, and the distribution of stress through the mass of the strained body. Just such theoretical considerations and their experimental application led us to the fundamental axiom that we wanted to use obly materials, the properties of which we knew, and which were ductile enough to distribute the stresses which might, for one reason or another, accumulate in certain parts. I can only answer Dr. Barclay's statement concerning the nut and bolt construction, which he calls "a very unreliable piece of mechanism in the presence of alternating or intermittent stress," by the statement that we believe that very complete contact is established between the nut and the bolt and the bearing surfaces, insured by extremely high-grade ductile steel and by an initial stress which, as Prof. Field points out, is a great many times the normal stress.

Where the steel manufacturer is also the designer and builder of the turbo-rotor, I should feel less hesitancy in using a solid rotor forging than I should where it is impossible for the designing engineer to follow the process of manufacture at the steel mill at every step. Nevertheless, I prefer to use a construction where a complete knowledge of the material all through the mass can be obtained readily by the removal of test pieces, to a material in which I have to rely upon probability as to its internal texture. But it is, perhaps, a question of degree of probability, as we cannot cut up the centres of our discs any more than Dr. Barclay can enter into the centre of his forging, although inspection of the plates after machining is a valuable check. It is not wisdom to be dogmatic, nor does it matter whether Dr. Barclay's views are right or our views. What matters is that we shall succeed in developing the safest type of turbo-rotor in which the possibility of trouble is reduced to a minimum. "For as you know, security is mortals' chiefest enemy," and as we feel that we can better supervise and control the mechanics who do the work on the assembling of the plates, than the metallurgists and workmen in a steel plant which is not under

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our control, the balance of opinion has favoured the plate rotor construction. Eleven years of experience with it is not a very long time, but it has given us a certain measure of confidence. Moreover, should failure occur in a specific unit, such failure would not be likely to overcome us all of a sudden, but it would make itself felt by vibrations and other difficulties regarding the balance of the unit. Such a rotor would not let go without warning as a solid rotor *does*, and this I consider a valuable argument in its favour. However, we do not consider the adoption of the plate rotor construction as an expedient resulting from inability to obtain high-grade forgings as Dr. Barclay puts it. We consider that the highest grade forging contains a factor of uncertainty greater than that inherent in the plate construction.—I am, &c.,

Boston, U.S.A., May 4. B. A. BEHREND.

THE EDUCATION BILL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has only just been called to a notice in your issue of May 17 concerning my amendment to the Education Bill on the subject of Works Schools. You wholly misunderstand its effect. It is not a hostile amendment to the schools, but it is designed to give the student a choice. He is not to be compelled to go to a school at his works if he prefers to go to some other school and take up a different form of study. If he wishes to go to the Works school, he may do so, but obviously we must preserve his freedom of choice.—I am, &c.

House of Commons, May 30. J. HOWARD WHITEHOUSE.

[We regret we are compelled to hold over some correspondence.—Ed. *E.*]

A Power Supply Engineers' Association.

On the instructions from the Council of the Institution, a mass meeting has been held in Newcastle to discuss the formation of the proposed Association of British Electrical Engineers, Electricity Supply Section.

Mr. MARSHALL (chairman) explained that it was not an ordinary Institution meeting open only to all its members; it was a special meeting of electrical supply engineers of all ranks, whether members of the Institution or not, called to hear from Mr. Robinson, honorary secretary of the Supply Section of the British Electrical Engineers' Association, a statement of the objects of the new Association, and, if thought fit, to take steps by resolution and by the appointment of delegates to carry the proposals of the Association into effect. Invitations had been sent to all supply undertakings in the district. The Institution was debarred by its constitution from taking action of a political character. In view, however, of the strong feeling which pervaded the country that electrical engineers had not the recognition and representation which they, as a useful professional body of men, deserved, the Council had decided to give all possible support to the formation of that section of the Association and other sections at the earliest opportunity. The position as regards electrical engineers, more particularly those connected with supply undertakings, was at present most unsatisfactory. The decisive factor, to his mind, for better representation and for economic protection was the position of technical workers, as they were affected by the Government reconstruction proposals, and more particularly by the Whitley report.

Mr. ROBINSON stated the urgent need for the formation of an Association for the material and personal protection of professional or administrative electrical engineers appeared to be proved by the recent organisation of several such bodies, each of which was catering for the interests of a very limited section of their colleagues. Organisations existed for operatives, but there remained a class of engineers who could not see their way to join operatives' trade unions, because although they were technically employees they were practically employers, or at least confidential agents of the employers of the operatives. In the electricity supply industry he classed in that category the chief engineer and manager of an undertaking and all his engineering assistants down to and including the engineers-in-charge and the assistant engineers in-charge. That class of engineer had at present no representative body to look after his material, personal and individual interests. As a consequence the social status of these engineers had been unsatisfactory, the salary often ludicrously small and the conditions of employment leaving much to be desired. Obviously men who were the employers' agents must damage themselves in the estimation of their employers if they joined operatives' trades unions, but no objection could be taken to their associating themselves together with the object of being able to make collective representation to employers or bodies of employers upon matters which concerned themselves and their life's work in a manner suggested in the Whitley Report. Some associations of the classes of administrative officers referred to had been inaugurated. The chief objection to them was that they were small and not sufficiently influential. It had therefore been suggested that a new body should be formed, to be called "The Association of British Electrical Engineers," which would be charged with the duty of looking after the material and individual interests of all administrative electrical engineers.

At first it was suggested that the new Association should not be registered as a trade union, but on further consideration it had been thought more convenient to bring it into line with the recommendations of the Whitley Report by having it so registered. The Council of the Institution considered the matter on May 30, and decided that registration as a trade union should not be objected to. The general scheme was that the Association should consist of a number of sections, *e.g.*, section 1, electricity supply engineers; section 2, electrical plant manufacturers' engineers; section 3, electrical contractors' engineers, &c. Each section would have its own Council and each Council would have representation upon the Grand Council of the Association and he would like to see the Grand Council of the Association closely allied with the Council of the I.E.E. Such an Association backed by the I.E.E. should arrive quickly at a position of great strength and influence, and should be able to bring considerable pressure to bear whenever necessary in order to secure that qualified men were preferred and employed at satisfactory salaries. It had been proposed that the electricity supply engineers' section of the Association should be composed of members and associated members having the following qualifications:—

Members should be engaged in the business of electricity supply and should be corporate members of the Institution of Electrical Engineers. *Associate Members* should be persons of good general education engaged in the business of electricity supply and they should have had at least one year's training at an approved technical college, or two years' apprenticeship in an approved firm, company or corporation, or should have been engaged in an electricity supply undertaking in a responsible technical position for at least two years.

No more detail had been decided upon at present. It was thought better in the first instance to put the matter as far as possible before every electrical engineer in the country and as broadly as possible, so that a general discussion could take place. It was felt that the best procedure would be to get the matter talked over at each local section and afterwards to call a mass meeting in London, where all concerned would have an opportunity to say "yea" or "nay" to the proposition. He believed Mr. Wordingham would act as first president, which would ensure that the Association would be launched with a good skipper at the helm. The preliminary work had been most energetically undertaken by Messrs. H. Faraday Proctor, Ed. Calvert, A. P. MacAlister, W. J. Walker, A. C. Bostel and F. D. Napier, who had been nominated to act in their personal capacity by the Associations of which they were well-known representatives.

Mr. CLOTHIER, who attended the meeting of the Council in London, was able to confirm that that meeting unanimously supported the movement. It was agreed at the Council that the Association should be registered under the Trade Union Act in order to put it on a legal footing, and to give it the necessary authority and status in connection with the reconstruction proposals. Mr. Wordingham was conferring with the officials of the E.P.E.A. with a view to incorporating that enterprise with the work of the Committee which Mr. Robinson represented. There was vital necessity for unity.

Mr. THOMPSON spoke in favour of co-operation.

Mr. CARR asked for information in regard to the manufacturers' section of the Association, and Mr. ROBINSON replied that he was at the moment only acting for the power supply section, but that he knew of at least two other sections—viz., the manufacturers and the installing engineers.

Mr. R. P. SLOAN would be interested to hear of further details as to the working of the Association, but from the information available it would have his support. He asked if a senior member of the profession, though not a corporate member of the Institution, would be debarred from full membership of the new Association.

Mr. FISHLEY thought that it would not do to run the Association on the policy of existing workmen's trade unions.

Mr. LONGMAN, Mr. CUSWORTH and Mr. BUARD having asked questions,

Mr. TURNBULL thought that there might be a difficulty arising out of a chief engineer being a member of the same Association as his junior assistants, and that difficulties might arise when representations were being made by the chief to his committee on matters concerning the welfare of his assistants.

Mr. SHEARER said it was one of the qualifications of associate membership of the Institution that the applicant should have five years' experience in a responsible position, and he suggested that a similar qualification should apply to membership of the new Association.

Mr. VERNIER and others spoke in support of the formation of the Association and the necessity for a close alliance between it and the Institution of Electrical Engineers.

Mr. ROBINSON, in replying to the questions, said that the details of the work of the Association had not been fully decided. Much was left to the outcome of the mass meeting to be held in London, at which he hoped there would be a goodly representation from the North-east coast. Whether ladies should be admitted was "beyond" him to say. As to the proposal that the qualification for membership in the Association should be corporate membership of the Institution, he stated that the

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proposal had been made with a view to giving a definite status to the new Association. At the same time, it was in the interests of the Association to include all eminent men, whether corporate members of the Institution or not; but that was a matter which would need to have careful consideration at future conferences.

Mr. THOMPSON proposed, Mr. TURNBULL seconded, and it was unanimously resolved "That this meeting of electricity supply engineers of Newcastle and district, promoted by the Newcastle Local Section of the Institution of Electrical Engineers, supports the formation of an Association of British Electrical Engineers, and appoints delegates to represent it at a mass meeting to be held in London under the chairmanship of the president of the Institution of Electrical Engineers."

The following delegates were appointed: Messrs. W. T. Dalton, J. Cusworth, C. Vernier, M. F. Sheedy, H. S. Ellis and P. S. Thompson.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1917 SPECIFICATIONS.

13,883 STATHAM, N. Electrolytic cells particularly adapted for the electrolysis of salt or similar material. (26/9/17.) 114,974.

14,286 LOCKWOOD, A. A. Process for the electro-deposition of base metals. (3/10/17.) 114,976.

14,932 DIXON, J. L. Electric furnaces. (14/10/16.) 111,102.

15,722 HOYLE, J. R., & FAWCETT, P. Holders or fittings for the electrodes of electric furnaces. (29/10/17.) 114,395.

15,849 FLETCHER, R. E. H. Electric torches. (31/10/17.) 114,777.

16,008 TOCCHIO, M. Electric transmission of music. (2/11/17.) 114,987.

16,975 IRELAND, H. W. F. Electric-ignition distributors for internal-combustion engines. (17/11/17.) 114,990.

16,800 MITARD, P. G. Sparking-plugs for explosion motors. (15/11/17.) 114,781.

17,988 ZIMMERMANN, J. G. Dynamo or magneto ignition apparatus. (12/5/16.) 106,466.

19,084 RITTER & UHLMANN. Projection lamps. (2/1/17.) 112,447.

1918 SPECIFICATIONS.

8,150 KESSELRING, F. Continuous-current dynamos. (8/6/16.) 115,045.

17,593 MARKS, E. C. R. Apparatus for operating door bolts and the like by electrical means. (7/12/16.) 115,050.

5,815 DAVIS & SONS, J., & DAVIS, W. H. Miners' electric lamps. (25/4/17.) 115,084.

6,285 JACKSON, W. J., & MELLERSH. Electric welding apparatus. (3/5/17.) 115,105.

6,364 WOODS, A. E. Means for automatically recording calls in telephone systems. (4/5/17.) 115,107.

6,802 B.T.-H. CO. (G.E.C.) Phase conversion of alternating electric currents. (12/5/17.) 115,112.

7,185 DUBILIER ELECTRICAL SYND. Electrical condensers. (2/5/16.) 107,002.

8,318 GOLDSTON, E., & WOOD, E. W. Electrical switch apparatus. (11/6/17.) 115,129.

9,811 JACKSON, W. J. & MELLERSH. Multipolar magnetos for electric ignition systems. (6/7/17.) 115,147.

12,473 GRAHAM, E. A. Electric bells. (30/8/17.) 115,172.

14,096 SIEMENS & HALSKE AKT.-GES. Photometry and apparatus therefor. (12/1/17.) 112,614.

18,134 BEYERLEN, C. Measuring arrangement for mirror and prism reflecting stereoscopes, more particularly for Röntgen-ray exposures. (6/3/17.) 114,298.

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

April 22, 1918.

6,748 MACARTOIR. Instruments for tapping into field.
6,750 ROTTENBURG. Portable electric lamps.
6,761 B.T.-H. CO. (G.E.CO.) Electric motors.
6,762 B.T.-H. CO. & HASTINGS. Electromagnetic switches.
6,767 BENNETT & GARDE. Electric lamp holders and cord ropes.
6,781 REYROLLE & CLOTHIER. Electric switchgear.
6,785 ABRAHAMSON, CHRISTIANSEN & IVERKAGS. Electric time switches.
6,795 WADE. (Officine Elettro-Meccanicate.) Current regulating devices for variable speed dynamos.

April 23, 1918.

6,811 MACFADDEN. Electric testing apparatus.
6,816 CROMPTON & CO. & COLLIS. Isolating faults on electrical transmissions.
6,817 CROMPTON & CO. & COLLIS. Protective apparatus on alternating-current systems.
6,830 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO.
6,840 MAFFEI & CO. Circuit interrupters for electric ignition of internal combustion engines. (27/4/17, Italy.)
6,856 DESSANER. High-tension transformers.

April 24, 1918.

6,875 WIEGOLASKI. Independently stretching out double or multiple electric arms, &c.
6,896 JENSEN. Ferrari's relay for protection of multiphase motors, &c. (24/4/17 Denmark.)
6,900 B.T.-H. CO. (G.E.CO.) Electric fluid turbines.
6,910 LITHANODE (LTD.) & RAMSBOTTOM. Vents for electric accumulators and batteries.
6,914 MORRIS & REBBUCK. Apparatus for detecting variation in magnetic field.
6,918 VANDERVELL & MIDGLEY. Electric starters for internal combustion engines.
6,932 ALLEN & NORTH. Terminals for magnetic-electric machines, &c.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W.1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Officer for the Week.—Capt. W. Darley Bentley.
Next for Duty.—Capt. E. G. Fleming.
Monday, June 10-Friday, June 14.—Drills as usual.
Saturday, June 15.—Commandant's Parade at Headquarters, 2.30, for drill in Hyde Park. Dress: Drill Order with rifles.

SPECIAL NOTICES.—All drills will take place at headquarters unless otherwise stated.

The medical officer will attend for the examination of recruits on Thursday evening at 6.0.

Summer Camp.—Arrangements are now being made for this camp to start on August 3.

Commercial Topics.

Publishers' Notice.

In consequence of the greatly increased cost of materials and labour in the production of books we are compelled to raise the prices of those we publish, and the following alterations will take effect as from and June 10, 1918:—

Catalogue Price.	New Price.	Catalogue Price.	New Price.
s. d.	s. d.	s. d.	s. d.
1 0	1 6	6 0	7 6
1 6	2 0	6 6	8 0
2 6	2 6	7 6	9 0
2 6	3 0	8 6	10 6
3 0	3 6	9 0	11 0
3 6	4 0	10 6	12 6
4 0	5 0	12 6	15 0
4 6	5 6	15 0	18 0
5 0	6 0	18 0	22 0

Single copies of THE ELECTRICIAN Primers are now 6d. each and the Glossary 1s. each.

8, Bouverie-street, London, E.C. 4. BENN BROTHERS, LIMITED.
June 1, 1918.

* * * *

The Small Tools Order (1918).

The Minister of Munitions notifies that as from the 31st ult. he authorises every person, until further notice, to manufacture for his own use (but for no other purpose) all or any of the small tools referred to in the above Order. Applications for licences to manufacture small tools for other purposes are to be addressed to the Controller of Machine Tools, Charing Cross-buildings, London W.C. 2.

* * * *

Local Authorities and Industrial Councils.

At the meeting of the Association of Municipal Corporations on Friday the following recommendations of a committee were approved:—

That the association accept the general principles of the Whitley Reports in favour of appointing joint industrial councils, district councils and works committees in connection with industries carried on by municipal corporations.

That a separate industrial council should be established for each industry, but that, seeing that a decision given by one council would probably react on the others, on the constitution of the councils steps should be taken for keeping them in touch with one another and for co-ordinating their decisions.

That inasmuch as separate councils are to be established for each industry, it follows almost necessarily that in the formation of the council for an industry carried on both by the local authorities and by companies the employers' side must represent both of these classes.

* * * *

Income Tax Allowances for Depreciation of Plant.

In the Committee stage of the Finance Bill on Monday, Mr. G. Terrell moved an amendment to Clause 26 (which makes provision as to deductions for wear and tear of plant, &c.) that the case of any person dissatisfied with the amount of deduction for wear and tear, or for special depreciation, should be referred to a Board of Referees.

Mr. Terrell contended that the Government were taxing considerably more than net income at present. The amendment was, however, negatived by 78 votes to 57. A series of amendments by Mr. Terrell on the subjects of obsolescence and depreciation were also defeated, and the clause was added to the Bill, as was clause 27, which provides that no deduction is to be allowed on account of the annual value of premises abroad.

* * * *

Employees and the Trade Boards Bill.

The Employers' Parliamentary Council have issued a memorandum on this Bill which gives powers to the Minister of Labour to establish wages boards for the compulsorily fixing of rates of wages.

The Bill is an extension of the Trade Boards Act, 1909, is restricted to what were called "sweated industries," and is regarded as an attempt to fix permanently the inflated wages and artificial conditions of employment prevailing during the war. Under the principal Act, extensions could be made only by provisional order confirmed by Parliament; but the present Bill transfers powers from the Board of Trade to an individual Minister, and practically removes the safeguards given by the principal Act. The Employers' Council urge the retention of the existing safeguards, and submit that the Bill should not be promoted in anticipation of the proceedings of the Joint Standing Industrial Councils to be established in the several industries, among the essential functions of which will be the fixing of rates of wages to correspond with the demand for "a higher standard of comfort generally." If the Joint Councils cannot be trusted to settle harmoniously such a fundamental matter as the fixing of the rate of wages without their arrangements being subject to the decisions of a Statutory Wages Board, their prestige will, it is contended, be destroyed, and the scope of their operations will necessarily be seriously diminished.

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Electricity Supply.

Extensions.

Aylesbury.—It is proposed to lay a supply cable along Bicester-road to Heydon Hill Farm.

Halifax.—The Director of Electric Power Supply has refused to allow the Electricity Committee to purchase a new boiler.

The Committee has protested against the decision, and has placed on record that it cannot be held responsible should there be a failure or curtailment of supply. It is urged that a new boiler is all the more needed owing to the inferior quality of coal now available. The resolution of the Committee is to be sent to all cities and county boroughs in Yorkshire with the view of a joint protest to the Ministry of Munitions against the treatment accorded to municipal corporations with regard to extensions and maintenance of existing power stations.

Todmorden.—The Electricity Committee, which has been considering the question of putting down new generating plant, has decided that in view of the large expenditure which would be involved, to take a bulk supply from the Yorkshire Electric Power Co. The Council has approved of the proposal and the L.G. Board has been asked to sanction the borrowing of £5,500 for the erection of a sub-station.

General.

Aldeburgh.—The Aldeburgh Electric Supply Co. has written to the Council suggesting an increase of 33⅓ per cent. in the cost of electric current.

The company points out that the extraordinary increase in the cost of fuel and other materials had affected it so much that the shareholders had not received any dividend since the war. It did not wish to apply under the Courts Emergency Powers Act for relief; but as the present contract expired next year, it proposed that the Corporation should enter into a new contract from June 1, increasing the maximum charge by 33⅓d. per cent. above present prices, the charge for lighting being 42s. instead of 37s. 3d. per lamp when the lamps are re-lighted.

The matter was referred to the Paving and Lighting Committee.

Birmingham.—The Electric Supply Committee's report for the year ended March 31 states that after providing all capital charges, which absorb £171,964 and setting aside the net calculated profit on the plan supplied under agreement with the Ministry of Munitions, there remains £64,763.

Of this sum the committee has carried £39,500 to renewals and special expenditure account, leaving £25,263 which it is proposed to pay to the credit of the borough rate. The units sold during the year were 160,275,400, the gross revenue being £852,554, compared with 149,724,637 units and £717,831 in previous year. The increase of 10,550,763 units was almost entirely confined to high-tension supplies. The costs show substantial increases under practically every head of expenditure, and it is calculated that the advances in the rates of pay sanctioned to the employees during the year will cost in a full year not less than £37,500.

The Tramways Committee report that after paying all operating expenses and interest and sinking fund charges, there is a credit balance of £101,699. Of this sum £63,898 has been carried to reserve, £12,801 to motor-bus suspense account, and the surplus of £25,000 to borough fund. The traffic receipts for the first time in the history of the undertaking have exceeded £1,000,000. The number of passengers carried by the tramways was 198,402,908 and the receipts were £984,287. With omnibus receipts, &c., the total was £1,062,204. The increase in traffic receipts over previous year amounted to £167,913, or 18·77 per cent. The total expenditure in respect of tramcars and omnibuses was £136,843 (19·98 per cent.) in excess of the previous year. The balance at reserve has been reduced to £68,892, and the committee considers this most unsatisfactory and that it should be considerably augmented. It is hoped the revision of fares and stages recently authorised will enable the fund to be put in a more satisfactory condition.

The reports were adopted by the Council on Tuesday.

Electric Power in Oilfields.—A paper on "The Application of Electric Power to Oilfields Requirements" was read at the meeting of the Institution of Petroleum Technologists last week by Mr. J. Wilfred Burford, M.Inst.M.E., A.M.I.E.E.

Mr. BURFORD said "that modern electrical machinery is far less complicated and infinitely more reliable and efficient than steam-plant, will not be denied by any engineer who thoroughly understands the principles of the two forms of power: and, when comparing electrical machinery with the majority of steam-plants in use on oilfields, there can be no question as to which is the more desirable." In cases where electricity had not proved a success on oilfields, due to the motors "stalling," and to transmission-lines breaking down, the failures could be traced to faultiy-designed installations and the prejudice of ignorant operators. Electrical power was extensively used for drilling, cleaning out and pumping oil wells in the United States of America, especially in California and West Virginia. In California power was supplied by large hydro-electric power plants, such as the Pacific Light & Power Co. and the San Joaquin Light & Power Co. In the latter case power was generated and used by the South Penn Oil Co. from a power plant operated by large gas-engine units.

For supplying power to the oil-fields of Roumania two power-stations were established, one using water-power and the other steam-plant. Power in the Baku district of Russia was also furnished from two power-houses, aggregating 20,000 H.P. Considerable developments in the application of electric motors to oil wells had taken place since the paper was drafted, and they tended to show the firm hold electric power now had in the oil industry—a hold which was increasing, especially since the improved prices for crude oil had enabled operators to consider improved methods of production. In the United States of America there are now 1,750 instances of the application of electric motors to oil wells, aggregating 38,050 H.P. In California 130 wells had been drilled by electric power, the deepest of which reached a depth of 2,700 ft., while one was taken down to 3,100 ft. in West Virginia. In Russia 27 per cent. of the 11,000 wells in the Baku district were operated electrically, necessitating generating plant amounting to 70,000 kw. capacity. Roumania had about 200 wells electrically operated, aggregating 14,000 H.P. For the past year the Burmah Oil Co. had been carrying out successful experiments with electric motors for drilling, pumping, pulling and cleaning, in the Singu field.

Electrical Power Engineers' Association.—The National Executive of this Association met at Birmingham on the 1st inst.

Among those present were Messrs. Lunn, Langley, Annett, Atkinson and Thomas (Northern Division), Bowser, Mason, Sutton and Burgess (Midland Division), and Bostel, Jeffrey, Healy and Law (Southern Division), with the Hon. General Secretary (Mr. W. Arthur Jones).

Mr. H. W. Healy was elected chairman. It was resolved, in view of the draft proposals of the West Yorkshire Section having been received too late for detailed consideration by the Divisional Councils, that the general outlines of the rules of the Association should be considered. Only by unanimous agreement of the National Executive are the rules to be considered binding on members; any controversial points not agreed upon to be submitted to all Divisions (existing at June 1) for re-consideration. The further recommendations of these Divisions are to be received by the Hon. General Secretary by July 6 and to be decided upon at the adjourned National Executive meeting to be held at Manchester on the 27th prox. Meanwhile, the draft rules from all sections are to be collated by the Divisional Secretaries.

It was arranged to form a junior section for pupils, apprentices and improvers. It was decided to send representatives to the conference of employers and Trade Unions connected with the electricity supply industry to be held at Manchester during June to discuss the formation of an Industrial Council.

Among the objects of the Association unanimously agreed upon were:—To raise and maintain the efficiency and general status of engineers engaged in the electrical industry; to act as a protective organisation on behalf of its members; to secure that only qualified engineers are appointed to responsible positions involving the management, direction or control of engineering matters connected with the electrical engineering industry; to secure legal certification of all qualified engineers; to obtain recognition as a body of professional engineers and to ensure representation at all conferences affecting the interests of members; to obtain for members the best possible conditions of employment and adequate remuneration; to ensure a maximum of six days a week of employment for all members engaged on shift duties; to provide legal assistance for members; to promote educational and social intercourse amongst the members, &c.

Eastern Section.—Owing to the increasingly large number of engineers joining the E.P.E.A. it has been found advisable to form the Southern Division into Sections, and the second of these was inaugurated at Stratford on the 28th ult. The title of the new Section is the "Eastern Section," and it will include members from electricity supply stations in East London. Representatives were present from Barking, Bow (Charing Cross and Strand), East Ham, Ilford, Leyton and West Ham. The following officers were elected:—

Chairman—Mr. F. Farndon. *Committee*—Messrs. Bendix, Edgerton, Gilbert, Grime, Henwood, Jones, McLaren and Wilson. The Hon. Secretary is Mr. A. J. Giffen, 277, Shrewsbury-road, E. 7.

A general meeting of the members in the London division will be held on the 17th inst. (at 7 p.m.) at St. Bride Institute, Fleet-street, E.C., when Mr. A. C. Bostel will give an address on "Trade Unions and Incorporated Societies." The chair will be taken by Mr. C. H. Wordingham, president of the I.E.E.

Increase of Charges.—The Charing Cross, West End & City Electricity Supply Co. has applied to the Board of Trade for an order to increase their maximum price for lighting purposes from 4d. and 5d. to 6d. per unit.

Nottingham Electricity Committee recommend an increase of 13⅓ per cent. in the charges for current, making 33⅓ per cent. over pre-war rates.

Faversham Council is increasing the charge for current for lighting by ½d. per unit to consumers of over 125 units per quarter, and the flat rate for current is to be 3d. per unit.

At Leek the charge for private lighting is to be 5d. per unit plus 40 per cent., and the power rates will vary from 2d. to 1½d. per unit plus 50 per cent., or, alternatively, £3. 15s. per half-year per kilowatt demanded plus ½d. per unit, plus 50 per cent.

At Hornsey the charges for current are to be increased to 60 per cent. over pre-war rates.

The North Metropolitan Electric Power Supply Co. has increased its charges to 33⅓ per cent. over pre-war rates.

Lincoln.—The Council has requested Sir John Snell to prepare a report on its electric supply undertaking.

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New Coal and Lighting Order.—The Coal Controller proposes to issue a new Coal and Lighting Order at the end of the month.

The new Order will ration coal, gas, and electricity on a coal consumption basis at the rate of 3½ tons of coal to two rooms, an extra ton to be allowed for each additional room. Thus, a householder with four rooms will be entitled to 5½ tons of coal per annum, and if he uses three tons as fuel he will have 2½ tons to cover his lighting, equal to 37,500 cub. ft. of gas, as one ton of coal will be considered equal to 15,000 cub. ft. of gas or 800 B.T. units of electricity. Small consumers will probably be dealt with on a coupon system, and the scheme will be controlled by committees in each district.

Electric Traction.

Bath.—On Thursday last an electric tramcar left the rails on Locksbrook Hill, Weston, and overturned. About 25 persons received injuries, one of the victims succumbing later in the day.

Bolton.—The salary of the tramways manager (Mr. J. Barnard) has been increased from £525 to £700 per annum.

Glasgow.—It is announced that the revenue of the tramways department for the year ended May 31 amounted to £1,404,110, an increase of £158,602. The passengers carried were 431,000,000, an increase of about 42,652,000. The above figures break all previous records of the tramways department.

The revenue of the electricity department reached three-quarters of a million.

Belfast.—The adjourned summons by the tramway employees against the Corporation for failure to comply with the award of the Committee on Production granting the men 8s. a week increase of wages were again before the General Munitions Tribunal last week.

On the last occasion an undertaking was given by the Corporation that the arrears due to the men on the award would be paid. The Corporation, however, had paid a certain number of employees the additional 8s. and other employees the additional 12½ per cent.

Mr. LEWIS (for the Corporation) said the arrears under the award had been paid to over 800 men to whom it applied, but there was a dispute in regard to four cases, where men who had been paid 8s. claimed the 12½ per cent. The Corporation was willing that the point should be referred to the Ministry of Munitions.

After discussion the summonses were withdrawn, on the understanding that the point in dispute should be referred to the Committe on Production.

Two new summonses were then placed before the Tribunal, these being at the suit of Geo. Bartley (conductor) and James Freeman (cleaner), against the Corporation for alleged contravention of sec. 2 of the Munitions of War Act, 1915, by serving notice of dismissal on complainants (who had sought redress from the Tribunal), and thus declaring a lock-out.

After discussion the Chairman ruled, as a point of law, that the signature of the tramway manager to the notices had not been legally proved, and dismissed the summonses.

Leeds.—The Tramways Committee recommends the abolition of half-penny fares and the re-adjustment of the other stages. On Monday an extension of the tramway parcel delivery system.

Hitherto parcel delivery facilities were confined to three routes, but now practically the whole of the Corporation tramways will carry parcels.

Newcastle-on-Tyne.—The Tramways Committee recommends that the salary of the tramways manager (Mr. E. Hatton) be increased by £100 a year for five years, making the maximum £1,500 per annum.

Sunderland.—The number of the stopping places on the tramway routes is to be reduced, and no special cars are to be let for school treats, &c.

Tramway Workers' Wages.—At the annual conference of the Amalgamated Association of Tramway and Vehicle Workers last week, the president (Mr. E. H. Bawden), in the course of his presidential address, said he questioned if there had ever been a period in the history of the association when so much had been accomplished.

As the result of the war they would be faced in the future by problems greater than those which faced them to-day. They had had applications pending for the extensions of the 12½ per cent. to all tramway workers and for bringing up the rates paid to the women employees to a standard equal to that of the men. It had been promised that the women should have the same wages and conditions, and they would not be satisfied until that promise was fulfilled. An application was also pending for the extension of the 12½ per cent. to the carters.

On the subject of Industrial Councils, he pointed out that they would not serve with the municipal Employees' Association, because it was felt that as they accepted employees eligible for the membership of other societies it was an unnecessary addition to trades unionism.

Foreign Notes.

A Large German Electric Generator.—According to the "Daily Mail," the Allgemeine Elektricitäts Gesellschaft of Berlin is now building a turbo-generator of 50,000 kw.

Chili.—An engineer has recently investigated on behalf of American promoters concessions for using water power in the South of Chili. Concessions for about 60,000 H.P. have been secured and it is expected that about 40,000 H.P. will be taken by a copper company, while a cement company and local electric light and traction companies will also require energy.

China.—The following are extracts from a report by the British Consul General on the trade of Canton in 1917:—

Engineering business has come almost to a standstill. Electric lighting plants have been installed in the country districts, and several are on order, but for fresh inquiries it is impossible to guarantee delivery either ex works or arrival in China.

A notable feature of late has been the increasing activity of American manufacturers. British firms receive communications saying that their names have been given to the writers by the American Consul. Similar methods should be adopted by British manufacturers.

Japanese competition is also becoming increasingly felt in electric lamps and in the cheap general lines.

Japan.—According to the "Japan Times," the new corporate undertakings of Japan, together with expansions of old undertakings, planned during 1917 involved a total capitalisation of over 2,000 million yen, or about 1,000 and 1,500 million yen, respectively, more than in 1916 and 1915. Of the capitalisation, manufacturing represented 788,405,000 yen, mining 208,622,000, water transportation 175,965,000, electricity 118,712,000, railways 94,060,000, gas 185,000 and commerce and others 235,560,000 yen.

Organisation of the German Electrical Industry.—It is reported that hitherto the economic interests of the German electrical industry have not been centralised, only a loose organisation having been brought about during the war by means of a war committee. A permanent organisation has now been established under the title of the Central Association of the German Electro-Technical Industry. It is expected that all manufacturers of electrical plant and apparatus will become members of the new association.

Miscellaneous.

Bank Amalgamation.—On Tuesday the Chancellor of the Exchequer (Mr. Bonar Law) announced in the House of Commons that the Government had decided to introduce legislation to give effect to the recommendations of the Committee appointed to consider the question of Bank Amalgamation.

Meanwhile an Advisory Committee will be set up, with Lord Inchcape and Lord Colwyn among its members.

Education Bill.—Some progress was made with the Committee stage of this Bill last week. Clauses 7, 8 and 9 were dealt with, and the Committee adjourned when Clause 10, relating to the compulsory attendance at continuation schools, was under discussion.

Fires.—A fire broke out at the offices of the Coatbridge & Airdrie Electric Supply Co. (Ltd.) on 31st ult. doing damage estimated at £1,000.

A fire also occurred last week in the mess room, offices and stores at the St. Peter's power station of the Isle of Thanet Tramways & Lighting Co. The service was not interrupted. The damage amounted to between £2,000 and £3,000.

Register of Overseas Buyers.—This book, which is published by Messrs. Benrose & Sons (Derby), has been compiled with the assistance of Chambers of Commerce and H.M. Consuls abroad.

In addition to a list, extending to over 200 pages, of importers in the British Colonies and Dominions and in Allied and Neutral countries, arranged geographically under the classes of goods they import, the book includes a number of articles dealing with the requirements of overseas buyers and the best methods of extending trade with them. The price of the Register is 21s.

Trade Union Assault Case.—At the London Sessions last week Edward Owen, electrician, was indicted for having assaulted Albert Edward Muller.

Prosecutor and defendant were employed by the New System Private Telephone Co., and all the workmen, with the exception of three, were members of the Electrical Trades Union. Owen was the shop steward, and Muller on entering his employment was given a week to join the union. Before the time was up it was alleged that Owen struck Muller over the right eye and knocked him down.

After hearing the evidence defendant was convicted and released on probation, he having given an undertaking not to molest prosecutor.

Tenders Invited and Accepted.

Cables.

WARRINGTON Electricity and Tramways Committee require tenders by noon June 18 for the supply of h.t. lead-covered and medium-tension rubber-covered cable. Specification, &c., from the Borough Electrical Engineer.

Meters.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. July 3 for the supply of 21 electric meters for power circuits. Specification, &c., from the Commissioners' Office, Spencer-street, Melbourne.

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Telephone Material.

The Deputy Postmaster-General, Melbourne, requires tenders by 3 p.m. July 2 for g.i. wire and gal. steel stranded wire (schedule 1,436), copper wire (h.d. enamelled covered and twisted pair), copper sleeves (schedule 1,449), and telephones and diaphragms (schedule 1,450) for the AUSTRALIAN COMMONWEALTH. Postmaster-General's Department. Specifications, &c., from the General Post Office, Melbourne, Sydney, Brisbane, Adelaide, Perth and Hobart.

BARNES.—The Urban Council has accepted the tender of W. T. Henley's Telegraph Works Co. for the supply of cable and that of Doulton & Co. for stoneware ducts.

CHESTER.—The Council has placed an order with Drake & Gorham for an electric wagon at £1,439.

HAMMERSMITH (LONDON).—The Borough Council has accepted the tender of the Electrical Apparatus Co. (Ltd.) for the supply of electricity meters for one year.

YORK.—The Council has placed an order with Babcock & Wilcox for the supply of coal elevating plant at £1,797.

Appointments Vacant.

The Council of the University of Hong Kong require a professor of electrical engineering (salary £600 per annum, with quarters or allowance of £100) and two lecturers in civil and mechanical engineering (£400 per annum, with quarters for residence). Applications to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, Westminster, S.W., by June 28. *See also an advertisement.*

A charge engineer (salary £180, plus 12½ per cent.) and a switchboard attendant are required at Derby Corporation electricity works. Applications to borough electrical engineer (Mr. T. P. Wilmshurst), 9, Irongate, Derby. *See also advertisements.*

Business Items.

The "Z" Electric Lamp Mfg. Co. notify that in future Messrs. Andrews & Co., 40, West Campbell-street, Glasgow, will act as their representative in Scotland.

Plant for Sale.—The Electricity Committee of Belfast Corporation have for sale one 1,000-kw. and two 200-kw. steam dynamos, condensing plant, four steel cooling towers, four electric motors, &c. Further particulars and conditions of sale may be obtained at the electricity works, East Bridge-st., and tenders must be lodged with the town Clerk (Mr. R. Meyer), City Hall, Belfast, by 10 a.m. June 19. *See also an advertisement.*

Magnetos.—The Runbaken Magneto Co., Ltd., of Manchester, has recently issued a booklet, which gives particulars and prices of the Du 4 type of Runbaken high-tension magneto.

Liquidations, &c.

A meeting to receive an account of the winding up of the Automatic Electric Block Signalling Co. (Ltd.) will be held at 47, Parliament-street, London S.W. 1, on June 19.

A meeting to receive an account of the winding up of Calvert's Circulation Fuel Economiser (Ltd.) (in liq.) will be held on June 17 at 36, John-street, Bedford-row, London, W.C. 1.

Companies' Meetings and Reports.

West India & Panama Telegraph Co. (Ltd.)

The 81st ordinary general meeting was held on May 29, Sir ALEXANDER FREEMAN KING, K.C.B., chairman of the company, presiding.

The SECRETARY (Mr. J. Winser) having read the notice convening the meeting, &c.,

The CHAIRMAN said: The accounts for 1917 now before you are the first to be presented for a whole year, instead of half-yearly to June and December as heretofore; we have also taken the opportunity of slightly altering their form and of discontinuing the comparative figures. It may be of interest for you to know that the ratio of expenses to income was slightly less in 1917 than in the two preceding years; and in this connection I think it only right to bring to your notice the zeal and loyalty of our staff both at home and in the West Indies, working under the able guidance of manager and our secretary, and under the direct supervision in the West Indies of our superintendent and our ship's captain. All these gentlemen are also stern economists, but, nevertheless, the fact remains that the cost of materials and labour is becoming dearer and dearer, and to a great extent beyond control, and consequently, however watchful they and your board may be of every item of expenditure, it is possible that the lower ratio of expenses to revenue may not be maintained. The chartering of our ship to connecting companies is not an unusual feature in the accounts of recent years, but it is not a certainty, and we can only hope that in this present year also some of our friends in the West Indies may need the service of our cable ship. On the whole the year 1917 was a good one for us. It has enabled the directors not only to place £10,000 to reserve and to recommend the payment of a bonus on the ordinary shares, but also to write off the cost of extending the date of maturity of the debentures. As shown in the accounts, this operation cost £6,065, of which amount £5,572 represents the premium of £7 per bond offered to holders of the debentures to extend them, the balance of £493 being made up of bankers' and brokers' commissions, agreement stamps, &c. In view of the increased cost of cable, as well as on general grounds, your directors have deemed it opportune to strengthen the reserve fund by the £10,000 I have just mentioned, bringing that fund up to £105,000. On the other side of the balance-sheet, however, it will not be overlooked that the investments, which cost £104,000, have depreciated by nearly £28,000, their present market value being about £76,500. Manifestly, therefore, we have every reason for adding to our reserves. Our traffic receipts for the current year so far show a falling off. Some of the monthly totals in 1917 were unusually good owing to special circumstances, and I think we could scarcely expect to see the same receipts from traffic this year. I now move the adoption of the directors' report and accounts.

Mr. T. W. GOULDING seconded the resolution, which was carried unanimously. Sir Timothy A. Coghlan, K.B., I.S.O., was re-elected a director, and Messrs. Deloitte, Plender, Griffiths & Co. were reappointed auditors. A vote of thanks to the chairman, directors and staff terminated the proceedings.

BROTHERTON TUBES & CONDUITS (LTD.)—The trading profit for the year ended March 31 was £15,266, and after adding transfer fees and deducting amounts written off for depreciation of plant, interest on loans, &c., and adding amount brought forward (£6,770) the balance is £19,793. The board recommend a dividend of 1s. per share (less tax), £2,437. 10s., carrying forward (subject to excess profits duty) £17,355.

ELECTRIC CONSTRUCTION CO. (LTD.)—At the meeting last week the chairman (Mr. P. E. Beacheroft) said that, notwithstanding the difficulties which were foreseen and encountered, they had again considerably increased their turnover and again showed a substantial increase in net profit. The increased gross profit was £9,600 only, but to that has to be added £2,600 received additional for interest and dividends and a reduction of £3,100 in general charges and maintenance of plant and buildings. Those accounted for the increase of £15,300 in net profit. The buildings and plant had been maintained in as high a state of efficiency as was possible, and the amount expended was £500 less than last year. The net profit for the year was £66,826. Adding amount brought forward and deducting munitions levies and excess profits duty for two years, the available balance was £68,028. In addition to the interim dividends, the directors recommended a final dividend on the preference shares and a final dividend at rate of 9 per cent. per annum on the ordinary shares (making 7½ per cent. for the year), and a bonus of 2½ per cent. on the ordinary shares, transferring to general reserve £9,326, leaving to be carried forward £31,887. They had continued the policy of purchasing the company's debentures when a favourable opportunity offered. At March 31 the reserve fund amounted to £63,174, and with the contribution out of profits would stand at £72,500. Year by year they had provided considerable sums for new plant and tools, which should, after this disastrous war was over, place them in such a strong position as to costs of production as would enable us to meet any competition. Immediate prospects were quite encouraging, as they had commenced the new financial year under auspices more promising than heretofore; and, assuming that the supply of materials was maintained in a reasonable manner, the results should prove satisfactory. To enable the country to recover from the financial strain of the war a larger output per head would be essential, and if, in exchange for the removal of restrictions relating to output, workpeople secured a larger share of the proceeds of capital and labour, the result would be for the general good. They were members of the Federation of British Industries, which was taking an active part in these matters, and any measures framed to that end would have their sympathy and support. Meantime, the relations with their own workpeople continued to be of the most harmonious character. Although Sunday labour was discontinued by the Ministry of Munitions of War in the beginning of their last financial year, their turnover, with only a comparatively small addition to their tool equipment, showed an increase, and that had been the experience of others. There had been many rumours prevailing of amalgamations or reciprocal trading relationships between companies having kindred businesses, and he could only suppose that there was some such rumour with regard to their company. No arrangement of that kind, however, had been under consideration. The whole attention of the board and management was devoted to the advancement of the company's interests without regard to the fluctuations of the market value of the shares. Many of them had held the bulk of their shares from the early years, and had endured with patience and confidence the days of stress and troubles, but they were now reaping a well-earned return, due to the strenuous labour on the part of their active management.

METROPOLITAN CARRIAGE, WAGON & FINANCE CO. (LTD.)—The chairman (Mr. F. Dudley Docker, C.B.) stated at the annual meeting last week that it was proposed to make a considerable increase in the nominal capital of the company. It was felt that in the new world which would exist after the war every undertaking that wished to succeed must be big and self contained and that the company should as far as possible be able to exercise some measure of control over anything that affected the foundations and structure of the industry. He mentioned last year that the company had embarked in electrical business and had purchased from the Americans the control of the British Westinghouse Co. They would agree that the electrical trade was a key industry, and to be successful it must be organised on broad and sound lines. In the past it had been almost entirely controlled by other nations, because there were too many competing interests in this country;

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each suffering from insufficient equipment. It was intended to strain every nerve and use to the full the resources of brains and capital to build up this industry. He was convinced that upon electrical enterprise rested the fate of nearly every industry in the country. After the war we should have the keenest competition from Germany, a country which had spent on research a sum exceeding the whole of the dividends ever paid in our country by the whole of the electrical industry. The company intended to have a research department second to none in the world. To strengthen the position an alliance had been entered into with Messrs. Vickers, who would share with the company in its electrical work. In addition the directors had recently acquired large interests in the South Metropolitan Electric Light & Power and the West Kent Power Companies, both of which had areas ripe for development. In the past the company had devoted a vast amount of time and attention to the electrification of railways, and the enterprises in which interests had been acquired would enable the company to undertake the whole work of electrifying a railway, even to supplying the power. This was a great step forward, as in the past some of this work had to be shared with the foreigner. At the outbreak of war the manufacture of glass bulbs for electric lamps had been almost exclusively done abroad. He was glad to say that in conjunction with the General Electric Co. the Metropolitan had agreed to purchase the British rights in special machines for making these glass bulbs and it was hoped soon to have the first machine installed and at work. Then Great Britain would be independent so far, at any rate, as the manufacture of these bulbs was concerned. They had further entered into partnership with the B.S.A. for the manufacture of abrasive wheels, another key industry, for which goods again we had been largely dependent upon other countries. Dividends of 2½ per cent. and 3 per cent. (less tax) were declared on the "A" and "B" preference shares, making 5 per cent. and 6 per cent. respectively for the year, and a final dividend of 1s. per share for the six months ended March 31, 1918, together with a bonus of 1s. per share on the ordinary shares (both tax free). Subsequently it was resolved to increase the capital to £10,675,000 by the creation of 7,000,000 ordinary shares of £1 each.

PEEL-CONNOR TELEPHONE WORKS (LTD.—For the year ended March 31 the net profit was £22,902 and out of this £10,000 has been placed to general reserve, leaving £12,902. With £5,188 brought forward the available balance is £18,090. Interim preference dividend paid in November absorbed £2,500 and the directors recommend the following dividends:—Preference shares (balance) absorbing £2,500 and 2s. per share on the ordinary shares (tax free) absorbing £8,000, leaving to be carried forward £5,090.

SHANGHAI ELECTRIC CONSTRUCTION CO. (LTD.)—The chairman (Sir Alfred Dent, K.C. M.G.) reported to the meeting on the 30th ult. that the gross receipts for the past year amounted to £161,363, against £153,757 in the previous year, and after deducting £35,477 for loss on native coinage there remained £125,885, compared with £115,006. After deducting working expenses in Shanghai, the operating profit was £53,145, against £49,330, and after bringing in profit on exchange, charging London expenses and interest and including the balance brought forward of £2,509, the available balance was £70,014, compared with £49,509 last year. They recommended a final dividend of 5 per cent., making 10 per cent. for the year, and a bonus of 2½ per cent., leaving £15,014 to be carried forward. By far the greater part of the profits had been remitted home, and the profit on exchange was £17,852, against £1,810. As regarded the rail-less service, they were still in negotiation with the Council, and hoped soon to get sanction to carry out at least part of the comprehensive scheme which the company had laid before them. The advantages of that mode of traction were obvious as against the permanent rail, and it had certainly been much appreciated by the public and by owners of property along the short distances now in working. The company had carried 73½ millions of passengers, and had run over 4,000,000 car-miles.

WELLINGBOROUGH ELECTRIC SUPPLY CO. (LTD.)—The revenue for 1917 was £3,546 and working expenses were £2,047, leaving £599. After providing for interest, there was a deficit of £10, which increases the debit balance to £576.

New Companies.

ALLOY WELDING PROCESS (LTD.) (150,396.)—Private company. Reg. May 9, capital £120,000 in £1 shares (20,000 cumulative preference), to enter into agreements with the Russo-British Finance Co. and with E. J. Jones, to acquire certain inventions relating to improvements in electric, blow-pipe and other forms of welding and soldering, and to carry on the business of engineers, &c. First directors are E. H. Jones (managing director), W. A. Hunter and F. W. Poyner.

ELECTRO LEATHER INDUSTRIES (LTD.) (150,443)—Reg. May 15, capital £100,000 in £1 shares, to take over the business of a tanner, hide steriliser, electrical and chemical specialist and manufacturer carried on by L. A. Groth as the Electro-Leather Industries. First directors are L. A. Groth, A. B. Swales, I. Smith, G. L. Shepherd and A. Jessop.

MAGNETO & SPARE PARTS CO. (LTD.) (150,486)—Private company. Reg. May 21, capital £1,000 in £1 shares. Objects as indicated by the title. First directors are G. Halham and S. H. Parrott. Reg. office: 337, Broad-street, Birmingham.

MONOMETER MFG. CO. (1918) (LTD.) (150,557).—Private company, reg. May 28, capital £16,000 in £1 shares (15,000 8 per cent. cumulative preference), to take over the business of engineers, &c., lately carried on by the Monometer Mfg. Co. (Ltd.), and to carry on the business of mechanical, hydraulic, electrical and general engineers, watch and clock makers, manufacturers of monometers, pyrometers, thermometers, heat regulators and other apparatus, &c. First directors are:—H. J. Thomas and W. H. Gould.

QUAIN ELECTRIC CO. (LTD.) (150,401.)—Private company. Reg. May 9, capital £20,000 in 10,000 cumulative preference and 10,000 ordinary shares of £1 each, to enter into an agreement with the Russo-British Finance Co. (Ltd.) to acquire certain patents relating to improvements in electric heaters and radiators, and to carry on the business of electricians and electrical engineers, &c.

City Notes.

DOULTON & CO. (LTD.)—After providing for debenture interest and including £13,552 brought forward, the balance is £68,703 (against £61,052). The preference share dividend for 1916 has been paid, leaving £51,203, which has been carried forward.

MARCONI WIRELESS TELEGRAPH CO. OF AMERICA.—A dividend of 25 cents per share has been declared.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—A dividend of 5 per cent. has been declared on the ordinary shares, making 8 per cent. for the year (tax free), and £17,307 carried forward.

WESTERN TELEGRAPH CO. (LTD.)—The directors of this company have to-day declared the third quarterly interim dividend of 3s. per share (tax free) for the year ending June 30, 1918, being at the rate of 6 per cent. per annum. The transfer books will be closed from June 15 to 22 inclusive, and the dividend will be payable on the 24th inst.

The Round Table.

By "kVA."

I heard a splendid example of the popular idea of the speed of electric tube trains at King's Cross last week. A very Scotch lady with much luggage squeezed into the lift, which was at once sent down by the attendant. When we touched bottom the dear soul turned to one, and in her broadest accent inquired "Is this Waaterloo!" Some hustle (and some don't across the border).

* * * *

EVENT OF THE WEEK.—The B.O.T. Report and the fluttering in the municipal dove cotes.

* * * *

The very latest in domestic electrics is thus described by the Montreal "Family Herald":—

A newly-invented machine, driven by electricity, plucks a fowl, clean of all its feathers, in less than five minutes, and tidily gathers all the feathers into a receptacle. "A small electric motor turns a suction fan, and also a roller contained within the instrument itself, the power being transmitted by means of a flexible cable. The roller is hollow, and its outer surface is pierced by a number of slits, which permit the incoming blast produced by the fan to pass freely through it. The top of the instrument is hooded, and attached to this hood is a little rubber roller, which rests firmly against the surface of the larger drum-like wheel. The feathers of the fowl, sucked up against the two rollers, are plucked by having to squeeze between the rollers, after which they are blown to a tank."

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, June 4, 1881.]

THE ST. GOTHARD TUNNEL CABLE.—This cable, which was manufactured at the works of Messrs. Felten & Guilleaume, of Mulheim-on-Rhine, cost 3·80 marks per metre (a mark is worth about one shilling). It was laid in an iron tube, covered with wood, and fixed to the wall of the tunnel.

GAS v. ELECTRICITY.—At the quarterly meeting of the Manchester District Institution of Gas Engineers, held at Buxton on Saturday, May 28th, the president, in the course of some remarks, said that "he, as one having some experience in electric lighting, could say that it was only by the use of the most modern improvements in gas-making machinery that they could compete with the electric light."

SWAN'S LAMP ON AN ATLANTIC LINER.—The Inman steamer "City of Richmond," which recently arrived at New York, had on board Mr. Bates, electrician, and his staff, who went over to note the working of the Swan incandescent lights, with which the ship's cabin was illuminated during the voyage. The main saloon was lighted by six lamps, comprising 30 jets, and 11 others were distributed at various points on board, making 17 in all. Some of the state rooms were similarly illuminated. The light is described by those who observed it during the voyage as very steady and mellow, not subject to fluctuation or accident, easily managed and very brilliant. The six lamps in the main saloon rendered the apartment as light as day, enabling passengers to read at any point.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

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CONTENTS.

NOTES	117
Arrangements for the Week	119
Calculation of Commutators of Alternating-Current Machines. By M. Schenkel. Illustrated	120
Notes on Electro-Culture. By Ingvar Jörgensen. Illustrated	122
New Turbine Plant at Hull. Illustrated	125
Association of Consulting Engineers	126
Applications of Electricity on Shipboard	127
ELECTRO-CULTURE	128
REVIEWS	128
On the Temperature Variation of the Electrical Conductivity of Mica. By H. H. Poole. Illustrated	129
CORRESPONDENCE	131
Trade Parliaments and Their Work. By E. J. P. Benn	132
6,000 Ampere 3-Phase Alternator Switchgear. Illustrated	133
Patent Record	133
Volunteer Notices	133
LEGAL INTELLIGENCE	134
PARLIAMENTARY INTELLIGENCE	134
Commercial Topics	134
Electricity Supply	134
Tenders Invited	136
Companies' Meetings and Reports	137

Notes.

British Electrical Engineers' Association.

FOR some little time there has been a move on the part of power supply engineers to form an association for the protection of their interests, and from the account of a meeting which we published in our last issue our readers will gather that the movement is extending to the electrical industry generally. The object in view is to secure greater recognition of technically trained men. There is no doubt that the position hitherto has been very unsatisfactory for all members of an engineering staff, except, perhaps, for the heads of departments. Salaries have been low and work has been plentiful. Engineers do not object to the latter, but it is no compensation for low salaries, and they have a right to expect a suitable reward. If it were merely a personal question it would not so much matter, but it is quite clear that the electrical industry must suffer if the salaries which are offered are not sufficiently good to attract the best men. The present movement has, no doubt, received an impetus from the Whitley Report, which urges combination. One method of securing this combination would be to join one of the ordinary trade unions. This it is felt, and we think rightly, would not be desirable, for members of an engineering staff are entrusted with much that is confidential, and therefore it is better that they should form their own association. They are at the same time employers and employees.

Should It Be a Trade Union?

IT may be asked whether there is any real reason why the association should be a trade union. The advantage of a trade union is that it has a legal status, and it also comes within the terms of the Whitley Report. Consequently, although we do not think that responsible engineers would ever adopt the strike, which has proved such an effective weapon in the hands of ordinary trade unions, the case, nevertheless, seems to be clearly in favour of this method of formation. The meeting held at Newcastle-on-Tyne was more particularly in reference to power supply engineers. It was stated, however, that the meeting was held with the approval of the Council of the Institution of Electrical Engineers, and that it was contemplated to form other sections, such as a manufacturers' section and a contractors' section. We gather that active steps are now being taken towards the formation of a manufacturers' section. It may be felt that there is some difficulty in a chief engineer joining an association of this kind. Nevertheless, it must be admitted that his aims in regard to proper recognition are the same as those of his subordinates, and therefore there is no prima facie reason for his exclusion. The fact that the Council of the Institution of Electrical Engineers is in favour of the body is a very important point, and will add materially to its strength. We think that such an association will be for the good of the industry, and therefore we hope that engineers generally will give it their support, and that a comprehensive body will be formed instead of a number of independent sectional associations.

The New Fuel and Lighting Order.

IT has been common knowledge for some time that a new scheme for the combined allocation of coal, gas and electricity is in preparation, and on Friday last the Controller of Coal Mines gave an address on the subject at a meeting arranged by the Scientific, Trade and Technical Circle of the Institute of Journalists. We gather that the full text of the Order will be issued shortly, and that the object of the meeting was to inform the Editors of the daily and technical press of the general tenor of the new proposals, and especially of the circumstances which render necessary further steps in the direction of economising fuel. We must postpone detailed discussion of the Order until its full terms are made public. Meantime it is useful to have an inkling of the general procedure contemplated, and as the Chairman of the Circle, Mr. GASTER, remarked in his introductory remarks, technical journalists will appreciate the recognition of the value of their services by the Controller in taking them into his confidence, and will gladly do their best to prepare the minds of the public for the coming measure. The particulars we give in what follows are based on an official memorandum furnished to the meeting, which will no doubt be of assistance in indicating the salient points of what is necessarily an intricate and complex measure.

An Outline of the Scheme.

BRIEFLY, the present scheme consists in allowing every householder a certain amount of fuel, and for this purpose electrical energy and gas are taken into account, and are expressed in terms of a ton of coal. Consequently, the consumer who at present has a number of gas fires will be no better off than the householder who merely depends on coal fires; it will all be taken into account. Obviously, it is a much fairer basis than that which has been adopted hitherto. Some additional allowance will be made on account of lighting, whether by electricity or gas; but, apart from this, it is proposed to take gas into account at the rate of 15,000 cubic ft. as equivalent to 1 ton of coal (though this figure may be varied

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according to the locality), and electricity by adopting a figure of 800 units as being similarly equivalent. We are inclined to think that the figure for gas is more favourable than that for electricity, and those who at present rely upon electricity for heating and cooking may find this figure rather low from the po nt of view of being an equivalent. By this we do not mean that many generating stations obtain more than 800 units per ton of coal. Unfortunately, this is not the case, though some of the more efficient stations may reach a higher figure: i is not really from the absolute point of view that we can make any criticism. As was pointed out by the Coal Controller, there is not necessarily any correspondence between these two figures; they merely represent a compromise which is thought to be fair and reasonable. As to the actual amount of total fuel to be allowed, this does not appear to have been fixed so far—at least, no definite figure has been published, though a figure of 1 ton of fuel per room up to 20 tons per annum has been mentioned, with a minimum quantity of 3 or 4 or 5 tons according to the locality. There is no doubt that those living in the larger houses will find greater difficulty than the smaller householder. This, however, is intended, as it is realised that very little economy can be expected in the smallest class of house. With regard to the use of electricity and gas as against the use of raw coal, we think it may be pointed out that their use is distinctly desirable, as this leads to much less labour than is entailed by the delivery of coal to individual houses. Consequently, we think their use should be encouraged as far as possible. In conclusion, it may be said that the new Order will undoubtedly cause some inconvenience. Control at the best of times is unpopular; but we have to accept the fact that we are at war, and the best thing to do is to assist the Coal Controller to our utmost in the reduction of coal consumption, so that the coal may, as far as possible, be used in the directions in which it is most urgently required for the needs of the country as a whole.

The Causes of Industrial Accidents.

AN interesting Report, issued by the Health of Munition Workers' Committee, describes some investigations by Dr. H. M. VERNON on the causation of industrial accidents. The Report deals with about 50,000 accidents in four factories, an attempt being made to relate the accidents and the output per hour. In some respects the conclusions of the Report seem to diverge from those arrived at in previous investigations. It has hitherto been assumed that accidents became more prevalent in the later hours of work, as operators became more fatigued, and were more frequent on the night shift. Generally speaking, this was not the case in the factories Dr. VERNON examined, the chief factors controlling the accident rate being apparently the speed of work and the mental state of the worker. One variety of accident (injuries to the eye through foreign bodies) was 7—27 per cent. more numerous by night than by day, and this was ascribed to artificial lighting, the percentage increase being greatest in the worst lit factory. On the other hand, Dr. VERNON does not furnish evidence of the close connection between defective lighting and other forms of accidents—*e.g.*, those due to persons falling, which was so strikingly brought out in the Report of the Home Office Departmental Committee on Lighting in Factories and Workshops. On the whole, we are inclined to think that it would not be judicious to generalise from these results. Inquiries of this type are greatly needed, and Dr. VERNON's investigations were evidently made with great care, but apply to a limited field. We should like to see them extended to many other factories, carrying on widely different kinds of work, and operating under very varied conditions as regards lighting and other material circumstances. This is a matter which will, no doubt, receive the consideration of the London Safety First Committee, which is now extending its investigations to industrial processes.

Royal Society.—Among the Papers read yesterday before the Royal Society were the following: "Experiments on the Effect of the Vibration of a Stretched Wire Forming Part of a Closed Electric Circuit," by Admiral Sir Henry Jackson, G.C.B., F.R.S.; and "The Diamagnetism of Hydrogen and the Value of the Magneton," by Dr. A. E. Oxley.

The Use of Tikker and Telephone for Current Measurement.—In a recent contribution by Mr. Gondet, before the Société Française de Physique, allusion is made to the possible applications of the tikker employed in wireless telegraphy, the function of which is to produce interruptions of current of a frequency capable of producing a musical note. A tikker of this type, used in conjunction with a telephone, could often be employed in practice, instead of a galvanometer, as a convenient means of recording small continuous currents of the order of 1 microampere upwards. A sketch is given of a Wheatstone bridge arrangement using the tikker and telephone which is recommended for industrial work.

A Source of Platinum in Germany.—In a lecture before the London School of Economics last year Mr. Johnstone, of the Imperial Institute Research Department, referred to platinum as one of the very few rare "key" metals that do not occur in considerable quantity in the British Empire. Several possible sources of supply by treating various Canadian by-products were, however, mentioned. According to "Metall und Erz," a process has been developed in Germany for obtaining platinum from a variety of ore at Wenden, 200,000 tons of which have been located. Tests so far conducted indicate that about 32 gr. of platinum per ton of ore can be recovered, and the process is said to be a comparatively easy one.

Electricity in the Silk Industry.—The application of electrical methods in the weaving industry, and especially in connection with silk are discussed by Mons. Ch. Vallet in "L'Industrie Electrique." The chief advantage is said to be the avoidance of breakage of the fine threads, which appears to be inseparable to some extent from the use of steam and gas engines. The essential factor is regularity of speed, and the better results secured in this respect through the electric drive have led to an increase in production of 5-20 per cent. The question of the best arrangement of drive receives some consideration. Generally speaking the author inclines to the view that control by groups is preferable in a workshop where a large number of machines are working on identical processes.

The Collapse of Short Thin Tubes.—The conditions determining the bursting strength of thin steel tubes are of some practical importance, for example in relation to tubes in boilers. Some work on the subject was done by Sir William Fairbairn in 1858, and the problem has since been dealt with by others. A recent series of tests is that carried out by Prof. A. P. Carman at the Illinois University Engineering Experiment Station. The curves connecting pressure and length are substantially similar for tubes of a given material and thickness and diameter being in general hyperbolæ. There is, however, a "critical length" above which the collapsing pressure is constant and the curve therefore becomes horizontal. This length appears to be about six times the diameter. For lengths below this the collapsing pressure, and the form of the curve, can be calculated with fair exactitude, though there was some departure for thinner tubes, namely those of 1 in. and 2 in. diameter, for which the ratio thickness diameter is about 0·001 the agreement between calculated and observed data is less exact. The above refers to steel tubes. Data were also obtained on tubes of glass and hard rubber, for which the curve is of a materially different form.

The Grading of Carborundum for Optical Purposes.—In the search for suitable abrasives for fine grinding, especially in optical work, attention has been given to carborundum, and according to a contribution by Mr. J. W. French to the "Transactions" of the Optical Society, it is in general superior to emery. The chief difficulty is the separation of the finer grades of material needed as a preliminary to polishing.

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The coarse commercial carborundum is broken up in roughing mills, and the resultant sludge is not suitable for treatment by a current of air. The author discusses various elutrition methods which are necessary in order to separate out the finer grades. The use of centrifugal machinery has been proposed, and the author suggests that electro-osmose methods may prove of value in the final stages of treatment.

Occluded Gases in Ferrous Alloys.—In a contribution to the "Journal" of the Franklin Institute, Prof. G. Alleman and Mr. C. J. Darlington describe a new form of gas-tight furnace, suitable for continuous service at 1,900°C., which is stated to have given good results in the treatment of ferrous alloys. An important feature of the furnace is that all gases occluded in such alloys can be collected and removed. It is, perhaps, not generally known that ferrous alloys may occlude considerable quantities of gases, in some cases equal to about 200 times the volume of the metal. The gases are freed with varying difficulty, nitrogen being very tenaciously held. Removal of the gases changes, in a marked degree, the microstructure of the alloy and increases its density. It is suggested that to the other functions of aluminium, tungsten, chromium, &c., when used in ferrous alloys must be added their action as a catalytic agent to prevent the occlusion of gases, or aid in their elimination at lower temperatures than would otherwise be necessary.

Experiments on Visual Diffusivity.—A recent contribution by Dr. H. E. Ives to the "Philosophical Magazine," contains some interesting notes on "Visual Diffusivity," *i.e.*, the lagging of different colour-impressions received by the eye with respect to each other. The effect was demonstrated by arranging the various colours in line radially on a disc. When the disc is rotated the colours appear displaced with regard to one another and the line becomes broken. The experiment readily facilitates the detection of mixed colours. Thus a purple strip is resolved into two overlapping bands of red and blue. Of special interest is the comparison, by this means, of pure monochromatic yellow with a yellow which is subjectively indistinguishable but consists of a mixture of red and green. The pure colour is unaffected by rotation, while the mixed colour is blurred owing to the separation of its components. The result is of considerable interest from the standpoint of three-colour theories of vision, according to which spectrum yellow is the combined physiological effect of elements of red, green and blue. It would appear, as the author suggests, that some modification in such theories is rendered essential by this experiment, quite apart from the various objections that have been raised from time to time on physiological grounds.

Birthday Honours.—In addition to the list of names given in our last issue, the following further honours have been conferred:—

Knight.—The dignity of a Knighthood has been conferred upon Major Archibald Gilbey Gold. On the outbreak of war Major Gold raised a reserve regiment of the Essex Yeomanry. He joined Messrs. G. E. B. & G. W. Pritchett as a partner in the firm of Pritchetts & Gold in 1882, and has been a director of Pritchetts & Gold (Ltd.) since the conversion of the business to a limited liability company in 1900, and on the amalgamation of the Company with the Electrical Power Storage Co. in 1915 he became a director of the existing Company.

K.B.E.—Horace Darwin, F.R.S., chairman of the Cambridge Scientific Instrument Co. and member of Munitions Inventions Department Panel; Allan McGregor Smith, chairman of management Committee of Engineering Employers' Federation.

C.B.E.—Ernest John Pickstone Benn, chairman (unpaid), Trade Organisation Commissioners, Ministry of Reconstruction, and chairman of the Industrial Reconstruction Council; Edward C. C. Baly, F.R.S., professor of chemistry, Liverpool University and Deputy Inspector of High Explosives; Wm. W. Bradfield, managing director Marconi's Wireless Telegraph Co.; Alfred Dobree, member of Ordnance Committee, Ministry of Munitions; Holberry Mensforth, general works manager, British Westinghouse Co. and member Manchester Co-operative Munitions and Manchester National Shell Factory Boards of Management; Geo. H. Nash, chief engineer, Western Electric Co.; John Newlands, C.I.E., Controller of Central Telegraph Office, G.P.O.; E. S. Shrapnell-Smith, chairman of Standing Joint Committee of Mechanical Road Transport Association and chief economy officer, Petroleum Executive; Andrew Wilson Tait, chairman British Aluminium Co.; Walter L. Topple, superintendent electric and Ordnance Accessories Co.; Chas. Hy. Wordingham, president of Institution of Electrical Engineers and director of Electrical Engineering, Admiralty.

O.B.E.—G. H Baillie, M.B.E., Chief Technical Adviser on Dilution of Labour, Ministry of Munitions; Frank Purser-Fletcher, electrical engineer, Department of Electrical Engineering, Admiralty; Holbrook Gaskell, chief engineer United Alkali Co.; Hector M. MacDonald, professor of mathematics, Aberdeen University, and Section Director, Labour Department, Ministry of Munitions; Hy. Ashley Madge, wireless telegraph expert, H.M.S. "Vernon"; Sidney W. Morrison, Section Director, Experimental and Technical Branch, Oriental and Glassware Department, Ministry of Munitions.

M.B.E.—Fredk. H. Broomfield, principal electrical cable overseer, Department of Director of Electrical Engineering, Admiralty; Capt. Sidney L. Dashwood, brigade wireless organisation officer, R.A.F.; Horace Dive, first-class clerk, London Telephone Service.

Obituary.

DEATHS ON ACTIVE SERVICE.—The following deaths are reported: Lieut. Wm. H. McFarlane (A. and S. Highlanders), aged 21, who died in action on May 27, was, at the time of the outbreak of the war, an engineering student at the City and Giulds' of London Technical College, Finsbury.

Lance-Corp. F. Woods (London Regt.) formerly employed by the India Rubber Co., died of wounds in France about a month ago.

Personal.

On the recommendation of the Council of the Royal Society of Arts, the Duke of Connaught, as president, has awarded the Albert Medal for 1918 to Sir Richard T. Glazebrook, C.B., Sc.D., F.R.S., "for his services in the application of science to the industries of peace and war, by his work as director of the National Physical Laboratory since 1899, and as chairman of the Advisory Committee or Aeronautics."

Mr. A. Nichols Moore, borough electrical engineer of Newport (Mon.), has been invited by the Coal Controller to accept the appointment of District Engineer in connection with the scheme for economical use of coal for industrial purposes.

WAR CASUALTIES.—The following casualties are reported:—

Pte. L. North (London Regt.) formerly in the India Rubber Co.'s general office, is a prisoner of war in Germany.

Pte. S. R. Ward (M.G.C.) and Pte. T. Houghton, formerly in the service of Messrs. Dick, Kerr & Co., are also prisoners of war in Germany.

Signaller J. S. Pickles (Cheshire Regt.), formerly a Blackburn tramway employee, is reported missing.

Corp. W. Perkins (Cyclist Batt.) is a prisoner of war at Limburg. He was also a Blackburn tramwayman.

Pte. J. W. Miller (Lancs Fus.), formerly a South Lancashire tramwayman, is a prisoner of war at Soltau (Hanover).

Arrangements for the Week.

FRIDAY, June 14th (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, South Kensington, S.W. Discussion on "The Teaching of Physics in Schools," to be opened by Sir Oliver Lodge, F.R.S. Contributions are also expected from Prof. T. P. Nunn, Prof. R. A. Gregory, Prof. F. Womack and Messrs. C. E. Ashford, T. J. Baker, C. L. Bryant, G. F. Daniell, J. Nicol, F. W. Sanderson, A. T. Simmons and E. Smith.

SATURDAY, June 15th.

THE ELECTRICAL POWER ENGINEERS' ASSOCIATION, MIDLAND SECTION.

3 p.m. At the Imperial Hotel, Temple-street, Birmingham. General Meeting.

WEDNESDAY, June 19th.

BRITISH SCIENCE GUILD.

4 p.m. At the Mansion House, London, E.C. Address on "Education, Science and Leadership," will be given by the Rt. Hon. Lord Sydenham. Other speakers will be Sir Algernon Firth, Bart. and Sir Henry Newbolt, D.Litt.

THURSDAY, June 20th.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

10 a.m. At the Town Hall, Manchester. Presidential Address by Mr. S. J. Watson, and discussion on "The Future of Electric Power Supply," introduced by Mr. S. L. Pearce.

3 p.m. Alternative visits to the Stuart-street Power Station or the works of the British Westinghouse Co.

8 p.m. Smoking Concert at the Engineers' Club.

FRIDAY, June 21st.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

9.30 a.m. Council Meeting.
10 a.m. Resumed discussion on "Electric Power Supply."
11.30 a.m. Annual General Meeting.
3 p.m. To re-assemble if necessary to complete any adjourned business.

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Calculation of Commutators of Alternating-current Machines.*

By M. SCHENKEL.

Summary.—General formulæ are given for calculating the commutators of any type of alternating-current commutator machines. The dimensions of the commutators and particulars of the brush gear are fixed in relation to quantities that are only to a small extent in the control of the designer. It is important to note that the required dimensions are almost rigidly fixed. The application of the formulæ is illustrated by the insertion of average values.

It is known that the armatures of three phase commutator machines may be fed with a number of phases differing from the number of phases in the supply. If the commutator were to have as many brushes as correspond to the latter number of phases and to the number of poles on the machine, the commutator would be so covered by brushes and brush gear as to be very inaccessible, and the dissipation of heat from its surface would be obstructed. It is, therefore, desirable to dispense with some of the brushes.

A general solution of this problem follows if we consider that each of the supply phases is applied to the commutator at two points for each pair of poles. Fig. 1 illustrates this for a four pole three phase machine. There are two sets of brushes, one comprises the brushes B_1, B_2, B_3, B_1', B_2', B_3', and the other B_4, B_5, B_6, B_4', B_5', B_6'. The relative position of these two brush sets is arbitrary. There cannot be more brush sets than two per phase, nor more brushholders than two per phase and pairs of poles.

NOTATION.

D_k = Diameter of commutator in centimetres.
l_k = Length of commutator in centimetres.
l_b = Total length of the brushes on one brush stud in centimetres.
k_l = Number of commutator segments.
τ_k = Pitch of segments in centimetres (*e.g.*, 0·5 cm.).
h_b = Number of brush studs, if each stud were full.
h = Actual number of brush studs.
b = Breadth of one brush in centimetres.
F_b = Combined contact area of all brushes in cm.².
Z = Number of conductors in the winding connected to the commutator.
$2a$ = Number of parallel armature circuits.
$2p$ = Number of poles.
q = Number of phases.
m = Number of insulating segments bridged by one brush (always a whole number, *e.g.*, 2).
f_m = Bridging factor (*e.g.*, 0·9).
f_h = Factor for the completeness of the filling of the brush studs.
Φ_p = Flux per pole in c.g.s. units.
I = Total current per phase in amperes.
I_h = Current per brush-stud in amperes.
E_g = Back E.M.F. of the commutator winding per phase in volts.
KVA = Power on the commutator in K.V.A.
c = Supply frequency.
c_r = Frequency corresponding to the short-circuit voltage e_k.
W_k = Total commutator losses in watts.
n = Speed of armature in revs. per min.
n_r = Relative speed of armature and field.
e_k = Short-circuit voltage, calculated per insulating segment in volts (*e.g.*, 3 volts).
v_k = Peripheral speed of commutator in m/s (*e.g.*, 20 m/s).
β_b = Current density under the brushes in A/cm.² (*e.g.*, 8A/cm.²).
Λ_b = Contact voltage from one brush to commutator in volt (*e.g.*, 1·25 volt).
p_b = Pressure of the brushes in kg./cm.² (*e.g.*, 0·25 kg./cm.²).
μ = Coefficient of friction between brushes and commutator (*e.g.*, 0·25).
w_b = Heat developed per sq. cm. of brush contact in W/cm.²
w_k = Heat dissipating constant for the surface of commutator covered by brushes in W/cm.² (*e.g.*, 1·5 W/cm.²).
f_e = Factor for the E.M.F. E_g (*e.g.*, $0{\cdot}866 = \frac{1}{2}\sqrt{3}$).

The numerical values given in the above table are average values, and only admit of variation within close limits.

The breadth b of the brush is usually greater than the pitch of the commutator segments, and it is assumed that each brush bridges over m insulations (*see* Fig. 2), where m is a whole number. Hence

$$b = m\tau_k f_m \text{ cm.}, \quad \ldots\ldots\ldots \quad (1)$$

where f_m is a factor usually lying between 0·9 and 1·0. In Fig. 2 $m=2$ and $f_m=0{\cdot}85$.

According to the assumption made that each phase is connected to the commutator at two brushes the total possible number of brush-studs is $2 \cdot q \cdot p$. In Fig. 1, $h = 2 \cdot q \cdot p = 2 \times 3 \times 2 = 12$.

* Abstract of an article in the "Elektrotechnische Zeitschrift," Vol. XXXVIII.

It often happens that this maximum number cannot be used, *e.g.*, if some of the brush-studs would lie in inaccessible positions, or if it is required to rock one set of brush-studs past the other, as is intended in Fig. 1, or if the radiation of heat sets a limit to the number. If the h brush-studs are only partly filled, the number of studs that would be filled by the existing number of brushes is

$$h_b = 2q \cdot p \cdot f_h. \quad \ldots\ldots\ldots \quad (2)$$

where f_h is a factor, which has the value 0·5 in Fig 1.

It is easily shown that

$$\frac{v_k}{\tau_k \cdot k_l} = \frac{n}{6{,}000}, \quad \ldots\ldots\ldots \quad (3)$$

and that—

$$w_b = p_b \cdot \mu \cdot v_k \cdot 9{\cdot}81 = \beta_b \Lambda_b \text{ in W/cm.}^2. \quad \ldots \quad (4)$$

If we take the numerical values given above, we obtain the following table:—

v_k m./s	$p_b \cdot \mu \cdot v_k \cdot 9{\cdot}81$ W/cm.²	$\beta_b \cdot \Lambda_b$ W/cm.²	w_b W/cm.²	$\frac{w_b}{v_k}$ W/cm².s/m.
10	6·13	10	16·13	1·613
15	9·20	10	19·20	1·280
20	12·25	10	22·25	1·111
25	15·31	10	25·31	1·012
30	18·40	10	28·40	0·947
35	21·45	10	31·45	0·898

It appears that the quantity w_b / v_k does not vary greatly as long as v_k lies between the usual limits of 15 and 30 m./s.

The voltage between the two brush groups of one phase has its maximum value if they are spaced 180 electrical degrees apart, the armature having a diametral winding. If the brushes are not exactly opposite, the voltage between them will be less than the maximum value referred to, which will have to be multiplied by a factor f_e (*see* equation 8). The factor f_e is inserted to allow for the distribution of the field, and also for the type of winding, if this is not diametral. If the distribution of the field follows a sine law, then f_e is the sine of half the angle between the brushes, *e.g.*, for 120 deg., we have $f_e = 0{\cdot}866$.

If each phase is connected to the commutator in separate points, the current density under the brushes is determined by the phase current I, but, if the brushes of two groups lie on the same segments, the currents in two phases will combine to form a resultant current in those commutator segments. If such a relative position of the brushes is required permanently, the phases may be joined together before the brushes, and the current density under the brushes will be thereby reduced. For instance, in Fig. 1, $q=3$, $2p=4$, and if each phase were separately connected 12 brush-studs would be required, each carrying a current $I/2$, but if the phases are combined we should require only six studs, carrying $\sqrt{3}I/2$ amperes each. An arrangement of this nature is shown in Fig. 3 that is drawn for conditions similar to those of Fig. 1. It is obtained from the arrangement of Fig. 1 by rotating the white brushes 60 electrical degrees, so that B_5 and B_1 are brought on to the same segments.

From the above remarks it follows that the power on the commutator ($KVA = E_g \cdot I \cdot q \cdot 10^{-3}$) need not necessarily be equal to the power of the machine, although in most cases it is so, *e.g.*, in series machines and repulsion motors. In the case of shunt motors the speed of which is regulated down to the xth part of the synchronous speed by shifting the brushes, the power on the commutator is only the $(1-x)$th part of the power of the machine.

We may determine f_h as follows:—

The number of segments covered by brushes is $2 \cdot q \cdot p \cdot f_h \cdot m \cdot f_m$, so that

$$\frac{F_b}{\pi \cdot D_k \cdot l_b} = \frac{2 \cdot q \cdot p \cdot f_h \cdot m \cdot f_m}{k_l}. \quad \ldots\ldots \quad (5)$$

For the losses we have

$$w_b \cdot F_b = w_k \cdot \pi \cdot D_k \cdot l_b,$$

so that

$$\frac{F_b}{\pi \cdot D_k \cdot l_b} = \frac{w_k}{w_b}. \quad \ldots\ldots\ldots \quad (6)$$

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Inserting equations (5) and (6) in (3) we obtain

$$f_h=\frac{w_k}{\frac{w_b}{v_k}\cdot b}\cdot\frac{3{,}000}{q\cdot p\cdot n}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

From this we see that f_h depends, to a small extent, only upon the peripheral speed v_k of the commutator, and that, if we regard this quantity as constant, the product $q\,.\,p\,.\,n$ is constant. This shows that the number of brush-studs used must be reduced relatively to the maximum possible number of brush-studs, if q, p or n are increased. For synchronous machines $p\,.\,n$ is constant, and for such machines f_h decreases as the number of phases in the armature increases.

For instance, adopting the assumed numerical values we get

$$f_h=\frac{1{\cdot}5}{1{\cdot}111}\cdot\frac{3{,}000}{q\times p\times n\times 2\times 0{\cdot}5\times 0{\cdot}9}=\frac{4{,}500}{q\,.\,p\,.\,n}.$$

If $q=3$ and $p\,.\,n=3{,}000$, we obtain $f_h=0{\cdot}5$ for three-phase 50-cycle machines. Such machines must, therefore, be provided with half the maximum possible number of brushes. This is actually the case in practice, and the machines of this type with double brush sets have the current supplied on one-half of the commutator length and the current taken off on the other side; all the possible brush-studs are used, but they are only half filled.

whence the surface of the commutator that is touched by the brushes is given by

$$\pi\,.\,D_k\,.\,l_b=KVA\,.\,10^3\,.\,\frac{1}{e_k\,.\,\beta_b\,.\,f_e}\,.\,\frac{60\,.\,c_r}{n_r\,.\,p}\,.\,\frac{\pi}{q\,.\,m\,.\,f_m\,.\,f_h}\text{ cm.}^2 \quad (13)$$

With the aid of equation (7) we obtain

$$\pi\,.\,D_k\,.\,l_b=KVA\,.\,\frac{\tau_k}{e_k\,.\,\beta_b\,.\,w_k}\,.\,\frac{w_b}{v_k}\,.\,\frac{n}{f_e}\,.\,\frac{e_r}{n_r}\,.\,20\pi\text{ cm.}^2, \quad . \quad . \quad (14)$$

which contains only quantities whose values have been given above. The surface of the commutator is, therefore, proportional to the power developed in the commutator winding of the armature. The voltage e_k and the current density β_k, depending on the material used in the brushes, have a considerable influence and the commutator becomes smaller, the greater the values that are assigned to these quantities. It is very interesting to note that the influence of n, n_r and c_r is quite different for machines with rotating field and with pulsating field. In the former class c_r/n_r is a constant, and so the size of the commutator is not influenced by the frequency c_r, but rather by the speed in revs. per min., which, in its turn, depends on the supply frequency c.

On the other hand, if the field is pulsating n/n_r is constant, and the size of the commutator is not affected by the speed of rotation, but by the frequency and decreases with this quantity.

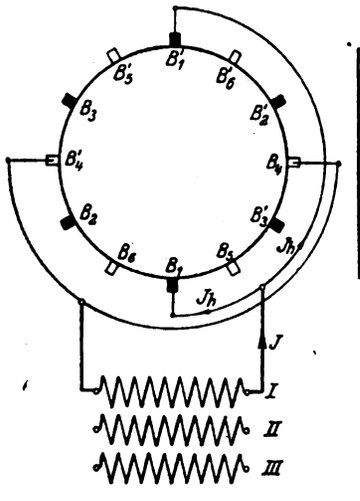

FIG. 1.—FOUR-POLE MACHINE WITH THREE-PHASE SUPPLY TO COMMUTATOR, BRUSH-STUDS HALF-FILLED, POSITION OF BRUSHES IMMATERIAL.

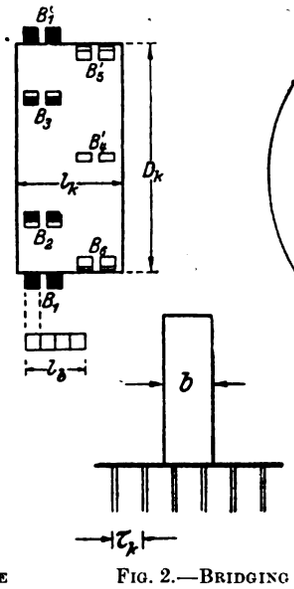

FIG. 2.—BRIDGING THE SEGMENTS BY THE BRUSH.

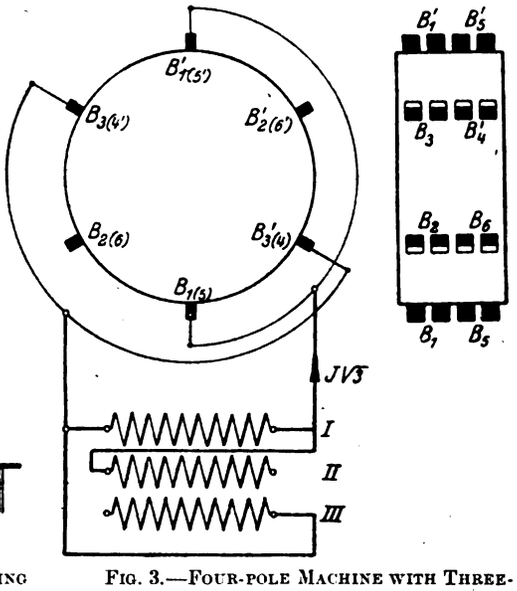

FIG. 3.—FOUR-POLE MACHINE WITH THREE-PHASE SUPPLY TO COMMUTATOR, BRUSH-STUDS HALF-FILLED, BRUSHES IN ONE OF THE SUPERPOSED POSITIONS, PHASE CURRENTS COMBINED *before* THE BRUSHES.

We see that the number of brush-studs is determined within narrow limits by the above considerations. It is fixed in the main by consideration of the heat developed under the brushes and the provision of sufficient heat radiating capacity.

If the maximum possible number of brush-studs are used ($f_h=1$) we have with the values assumed above $q\,.\,p\,.\,n=4{,}500$, whence, if $q=1$ or 2, $p\,.\,n=4{,}500$ or 1,500. It follows, therefore, that fairly high speeds are attainable only with single-phase machines, which have on this account an advantage over other forms of commutator motors.

We are now in a position to calculate the dimensions of the commutator for a given machine. We have the equations

$$E_g=\frac{p}{a}\,.\,Z\,.\,n_r\,.\,\frac{\Phi_p}{10^6}\,.\,\frac{1}{6{,}000\,.\,\sqrt{2}}\,.\,f_e\text{ volt}, \quad . \quad . \quad . \quad . \quad (8)$$

and

$$e_k=\frac{p}{a}\,.\,\frac{Z}{2k_l}\,\frac{c_r}{100}\,.\,\frac{\Phi_p}{10^6}\,.\,\frac{2\pi}{\sqrt{2}}\text{ volt}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Hence,

$$E_g=e_k k_l\frac{n_r}{c_r}\,.\,\frac{1}{60\pi}\,.\,f_e. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

Further, as pf_h is the number of points of supply of current per phase,

$$I=I_h\,.\,p\,.\,f_h=l\,.\,b\,.\,\beta_b\,.\,p\,.\,f_h=l_b\,.\,m\,.\,\tau_k\,.\,f_m\,.\,\beta^b\,.\,p\,.\,f_h\text{ ampere} \quad (11)$$

The total power in the commutator winding of the armature is

$$KVA=E_g\,.\,I\,.\,q\,.\,10^{-3}, \quad . \quad . \quad . \quad . \quad . \quad (12)$$

If we insert the numerical values given for the various quantities appearing in equation (14) we find that 56 cm.² of surface is required per kilovolt ampere.

It can be shown that the total commutator losses W_k are given by

$$W_k=\pi D_k\,.\,l_b\,.\,w_k=KVA\,.\,\frac{\tau_k}{e_k\beta_b}\,.\,\frac{w_b}{v_k}\,.\,\frac{1}{f_e}\,.\,\frac{n\,.\,c_r}{n_r}\,.\,20\pi\text{ watt}, \quad . \quad . \quad (15)$$

and the total contact area under the brushes is

$$F_b=KVA\,.\,\frac{\tau_k}{e_k\beta_b}\,.\,\frac{1}{v_k}\,.\,\frac{1}{f_e}\,.\,\frac{n\,.\,c_r}{n_r}\,.\,20\pi\text{ cm.}^2. \quad . \quad . \quad . \quad (16)$$

Inserting our numerical values, we obtain—

$$\frac{W_k}{KVA}=84\text{ watt per kilovolt-ampere},$$

and

$$F_b=3{\cdot}78\text{ cm.}^2\text{ per kilovolt-ampere}.$$

Electric Power Supply.—The report of the debate which took place at the Engineers' Club, Manchester, on March 5th last, on the Interim Report of the Coal Conservation Sub-Committee, is now available in pamphlet form, and extra copies may be obtained from the Hon. Secretary of the club, Albert-square, Manchester, at 4d. each.

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Notes on Electroculture.

By INGVAR JÖRGENSEN.

The question of electroculture has lately excited a considerable amount of attention. This is mainly due to the fact, which forces itself upon our minds more and more as the war progresses, that agriculture is an industry absolutely essential for the community and that this industry possesses potentialities for development like every other industry. At present developmental possibilities are limited by questions of man power, facilities for transport, supply of manures, &c., and for some time yet it may be deemed expedient to increase our food production by an extension of cultivated areas, rather than by the development of more intense methods of cultivation.

In view of the obvious economies which are possible as regards labour and fuel, the application of electrical energy in agricultural matters for power and lighting deserves close attention; at present, however, the limits for development in this direction are fixed by the material available from other essential war industries. The possibility that electroculture may become of practical importance in the near future is bound up with the possibilities of the development of intensive methods of cultivation in general and the more extensive use of electricity for power and lighting in rural areas.

Such considerations, however, should not be allowed to discourage research on the problems of electroculture. That research may yield profitable results is clear. There is indeed little room for doubt that during the next generation we shall witness the realisation of the possibilities of the living plant, and that we in our time shall see enormous developments of great plant industries.

We must, however, learn our lessons from the past; probably no subject can show such a vast expenditure of effort with so little result as the subject of electroculture. This is partly due to the fact that each individual investigator neglects the experiences of his predecessors, but chiefly to an under-estimation of the difficulties of the problems. It may not be out of place in an engineering journal to emphasise that although the subject presents a number of initial problems to electrical engineers, and although pure physics has rendered, and will continue to render, valuable help in electrocultural investigations, yet these aspects of the problems involved are elementary compared with those presented to agriculture and the plant industries.

The problems of electroculture are very attractive from a scientific point of view. A survey of the history of the subject makes it clear that we are confronted with a great number of difficult and complex questions. The solution of these problems will, however, widen the outlook of and give fresh stimulus to a whole range of other subjects. Therefore, apart from the questions of the day, namely—

1. Can crop production be increased by electroculture?
2. If so, is it an economic proposition?

it is of urgent necessity that we should attempt to master this subject which has been handed down as heritage from generation to generation.*

In the present article it is only proposed to deal with that branch of electroculture where an overhead network is employed. If we regard the matter from a purely physical aspect we are confronted with a system consisting of the following phases:—

Metal / air / plant / earth.

It is the analysis of this system as a whole which alone can provide the key for the investigation of the scientific and industrial possibilities of electroculture. The material for this electro-physical analysis is provided in part by empirical crop experiments. Electrical data in other fields of investigations in which parts of the system have been submitted to analysis, *e.g.*, in investigations dealing with the corona effect in transmission lines, may help materially, but in order to obtain experimental control the system must be investigated as a whole. Apart from the variables which can be introduced in the metal-air part of the system, *e.g.*, diameter and height of wires, potential to which they are charged, atmospheric conditions, &c., this is not an easy matter, as the plant phase makes the system a dynamical one in which conditions change continually during the life-cycle of the plant. Further experience gained from experiments with one plant species cannot be transferred to other species.

If we fix our attention on the empirical crop experiments where definite results of economic value have been obtained, we see that two essentially different methods have been used. The first (Lemström's) makes use of a discharging network at a comparatively short distance from the growing crop (about 0·5 metre). A constant discharge is aimed at by keeping the distance between network and crop constant. This method necessitates a frequent re-adjustment of the height of the network. The second method (that of the Agricultural Electric Discharge Co.) employs a network at a considerable distance from the ground (about 5 metres). The intensity of the discharge is in this case not affected to any great extent by the increase in height of the growing crop. In Lemström's experiments unidirectional current from an influence machine was used; the potential to which the network was charged was relatively low (a few thousand volts), the charge of the network was either positive or negative, although Lemström professes that better results are obtained by positive discharge. In the experiments with the apparatus of the Agricultural Electric Discharge Co., an intermittent unidirectional current obtained by means of induction coil and valve rectifier is used. The network is always charged positively, to a relatively high potential (max. 50–70,000 volts). Both Lemström and the A.E.D. Co., use a discharging system of parallel wires (S.W.G. No. 24), in the case of Lemström, 1 metre apart, but with discharging points for every metre. In the A.E.D. system the wires are 10–30 metres apart, and they are either bare or cotton covered.

It is easily realised that the conditions of discharge in these field experiments are not very analogous to any we know from the numerous investigations in pure physics where electrical discharges between conductors of different shapes and sizes have been examined. The essential feature of the discharge in the crop experiments is the large air gap between the electrodes and the undefined electrode, the plant. Further, the plant, as electrode, alters entirely its properties in the course of its life cycle, but space does not permit here a discussion of this interesting problem. The variables which we in the first instance are concerned with are: the diameter of discharge wires, the distance between them and the intensity of the discharge current. *Facts* concerning these variables will provide bases for the electrical engineering problems.

* It is not the place here to enter into a discussion of the conditions which have retarded the development of our knowledge of the relation between electricity and plant growth, but it seems clear that a lack of knowledge of the electrical conditions in such experiments made it extremely difficult to repeat them, and thus soon brought the subject into discredit. The following extract of a letter from the famous horticulturist and plant physiologist, T. A. Knight, to an electroculture investigator written in 1818, may be of interest to readers.

"I am myself perfectly satisfied that your conclusions respecting the influence of the voltaic battery upon plants are correct, but the opposite opinion that the electric fluid produces no effect upon vegetable being, has got possession of the public mind owing to erroneous conclusions having been drawn by former writers, who had imagined themselves to have witnessed the influence of electricity to be great in promoting the growth of plants. Your paper must, therefore, come before judges who have already drawn conclusions in direct opposition to yours. My wishes relative to your paper can point to one object only, which is that of doing you credit, and I fear that unless strong evidence can be made to meet the possibility of the operation of metallic oxydes, Sir Joseph Banks would request you to delay its presentation to the Royal Society. I have had a correspondence with him upon the subject, and I see that the erroneous conclusions which have been drawn relative to the influence of common electricity upon plants have made a strong impression upon his mind."

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Such facts must be obtained by quantitative measurements carried out in the course of a crop experiment, as the results obtained with a bare field on the one hand, and with a field carrying a sprouting or maturing crop on the other hand, are very different. This, of course, also holds for different crops; there is a great difference between the results obtained with a cereal crop and a root crop. If the *facts* are to be of any real use, then they must be obtained in relation to the crop. As regards the main *principles* of the interaction of these variables, experimental results already exist from which they can be deduced. In the following we

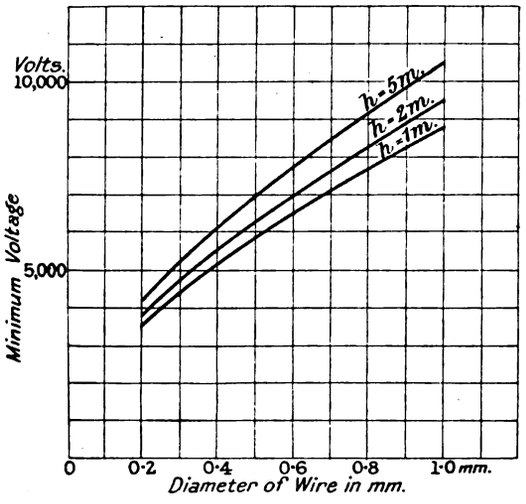

FIG. 1.

shall apply to our problem some theoretical considerations put forward by Townsend ("Phil. Mag.," 1914, 6, 28), in respect to the potentials required to maintain currents between coaxial cylinders. The formulæ obtained by Townsend from theoretical considerations can, of course, only give very rough approximations, but nevertheless it is instructive to apply his formulæ to the case where a wire instead of being in a cylinder is stretched at a uniform distance above the ground. The results obtained in this way have, perhaps, as much bearing on the crop experiments as results obtained from actual measurements with wires stretched over a bare field.

First we must, however, have an idea of the order of magnitude of the quantities with which we are concerned. The writer has had the opportunity of making measurements in a number of field experiments carried out by various investigators. The maximum discharge current used was of the order 1 milliampere per acre, which, with the distribution of wires employed, corresponded to a discharge intensity of 10^{-8} ampere per centimetre discharge wire.

Reverting to the discharge of electricity between coaxial cylinders we find that a definite potential is required to start the discharge.

Townsend found from Watson's experiments (THE ELECTRICIAN, 1910, 1913) that in the case of discharge between a wire and a coaxial cylinder of much larger radius the discharge commences when the electric force at the surface of the wire reaches a value given by the formula,

$$X_1 = 30 + \frac{9}{\sqrt{a}},$$

where A is the radius of the wire in centimetres and X_1 is measured in kilovolts per centimetre. It is independent of the diameter of the outer cylinder and also of the humidity of the air.

If V is the potential of the wire and E is the electric charge per unit length

$$V = 2E \log \frac{A}{a},$$

where A is the radius of the outer cylinder; and $X_1 = 2\frac{E}{a}$.

Thus we find the formula

$$V_0 = \left(30 + \frac{9}{\sqrt{a}}\right) a \log \left(\frac{A}{a}\right),$$

where the suffix 0 denotes the conditions required to commence the discharge.

If the wire instead of being in a cylinder is stretched at a uniform distance above the ground the above value for V must be replaced by

$$V = 2E \log \frac{2h}{a},$$

where h is the distance from the ground.

The electric stress necessary to commence the discharge is presumably not affected by the outer boundary, so that the above value of X_1 will still be correct.

In this case

$$V_0 = \left(30 + \frac{9}{\sqrt{a}}\right) a \log \left(\frac{2h}{a}\right).$$

Fig. 1 shows the relation between minimum potential and wire diameter for various distances from the ground.

When V is only slightly greater than V_0 the discharge current is small; the rise of potential $V - V_0$ required to maintain a given current of i amperes per cm. is given, provided i is not too great in the case of coaxial cylinders by the formula

$$\frac{V - V_0}{V_0} \log \frac{A}{a} = (1+\theta)^{\frac{1}{2}} - 1 + \log \frac{2}{1+(1+\theta)^{\frac{1}{2}}},$$

where

$$\theta = \frac{2i A^2}{ka^2 X_1^2},$$

and k the velocity of ions due to unit force.

Substituting $2h$ for A Fig. 2 and Fig. 3 are obtained, which for wires of 0·06 cm. and 0·03 cm. diameter respectively show the relation between voltage and discharge current when the wire is stretched at different heights from the ground.

A cause of uncertainty is the influence of neighbouring wires. If the distance between consecutive wires is 2 metres, and each is of radius 0·2 mm. and 2 metres above the ground, then the potential of any wire will be about 12 per cent. greater

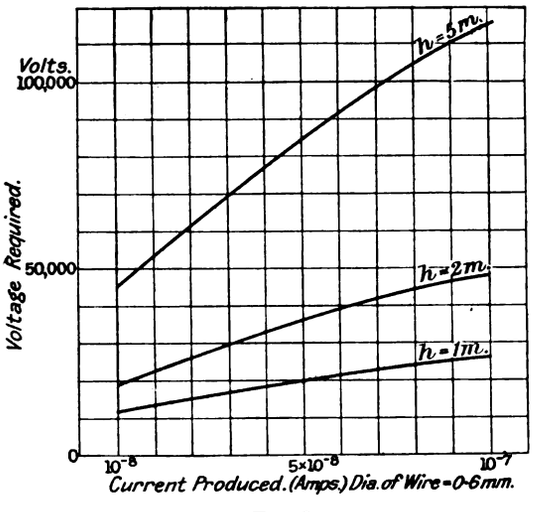

FIG. 2.

than in the absence of the others, the charge per unit length being the same. Increasing the distance between the wires will diminish this correction, but the distribution of discharge over the ground becomes less uniform. Reducing the size of the wires will also reduce it. The electric force at the surface of a wire is practically independent of the others; thus the effect of induction will be to increase the potential at which discharge commences.

The examples to which we have applied Townsend's formulæ indicate clearly their usefulness in regard to analyses of prin-

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ciples and as a foundation for electrical engineering work in connection with the subject. It is seen that the diameter of the wire is not of very great importance within the limits which tensile strength prescribes; thus there will be no difficulty in finding a wire S.W.G. No. 24 of a material of sufficient tensile strength for the spans which are likely to occur in practice; on the other hand wires of S.W.G. No. 30 are outside the limits of practical application. Further it is brought out what a great increase in voltage is required to maintain a current of even such a magnitude as 10^{-7} amperes per centimetre when the wires are at a considerable distance from the ground. The examples illustrated in Figs. 2 and 3 are calculated for a positive discharge and the usual value for k positive is applied. If k is negative it does not make any very great difference, thus confirming the experience gained from experiments with corona effect in alternating current lines.

It becomes clear from this exposition that the two problems with which the electrical engineer is confronted are: either (1) the arrangement of a discharge network at a short distance from the ground; this will simplify the construction of apparatus which can be built for moderately low voltages, or (2) the construction of apparatus capable of giving very high voltages, thereby enabling the network to be kept a considerable distance from the ground. Further experience alone can settle which of these methods is the simpler.

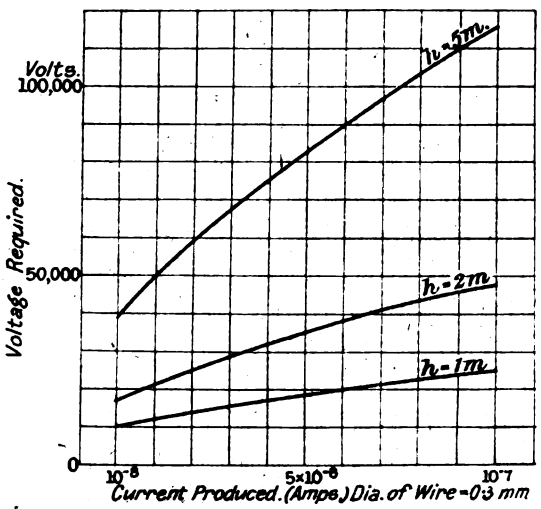

FIG. 3.

In the analysis of the discharge in the field, a great number of difficulties are met with. Many factors obscure the interpretation of the results obtained. Apart from the difficulty of eliminating leakage over surface of insulators, the fact must be borne in mind that a given network may give different results at different times owing to

1. Atmospheric conditions.

2. Alterations in the state of the wire, oxidation, accumulation of dust, &c.; thus, for example, Watson (1910) has drawn attention to the fact that corona effects alter their character according to the cleanness of the wire.

3. Influence of the crop on the character of the discharge, a cereal crop in its later stages will reduce the minimum potential considerably if the wires are moderately near the ground.

4. Complications introduced by the apparatus used for production of the high tension current. In many experiments it is obvious that the apparatus has been constructed for excessively high voltages, while on the other hand it was not dimensioned for the discharge current required. This is the case in many of Lemström's experiments with an influence machine.

The discharge between coaxial cylinders when alternating potential differences are established between the cylinders has been investigated by Whitehead (1911).

The general character of the phenomena are very much the same as with continuous current; the critical force, however, diminishes with the frequency of the alternating forces.

Granting an elaborate physical analysis of the complicated and variable system we are concerned with in the electrical discharge is accomplished, we are then at the beginning of the plant problems; the plant experimenter will then be able to control and reproduce his electrical conditions. But the task of the plant experimenter is by no means simple. The action of the electric discharge is provisionally best classified along with that of the stimuli. By using the word *stimuli* I simply intend to convey the meaning that the action is entirely different from that of *nutrients*; the effect depends on the intensity of the discharge used and on the phase of the plant's life cycle at which it is applied. It is not an agent which should be used uncritically throughout the season. The action of the discharge on the plant is probably at least twofold: an action analogous to the photo-electric effect and a chemical action caused by the circumstances that the ions act as condensation nuclei for the decomposition products formed by the discharge near the wires such as oxides of nitrogen, ozone, &c. The action will be different whether alternating or unidirectional potentials are applied.

It might, perhaps, not be out of place to state that there is no possibility of the oxides of nitrogen being capable of acting in the same way as the nitrates in the soil.

Readers of Lemström who are interested in this author's theory of the cause of the rapid plant growth in the arctic should consult a modern text-book on atmospheric electricity, where reference is made to the atmospheric electricity in arctic regions. No very exceptional conditions are recorded. See also a recent investigation of Norinder (1916). The light conditions, on the other hand, are very exceptional in the arctic; a good exposition of these is given by Sebelien (1905).

Though the scope for research work as indicated in this article is great, and though the progress of the subject is dependent on the advances in the research, yet empirical experiments may sometimes give results of economic value. It is sufficient to refer to Lemström's and Oliver Lodge's publications. The writer has reported two instances of crop increases in empirical experiments (1916, 1917).

Cambridge, January, 1918.

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New Turbine Plant at Hull.

In view of the growing demand for electrical power for local industries, the Hull Corporation, on the advice of their engineer, in 1911 embarked on a comprehensive scheme for three-phase supply to augment the existing high-tension and low-tension direct-current system. This scheme included the installation of three-phase turbo-generating plant, serving several sub-stations through a system of ring mains, and the initial stages were completed at the latter end of 1913.

To contain the new plant, reinforced concrete turbine and boiler houses were constructed, adjoining the older station; the former was designed to accommodate four 2,000 kw. sets, and can be considerably extended when required.

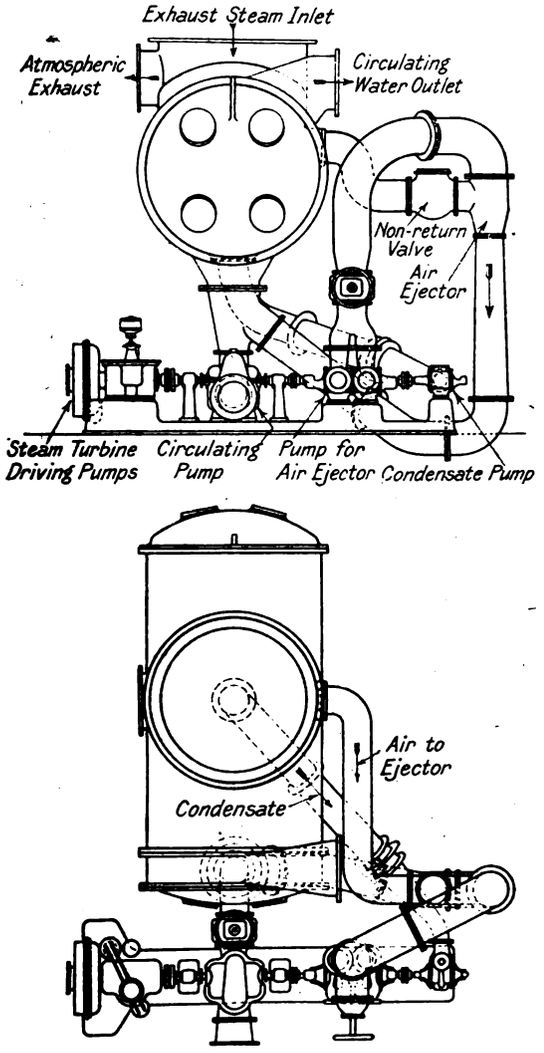

FIG. 1.—PLAN AND ELEVATION SHOWING ARRANGEMENT OF CONDENSING PLANT.

The first installation of generating plant comprised two Dick, Kerr turbo-alternators with an output of 2,000 kw. at 0·8 power factor, when running at 1,500 revs. per min. to supply three-phase current at 6,600 volts and 50 cycles. Steam at 180 lb. pressure, with 170 deg. of added superheat is supplied to these turbines, and they were fitted with ejector condensers in uniformity with the older plant. The initial boiler installation consisted of two Woodeson water-tube boilers, each having a heating surface of 6,100 sq. ft.

Early in 1915 the city authorities adopted a recommendation by the acting city electrical engineer (Mr. J. F. Magoris) for the installation of further plant, and it was decided in the interests of efficiency and general economy to instal a larger unit than previously and to adopt surface condensing, the contract for a 5,000 kw. turbo-alternator set being placed with Messrs. Dick, Kerr & Co. (Ltd.), who had supplied the earlier turbine sets. The new extension also includes a further Woodeson water-tube boiler of the same capacity as the previous two boilers, and also a Stirling boiler having a heating surface of 8,200 sq. ft. Both these latter two boilers are fitted with Erith-Riley underfeed stokers.

It was necessary to restrict the depth of excavation below the turbine set, in order not to interfere with the piling under the foundations, and with a view to obtaining the necessary head room for the condensing plant the turbine bedplate was raised some 12 in. above the normal floor level.

The turbine set is a compact machine, measuring roughly 30 ft. in length over the bedplate, which latter is longitudinally split. It is designed for an output of 5,000 kw. at 0·8 power factor at full-load when running at a speed of 1,500 revs. per min., and will carry 50 per cent. overload. The steam conditions are similar to those of the earlier turbines, and the condensing plant is designed to give a vacuum of 28½ in., with 30 in. bar pressure.

The turbine is a standard Dick, Kerr impulse machine, with 11 stages, the first being a velocity compounded stage, the ordinary stages are fitted with special bronze blading, while the velocity stage has alloy steel blades. The turbine body is of cast iron, split horizontally; the first half-dozen diaphragms are of cast steel, and the remainder of cast iron, and the body is supported at the exhaust end in such a way as to allow of freedom for expansion.

The steam admission end is closed by a cast-iron cover, with high-pressure steam-carrying parts of cast steel; the disc wheels forming the rotor are of special quality steel, and were accurately balanced and carefully tested when complete with their blading. All the turbine glands are of the labyrinth type and the end-glands are steam sealed, any excess steam from the high-pressure glands being taken to an intermediate stage of the turbine.

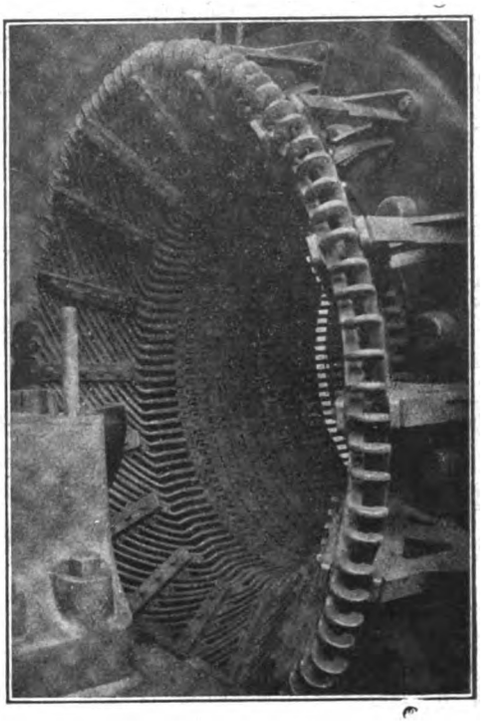

FIG. 2.—TURBO-ALTERNATOR SHOWING BASKET WINDING.

The turbine governor is of the centrifugal type, worm-driven from the main shaft, and, by means of an oil relay, this actuates a double-beat throttle valve with individual nozzle regulating valves arranged in series, which automatically control the admission of steam to the turbine under all load conditions. The actual movement of these valves is effected by pressure oil, the sequence of operations being the opening of the double beat throttle valve, controlling the admission of steam to the nozzle regulating valve chamber and the first group of nozzles, followed successively by the opening of the individual nozzle regulating valves, four in number, which control the admission of steam from the valve chamber to the remaining groups of nozzles. In addition to the ordinary governor, the usual safety governor is fitted in the turbine shaft, and is arranged to come into operation when the turbine attains a speed 15 per cent. in excess of the normal.

A complete oil-circulating system is provided to the bearings and for supply to the governor relay, pressure gauges being fitted to indicate oil pressure at the thrust block and relay cylinder. The oil after use is filtered and cooled in a condenser-type oil cooler, having

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200 sq. ft. of cooling surface; for starting-up purposes, before the main oil pump comes into operation, a duplex steam-driven oil pump is fitted.

The turbine is coupled to the alternator by a claw-type flexible coupling, lubricated by pressure oil.

The alternator frame and laminated core are built up in one piece, the laminations being securely held in dovetail slots machined in the frame. An interesting feature of the machine is the stator winding, which is of the barrel or basket type. The coils are former wound and mica insulated, and are laid in open slots; the projecting end-turns are given a conical formation, being inclined at about 45 deg. to the axis of the machine, and supported in position by massive bronze clamps. This arrangement gives an extremely rigid and, at the same time, well-ventilated construction.

The rotor, which is of the cylindrical type, and shaft, are machined from one solid forging, ventilating channels being cut below each coil and radial ventilating slots near the centre of the rotor. The winding consists of copper straps laid flat in the slots and bent on edge, with mica insulation between turns and to ground. The overhanging ends are retained in position by means of massive bronze end caps.

The ventilating air for this machine is passed through a Heenan & Froude cooler, being forced through the machine by an external motor-driven fan and discharged through the chimney opening on the top of the stator. A liberal number of air ducts are provided in the stator, and the cooling is effected by a combination of the radial and circumferential systems.

An exciter of the overhung type is carried on the end of the alternator shaft.

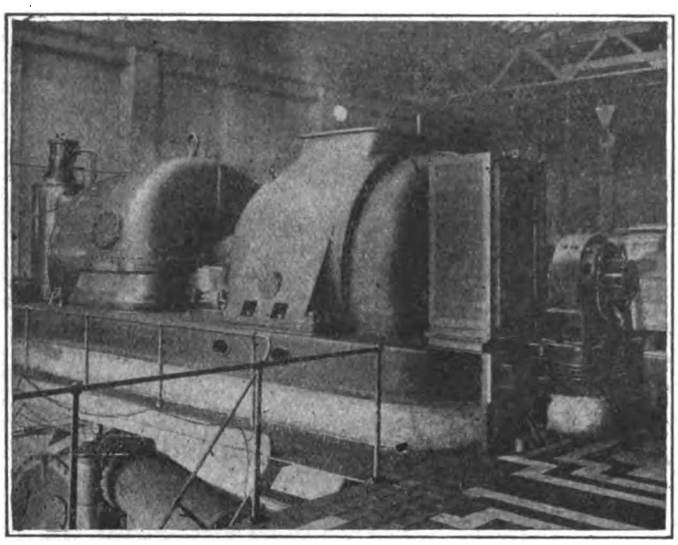

FIG. 3.—VIEW OF 5,000 KW. DICK, KERR TURBINE SET WITH EXCITER, RHEOSTAT, &C.

Although the lifting capacity of the crane was not equal to the weight involved, it was considered desirable that the stator should be in one piece, and the stator was therefore skidded into position, being fixed in a timber cradle supported by timbering, &c., over the condenser well and subsequently by means of successive lifts alternately on either side of the frame, following by the insertion of timber packing, raised the requisite amount to allow of its being slid into position on the bedplate.

It will be noted that the main field rheostat is fixed on the bedplate beside the exciter, this arrangement being adopted with a view to saving heavy copper cable runs to the switch gallery; this rheostat can, if necessary, be motor operated.

The condensing equipment, which was supplied by Messrs. Willans & Robinson, embodies some interesting features. The condenser itself has a cooling surface of 7,300 sq. ft., and operates in conjunction with the Willans rotary air pump system, in which a portion of the circulating water is passed through an ejector which takes the place of the ordinary air-pump. The plant is designed to handle 70,000 lb. of steam per hour, with an air displacement of 230 cubic ft. per minute.

The circulating water is delivered by two centrifugal pumps working in parallel, one of which delivers direct while the other delivers through the air ejector to the condenser; no additional water is required for the operation of the ejector. The circulating ejector and condensate pumps are direct-coupled, mounted on one bed, and driven by a Willans single-impulse wheel turbine, running at 2,000 revs. per min. The circulating water suctions are each coupled to duplicate strainer boxes, to enable a box to be opened for cleaning without affecting the circulating water supply to the pumps. This arrangement is necessary, because at certain seasons of the year the water contains weeds and at other numerous eels.

The exhaust steam from the pump turbine is utilised in a direct feed heater for heating the condensate, and should the latter be insufficient to absorb all the heat available, arrangements have been made by which the condensate can be supplemented from the general feed water supply. For testing purposes the condensate is weighed by means of a Holden & Brooke water meter.

A flooding valve is fitted to the condenser; the flooding water, which is taken from the town supply, is introduced through a perforated annular pipe fitted below the exhaust flange of the turbine. In case of pump failure this arrangement ensures a gradual transition to atmospheric working.

The guaranteed steam consumptions of this set per kilowatt-hour were as follows: 50 per cent. overload, 13·5 lb.; 25 per cent. overload, 13 lb.; full load, 13 lb.; 75 per cent. load, 13·5 lb.; 50 per cent. load, 14·3 lb.; and 25 per cent. load, 16·9 lb. It is satisfactory to know that these figures have been improved on in service.

In common with other undertakings, that of the Hull Corporation has experienced the difficulty of obtaining the necessary plant to cope with the increasing demand for electricity, and for many months prior to starting up the 5,000 kw. turbine set the two previously installed 2,000 kw. Dick, Kerr machines had been regularly supplying loads of up to 4,800 kw. between them. The 5,000 kw. set was taken into commission on November 15 last, and two days later was loaded in excess of its normal rating; we gather that some 4½ million units were generated by this set during the first three months of operation.

Some idea of the growth of three-phase supply in Hull can be gathered from the fact that in 1911 when three-phase supply was started, the load was 100 kw., while at the present time it has risen to 5,200 kw., with a considerable amount awaiting connection. Over 35,000 H.P. of electric motors are now connected to the mains, and individual motors of large size are being adopted, the department being about to connect up one of 900 H.P.

It may be mentioned that the Department operates 17 rotary and nine static sub-stations; 13 of these are three-phase sub-stations, and over 250 miles of mains are in use.

In conclusion, we are indebted to Mr. Magoris, the acting city electrical engineer, for his assistance in preparing these particulars of the most recent development in connection with the undertaking which he controls.

Association of Consulting Engineers.

The annual general meeting was held on Monday, May 27, at the offices of Messrs. Handcock, Dykes & Trotter, Mr. Frank Gill (chairman of the committee) presiding.

The report of the committee for the year 1917-18 states that members, because of work in connection with the war or on account of reduced staff due to the calling up of their assistants have more amd more been pressed to further exertions, and these exertions have been increased by the arduous and intricate negotiations which have to be made at each step with the Government Control Departments. Even when plant is required solely for munition work the necessities of the situation require the rationing of material, labour and transport, and each application requires much labour and attention. During the year a number of requests have been received from Government departments for the names of consultants qualified to advise on specified subjects, and steps have been taken to give the names of members duly qualified. This has not always been easy, because the inquiries have in some cases been for those having experience of a highly specialised character, and the committee therefore suggest that members should keep the hon. secretary fully advised as to any special or exceptional work on which they specialise, so that inquiries may be promptly and fully answered. The committee have again called the attention of a Government department to a case of an important official acting as consulting engineer to a municipality. The Minister concerned gave an assurance that permission to act in such a capacity would only be given in very exceptional circumstances. The consent, which a previous head of the same department had promised should in future be necessary before such work was undertaken, had not in this case been obtained. The attention of the committee having been drawn to a case in which an engineer imputed improper motives to consulting engineers, because their fees were in most cases measured by the cost of the works carried out under their supervision, the committee took up the matter with the firm employing the engineer in question. The principals of the firm stated they were not aware of the action of their employee, and that they wished to dissociate themselves entirely from his views. A statement indicating the aims and objects of the association has been drawn up and incorporated in the book of professional rules, and it is hoped that members will make these known and point out to properly qualified persons the advantage of joining the association as representing the views of the consulting

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members of the engineering profession. In carrying out war work the Government has in certain cases followed the practice of employing consulting engineers. But the practice apparently does not always obtain, and it seems desirable to point out that the practice and experience of consulting engineers qualify them to design, select and supervise the construction of works and plant, so as to produce an economical whole when viewed from the standpoints of effectiveness and true cost. With regard to reconstruction after the war, during the last 3½ years much work has remained in abeyance and will have to be undertaken later on. If consideration and planning is left until after the war there will be hasty and ill-considered work, and much can be done now in advance to prepare schemes so that execution may promptly be commenced when the time arrives. The Local Government Board has notified local authorities of its agreement with these views. The committee hope that the Minister of Reconstruction may yet press upon the various local authorities his desire to see such a policy of preparedness adopted. Three members were concerned in the arbitration relating to the Mexborough and District Water undertaking. The taxed costs of the arbitration were to be borne by Mexborough Council. The Taxing Master allowed half the amounts charged for the services of the engineers concerned. The liquidator of the Mexborough Water Co. repudiated liability to pay the balance. Action was taken to recover the balance, and judgment was given for the plaintiffs, with costs. The committee record with regret the deaths of two members (Lieut.-Col. R. W. Hammond and Capt. W. S. Strachan) on active service.

The CHAIRMAN moved the adoption of the annual report. He read abstracts from the report, and added that the committee felt that members of the staffs of local authorities or Government departments should not act as independent consulting engineers unless they had experience or knowledge which could not be obtained elsewhere, but an engineer to a local authority or Government department ought not to be called in unless he had such special knowledge or experience. In regard to reconstruction after the war, many towns had absolutely changed their conditions, works had started and the population had come in in large masses. Either those conditions had to be met—or the town had to drift back to its original condition. It was not likely that it would drift back, and, therefore, there was a very large need being built up in those towns for construction work. When the war came to an end, he supposed there would be a demand for clearing away this leeway and getting busy as quickly as possible. Then would come the difficulty. Unless the data were accumulated and the schemes prepared in advance, it was difficult to see how good work could be done when the need arose. The amount of skilled—or semi-skilled—labour and the amount of machine tools employed were a long way ahead of anything we had in the past, and this would have to find an outlet somewhere. There did not seem to be any suggestion that there would be for some time any lack of materials. Therefore, it seemed to him that there would be a switching-over period—probably short—and that there would be a continual increase in production, but instead of being munitions it would be something else, which would keep those towns, with their added populations, running more or less as they were at present. The Local Government Board was sympathetic with the committee's views. It had notified the local authorities that plans could be prepared, but it was not enough to say to the local authorities "You may do so-and-so"—the committee wanted them told that they ought to do so-and-so. Whether it would be possible to get the Minister of Reconstruction to put some pressure upon them was a doubtful point, but it seemed worth trying.

Mr. G. MIDGLEY TAYLOR seconded the motion for the adoption of the report, and it was carried unanimously.

The CHAIRMAN then presented the accounts. He said they were not paying their way at present. Subscriptions had temporarily been reduced. For the moment they were all right, because they were living on money which had been put away. This year the balance against them was £40, which would be met out of the accumulated savings. Later on it would be necessary to consider to what extent the subscription should return to its former, pre-war figure. He moved the adoption of the accounts, and the motion, having been seconded by Mr. E. L. MANSERGH, was carried.

The HON. SECRETARY announced the result of the ballot for membership of the committee. The following gentlemen had been elected: *London Members*—Mr. Herbert Lapworth, M.Inst.C.E., Mr. A. H. Preece, M.Inst.C.E., M.I.E.E. (Preece, Cardew, Snell & Rider), Mr. H. J. Rofe, M.Inst.C.E., Mr. A. P. Trotter, M.Inst.C.E., M.I.N.E. M.I.E.E. (Handcock, Dykes & Trotter). For country members there was no ballot, owing to the fact that there were only two nominations, that being also the number of members to be elected. The following were therefore elected automatically: *Country Members*—Mr. F. J. Moffett, B.A., M.I.E.E. (Moffett & Rosher, Birmingham), Mr. John Alexander Warren, M.Inst.C.E. (Warren & Stuart, Glasgow). Mr. John Alexander Warren, of Glasgow, had been on the committee a year or so ago.

Votes of thanks were accorded the hon. solicitor (Mr. Frederick E. Wright), the hon. auditors (Messrs. Cash, Stone & Co.), the chairman of the committee (Mr. Frank Gill), the hon. secretary (Mr. A. H. Dykes) and the hon. treasurer (Mr. J. R. Lowcock).

The CHAIRMAN said the real thanks were due to the hon. secretary and the hon. treasurer. Mr. Dykes had been hon. secretary from the beginning, and a great deal of the credit for the inception of the association was due to him. He had been very enthusiastic in the work, and deserved every possible praise.

Mr. A. H. DYKES said it had given him and Mr. Lowcock the greatest pleasure to be connected with the association. The best thanks that Mr. Lowcock or he could have would be for each member to try and introduce another member during the next year.

Applications of Electricity on Shipboard.

In a Paper before the Society of Naval Architects and Marine Engineers in New York, Mr. H. L. Hibbard recently remarked that in the use of electricity the American Navy was much in advance of the mercantile marine, and indeed, in this respect, has led all the navies of the world. Europe, however, seems to have led in the use of electrical apparatus for auxiliaries on merchant vessels. As an instance, the "Chile," constructed by Burmeister & Wain, is mentioned. This vessel, of 13,400 tons displacement and provided with 3,000 H.P. oil engines, was equipped throughout with electrically-operated auxiliaries both for engine-room and deck machinery. Three Diesel-driven 60 kw. generators were in use, one sufficient to supply auxiliary power at sea, but both used in handling cargo in port. The engine-room equipment included motor-operated ventilating fans, centrifugal water-circulating pumps, bilge, sanitary and ballast pumps, motors for use in repair shop, &c., while on deck electrically-operated steering gear, deck winches and anchor windlass were provided.

Attention is drawn to the influence of oil-operated engines in encouraging electrical methods. The Pennsylvania Shipping Co., New Jersey, has under construction six tank steamers propelled by geared steam turbines, but with electrical auxiliaries throughout. Two cargo vessels of 12,000 tons electrically propelled and operated by two turbo-generating sets, each furnishing power to a 1,500 H.P. motor, are under construction, and other vessels are in contemplation. All will have electrical auxiliaries. Alternating current is to be employed, owing largely to the merit of squirrel-cage motors of freedom from moving contacts in places where there is possible presence of oil vapour. With the same object, the controlling devices will be centralised in the generator room. A novel winch employing a constant speed motor and a set of planetary gear, facilitating variation of the speed of the winch, is a feature of the deck appliances.

In contrast to the above alternating-current system, the Texas Oil Co. is constructing a tank vessel of 6,000 tons, propelled by fuel oil engines and using 230 volt direct current for auxiliaries, which include variable speed cargo pump motors, bilge pump motors, electrically operated refrigerating machines, steering gear, deck winches and capstan. As compared with the merit of alternating-current squirrel-cage motors referred to above, direct current has advantages of saving in wiring, flexibility of speed control, and torque characteristics suitable for the deck equipment.

Among the advantages which have resulted from electrical installations on ships, the author mentioned saving in space and weight in the installation of the auxiliaries themselves, a very much higher efficiency of operation, and consequent saving in total fuel consumption, the elimination of long and objectional lines of steam piping, which on certain classes of cargo vessels are nearly always installed above deck, and result in continual steam condensation; also, on certain of the auxiliaries, particularly those requiring varying speed and load conditions, the electric motor offers some distinct advantages over the use of the steam engine.

Future Timber Supplies in Great Britain.—The seriousness of the position of this country in regard to timber is strongly emphasised in a recent number of "Production." In the year 1913 the woodlands of the United Kingdom were estimated to cover more than three million acres, though a large part of this area was improperly stocked and neglected. In the same year the imports of unmanufactured timber exceeded 11,500,000 tons, only 10 per cent. of the total consumption being home grown. Since the outbreak of war imports have been practically stopped, except for war purposes. Th minimum requirement of Government departments and controlled industries exceeds six million tons a year, and at the present rate of denudation of forests in the United Kingdom all substantial stocks of timbers will be exhausted by the autumn of 1919. Already one-third of the existing three million acres has been cut up. The future, therefore, deserves serious consideration, and no time should be lost in taking steps to re-plant home forest land, and to acquire information as to the supplies likely to be forthcoming after the war. It is satisfactory to note that the Ministry of Reconstruction is developing a scheme to deal with the matter.

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Electro-Culture.

Among the subjects which are claiming increasing attention at the present time must be included that of electro-culture. The subject is important at any time from the point of view of the better utilisation of our land, and doubly important if good results can be so obtained under present conditions. Although some measure of success has been obtained in this field of investigation, it has, nevertheless, been obscured by results which are frequently contradictory. This is due very largely to the fact that those who have been engaged in this very interesting subject are specialists in only one subject. For example, experiments have been carried out by electrical engineers, who, although acquainted with some of the electrical features, have very little knowledge of agriculture. On the other hand, agriculturalists have experimented without having a proper knowledge of the physics of the subject. It may also be said that both physicists and electrical engineers have carried out experiments while being totally ignorant of plant physiology.

At first sight the subject may seem comparatively simple. Actually, however, it is distinctly complicated, as indicated by an article which we publish this week by Mr. I. JORGENSEN. Taking first the physical conditions, we have an electrical conductor at a high potential discharging to earth, the conducting path consisting of air and plants in parallel. If one experiment is to be compared with another, the conditions of the experiments throughout must be thoroughly known. It is not enough to know simply the potential of the wire, the length of time during which the discharge is maintained, and the current that passes from the generator to the network. It must be remembered that the conductivity of the air will vary with the atmospheric conditions, and consequently the effect produced by the discharge may also vary. If the current is to be maintained constant, then the potential must be varied; on the other hand, if the potential is maintained constant, the current will vary.

Apart from the atmospheric conditions, there are many other variable factors. There is leakage, which will change according to the state of the weather; there is the state of the wire itself; there is the influence of the crop, which tends to reduce the voltage necessary for a given current as growth takes place. There are such questions as to whether the discharge is more effective at one period of plant growth than at another, or whether it is equally effective at all times. Further, there are variations that may arise from differences in the high-voltage pressure that is applied.

It is also, unfortunately, true that we do not know yet what are the fundamental processes which take place. Investigation has not yet decided whether the discharge has a chemical effect upon the atmosphere, and thus indirectly stimulates the plant, or whether the current actually traverses the plant itself. It is, therefore, very difficult to be certain that the conditions applied to any crop are the same as those applied to another crop at some other time. Even the control of an experiment by crops which are not subjected to electric discharge is not altogether a simple matter. It becomes clear that if such investigations are to be brought to a really useful conclusion it will be necessary to have thorough co-operation between physicists, agriculturalists and plant physiologists.

It is generally agreed that satisfactory progress in any subject cannot be made until the fundamental phenomena underlying a process have been elucidated. In the present case it seems highly desirable that this should be done, and that the phenomena should be studied in the simplest possible form, free from the many complications arising in dealing with crops. If a sound conclusion could be reached as to the mechanism, as it were, of the change which takes place, there would be a greater probability of our being able to say under what conditions the electrical discharge may be useful, and when it may possibly be harmful.

Reviews.

Theory and Calculations of Electrical Apparatus. By C. P. STEINMETZ. (London: Hill Publishing Co., Ltd.) Pp. xxii.+480. Price 20s. net.

Most students of the higher branches of electrical engineering are indebted to Steinmetz's pioneer work, "Theory and Calculation of Alternating-Current Phenomena," for much knowledge and inspiration. This work—the first edition of which appeared 20 years ago—has now reached its fifth edition, and its famous author tells us it has now become essential to subdivide it into three volumes, so as to include the most necessary structural elements of our knowledge of electrical engkneering. We have accordingly:—

"Theory and Calculation of Alternating-Current Phenomena," (5th edition). "Theory and Calculation of Electric Circuits," (1st edition). "Theory and Calculations of Electrical Apparatus," (1st edition); all of which have now appeared. This shows the position in the series of the book under review. Though there are numerous cross references to the other volumes and to the author's "Theoretical Elements of Electrical Engineering," which render it desirable to have these works available, the present volume can be regarded in many ways as independent. For this reason the reader does not feel disposed to complain that the subdivision as carried out has led to a certain amount of repetition.

The style of the new book is similar to that of the parent book, but the relatively larger amount of reading matter and its more practical nature will doubtless be welcomed by many non-mathematical readers. Moreover, the author puts his arguments and conclusions in a manner that make the book very pleasant to read, even when one is not at the moment directly interested in the subjects under discussion. Many of the problems discussed are of the kind met with by the designer from time to time, and it is very good to feel how the author takes the reader straight to the underlying facts. The discussions largely relate to standard types of machines, but some of those dealing with special apparatus are the most instructive from an educational point of view. The high standard of Steinmetz's work is so widely recognised, however, that it is superfluous to enlarge upon it, so that it seems preferable to give merely a short digest of the contents of the present book.

In the first 13 chapters dealing with induction machines, the author discusses speed control, multiple squirrel-cage motors, cascade control, secondary excitation, single-phase induction motors, regulation and stability, higher harmonics, synchronous induction machines, the hysteresis motor and the frequency converter or general alternating-current transformer. Then follow useful chapters on phase conversion and single-phase generation, synchronous rectifiers, reaction machines, inductor machines, surging of synchronous motors, review of alternating-current motors, single-phase commutator motors, split-pole converters, and unipolar machines.

The range of problems discussed is too wide for enumeration here. Thus the author deals with the temperature starting device, as used in the squirrel-cage motors of the Simplon

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Tunnel locomotives; the action of the shading coil, as used in single-phase motors for coiling fans; the action of unexcited synchronous machines with salient and non-salient pole rotors, and many such questions, in addition to commoner problems met with in practice. The chapters on synchronous rectifiers and single-phase commutator motors are particularly interesting, whilst throughout the book the author never loses sight of the importance of showing the relations between the various types of electrical apparatus.

The illustrations are good, both in number and quality, and the book can be heartily recommended to all interested in electrical engineering. Especially technical engineers will find the book refreshing and inspiring.

STANLEY PARKER SMITH.

Practical Electric Illumination. By T. CROFT. (London: Hill Publishing Co., Ltd.) Pp. xi.+225. 8s. 4d. net.

Mr. Croft has added another work to the growing series of handbooks on illumination. While presumably intended primarily to illustrate American practice in lighting the book is of interest to English readers. So far as United States practice is concerned it appears up to date. For example, it refers to the Lambert, a relatively new unit of brightness, and to recent literature on industrial lighting, such as the "Code" of the American Illuminating Engineering Society.

The author aims at being practical. His information is presented in tabloid form, and liberal use is made of illustrations, some of which will be found helpful in visualising such conceptions as flux of light. In some sections it rather lacks consecutiveness and gives the impression that data from various sources have been massed together without sufficient explanatory solvent. In presenting technical details the method followed has its advantages, especially to readers with a preliminary knowledge of the underlying principles of illumination. We think, however, that the style of exposition is hardly suited to an accurate explanation of the aether, the nature of light and the electron theory, all of which are dealt with in a cursory manner.

The book comprises 344 paragraphs, grouped in nine sections, dealing successively with fundamental principles, units, lamps and reflectors, interior and exterior lighting, &c. As a handbook on electric illumination it will be found useful, and there is an adequate index.

Miniature Electric Light. Edited by B. E. JONES. (London: Cassell & Co.) Pp. 156. 1s. 3d. net.

In the preface to this short manual the author remarks that ever since the introduction of the electric incandescent lamp there has been much amateur interest in "model" lighting from small lamps and batteries. Such methods are naturally of little use for ordinary house lighting, but may serve a useful purpose as occasional sources in country cottages, garages, &c., and as portable lamps. After a chapter explaining elementary electrical terms and first principles, an account is given of lamps and fittings, connections and wiring, and a comparison made between primary batteries and accumulators for such work. Methods of making simple pushes and switches, and periodic relays are suggested. The book should be interesting to amateurs in electrical work.

On the Temperature Variation of the Electrical Conductivity of Mica.*

By H. H. POOLE.

INTRODUCTION.

A description was given in a previous paper ("Phil. Mag." July, 1916) of some experiments on the dielectric constant and electrical conductivity of mica in intense fields. The method adopted consisted in measuring the charge and leakage current of a small mica condenser of known small thickness when charged to a known voltage, the latter being found by measuring the charge on an air-condenser or a thick-walled Leyden jar. No certain variation of the dielectric constant with field was observed, but the conduction current was found to increase very rapidly, according well with the formula $C=aXe^{bX}$, where C is the current density, X the potential gradient, a and b constants. It was suggested that the occurrence of the exponential term might be connected with a distribution of electronic velocities in accordance with Maxwell's law. On this assumption b would vary inversely as the mean electronic energy, and hence, presumably, as the absolute temperature. It accordingly seemed to be desirable to repeat the observations at different temperatures.

* Abstract of an article in the "Philosophical Magazine."

EXPERIMENTAL MODIFICATIONS.

Several other forms of condenser were then tried, the conductors being either well-ground brass surfaces or liquids such as mercury or glycerine. None of these were very satisfactory, but the experiments clearly showed that a varied very rapidly with the temperature and also was very different for different specimens of mica, while b was approximately independent of the temperature and had about the same value for all the different specimens used.

The simple expedient of silvering the mica was adopted and proved satisfactory. The silvering was done by Carey Lea's process, the so-called gold-coloured silver being used. The silvering mixture was applied with a brush and a very good coating was easily obtained

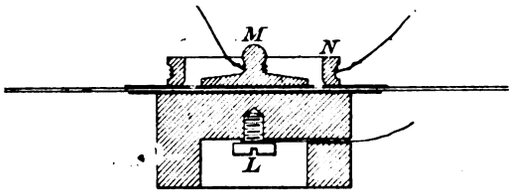

FIG. 1.

which was quite a good enough conductor for the purpose. As the unsilvered parts of the mica surfaces had to be left bare, instead of being coated with shellac, which would not have stood the high temperatures, trouble was anticipated from the brush discharge; this has the effect of increasing the effective area. An attempt was made to reduce this source of error by giving the condenser the form shown in section in Fig. 1. Here the thickness of the mica is greatly exaggerated and the silvered surfaces represented by heavy lines. The cylindrical piece of brass L, on which the mica rests, is supported on several thicknesses of mica and connected to the high-pressure source. The small piece of brass M, resting on the central silvered disc on the upper face of the mica, is connected to the galvanometers as shown in Fig. 2. The brass ring N, resting on the silvered guard-ring, is connected to earth. The effective area of the plates, as far as the galvanometers are concerned, is the area of the central disc. This is about 2·02 sq. cm., the diameter of the disc begin about 1·61 cm. The area affected by brush discharge is limited to

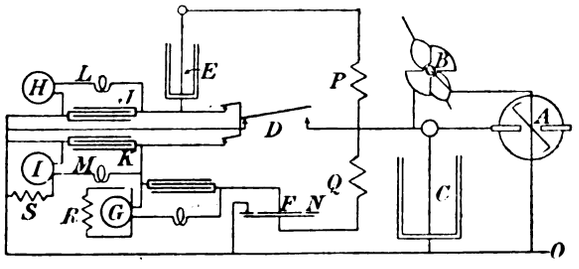

FIG. 2.

the annular space between the central disc and the guard-ring. Unfortunately the maximum possible increase of area due to brush discharge would be about 19 per cent. of the measured area, and there was reason to suspect the existence of error at high temperatures.

The mica sheet used was 0·0173 mm. thick.

The general electrical connections are shown in Fig. 2. The arrangement has been modified by bringing the galvanometers H and I to the earthed sides of their respective condensers and obtaining readings by earthing the source by means of the key D. This prevents the occurrence of a large P.D. between the central disc of the mica condenser and the guard-ring, thus rendering possible the use of a condenser of the form already described. A further advantage is that a much simpler form of key can be used. This is a modified Morse key, the moving part of which is permanently earthed.

R and S are known resistances used to reduce the sensitiveness of G and I. R was made infinite for the smaller leakage currents and varied, as required, for the larger currents. S remained at 4,000 ohms throughout, its effect on the sensitivity of I as a ballistic

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was directly found. The Leyden jar was used as the standard condenser E. The Wimshurst machine A was driven by a permanent magnet motor and the voltage was adjusted partly by varying the speed of the latter and partly by bringing an earthed pin-point near the machine.

The mica condenser was placed in an oven heated by gas. Although no self-regulating device was employed, the oven could be fairly rapidly brought to a nearly constant temperature and the variation during an experiment never exceeded 1°C.

The galvanometers H and I were standardised by means of a set of standard condensers. It was found that by suitably adjusting the scales the deflection could be made proportional to the quantity except near the ends of the scales, where small corrections, amounting to a few scale-divisions, had to be applied to the readings. The voltage applied to the condenser is proportional to the throw of H. The deflection of G, which measures the leakage current, was found to be proportional to the current over the range employed.

The results of a typical set of readings are shown below. Here X is the potential gradient in megavolts per cm., k the apparent value of the dielectric constant, and C the conduction current in micro-amperes per square centimetre.

Temperature 159·5°C.

X.	k.	C.	X.	k.	C.
0·64	7·95	0·027	1·62	8·50	0·413
0·85	8·22	0·047	1·64	8·54	0·436
0·98	8·24	0·072	1·75	8·62	0·553
1·13	8·37	0·115	1·83	8·60	0·688
1·16	8·43	0·121	1·93	8·58	0·853
1·30	8·47	0·181	1·95	8·62	0·853
1·37	8·49	0·218	1·97	8·68	0·953
1·39	8·45	0·234	2·00	8·58	0·997
1·42	8·50	0·247	2·01	8·62	1·002
1·55	8·56	0·346	2·03	8·62	1·012
1·58	8·25	0·374	2·07	8·56	1·105
1·58	8·57	0·407			

The mean values of k at different temperatures are shown below Here t is the temperature Centigrade recorded by the thermometer, t' is that calculated from the conduction current by the formula given later, δ the difference between these two values, and k the dielectric constant.

t.	t'.	δ.	k.
13·5	—	—	7·97
16	—	—	8·43
50·5	52	−1·5	8·22
81	79	+2	8·16
84	84·5	−0·5	8·41
111·5	111·5	0	8·50
143	142·5	+0·5	8·58
159·5	159·5	0	8·48
166	166	0	8·39
186	184	+2	8·52
227·5	227·5	0	8·71
229·5	232	−2·5	9·06

It will be seen from the first of the above tables of figures that at 159·5°C. k rose slightly with X, tending to an approximately constant limit for large values of X. Similar results were obtained at all temperatures except the two highest, where k, which was approximately constant for small values of X, tended to drop for larger values. The second table shows that the average value of k appeared to rise with the temperature.

It seems probable that the apparent variations of k may be entirely ascribed to the brush-discharge. We may expect the effect of this to be two-fold, (a) an increase of the effective area of the central dis·, and (b) an encroachment on this area by the brush-discharge of the guard-ring, causing a loss of charge and consequent reduction of k when the pressure is sufficiently high.

It is apparent that the observations on the dielectric constant only show that it does not undergo any large variation up to 230°C. The values obtained for k are, however, chiefly of use in enabling an approximate correction to be made of the leakage current density.

If $C = aXe^{-X}$ or $\log C = A + \log X - BX$, the values of $\log C/X$ ought to lie on a right line when plotted against X. The results of the observations at ten different temperatures from 50·5°C. to 229·5°C. are plotted in this way in Fig. 3, the logs being to the base 10. It will be seen that they lie very approximately on 10 parallel right lines, corresponding to the different temperatures. The parallelism of the lines indicates that B is independent of the temperature within the limits of error. The value found for it is 0·787. The value of A for different isotherms was found to agree fairly well with the formula $A = 43·34 + 15·47 \log T$, where T is the absolute temperature; so that the complete formula for C is

$$\log C = 43·34 + 15·47 \log T + \log X - 0·787X.$$

The author shows that for a given value of X the current is proportional to the 15·47th power of the absolute temperature over the range covered. In order to show how this formula agrees with the observations, it has been used to calculate the temperatures of the various isotherms. The results have been given in the second column of the previous table, and it will be seen that the agreement with the observed temperature is in general fairly satisfactory and in some cases remarkably so.

The variations in the values of C corresponding to the observations plotted in Fig. 3 are very large. For the lowest point plotted for 50·5°C. the value of C was 0·058 micro-ampere per square centimetre, while for the highest point plotted for 227·5°C. it was 4·57 micro-amperes per square centimetre. This was about the largest current that could be obtained and to do so necessitated driving the Wimshurst machine up to the limit of safety.

On comparison of the figures given above with those given in the previous Paper for another sample of mica, it will be noticed that there is a very great difference in the value of A in the two cases. The value previously given for a temperature 9°C. was 3·286, that found for the present specimen for this temperature from the formula is only 5·245; so that for a given field the current through the former specimen was about 110 times that through the present one. If this ratio holds for weak fields, the specific resistance of the present system in such would be about $1·5 \times 10^{17}$ ohm cms. Although this enormous difference in the resistivities of the two specimens is very remarkable, it does not appear quite so striking when the very great effect of temperature is taken into account

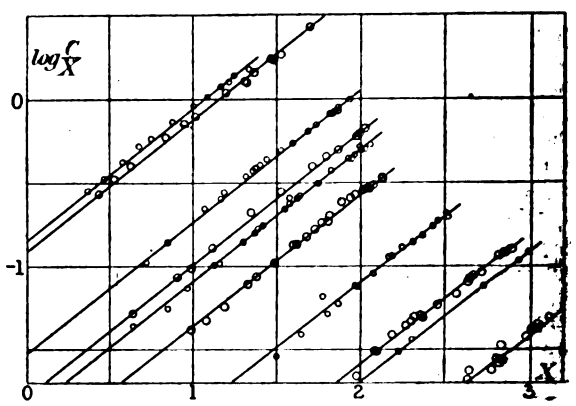

FIG. 3.

We find from the formula that the present specimen would have the same resistivity at about 109°C. that the former one had at 9°C. The relative effect of rise of temperature was about the same in the two cases. The two specimens came from different sources, the former being taken from a mica gas-chimney, while the latter was taken from a packet of mica sheets. The original sources in the two cases are not known.

On the other hand, the close agreement in the two values of B is remarkable, the figures being 0·794 and 0·787. This seems to suggest that this coefficient may have some fundamental significance, though the fact that it is independent of the temperature is opposed to the suggestion, previously made, that it was connected with Maxwell's law, unless we make the apparently improbable assumption that the mean energy of the electrons responsible for the conduction current is independent of the temperature, and attribute the great increase in conduction current with temperature entirely to a diminution in the energy required to escape from the atom.

Before attempting to give any theoretical justification for the comparatively simple law found connecting C with X and T, which may be merely an empirical formula that applies within the limits of error over the range covered, it seems to be desirable to extend the observations to higher temperatures and other dielectrics. One of the great hindrances to accuracy in the observations is the difficulty of obtaining a sufficiently steady high voltage source. For mica pressures up to about 5,000 volts are required if the sheet is not to be inconveniently thin. For other dielectrics much higher pressures will probably be required, as the sheets will have to be much thicker. For higher temperatures the conduction-current will be much larger and a more powerful machine will be necessary. It is hoped to continue the observations on the above lines in the near future.

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Correspondence.

THE IMPROVEMENT OF THE TURBO-ALTERNATOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the discussion upon solid *versus* plated rotors for turbo-generators of large size, it may be of interest to your readers to know that Messrs. Brown, Boveri & Co.'s experience with some 2,300,000 kw. of generators at work (largest 25,000 kw.) is absolutely in favour of the plated rotor.

Mechanical security is, or should be, the first consideration in the design of machinery of this character, and in this connection we, too, consider—as Mr. Behrend has well put it—that the highest grade forging contains a factor of uncertainty greater than that inherent in the plate construction.—I am, &c.,

9, Old Queen-street, Westminster, S.W.1. A. C. EBORALL.

ECONOMIC HISTORY AND ITS LESSON TO THE MANUFACTURER OF TO-DAY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Some great man once said that "Necessity opens our eyes to the advantages of fresh principles," but whilst Industrial Co-operation, as it is now proposed, is certainly a fresh principle to many, those who will take the trouble to look further into the matter will see that it is neither a fresh nor a new idea at all.

One has only to study ever so slightly the economic life of Great Britain during the last five or six centuries to note that the tendency, among people who have gained their livelihood by producing things, has always been to get together for the dual purpose of safeguarding their interests and for cheapening production. Interests were safeguarded in not being exploited one against the other by unscrupulous buyers, and production was cheapened and increased by the degree of specialisation of effort that can always be introduced when two or more people join resources.

Centuries back when the masses who tilled the soil consumed little else that was not produced either by themselves or the village artizans, every village had its own blacksmith, its own carpenter, its own weavers, its own cobblers, and last, but probably not even then considered least, its own brewing plant at the local inn; every craftsman was his own salesman and had to fulfill a multiplicity of duties as compared with his prototype of to-day.

What appertains now? The blacksmith purchases most of his shoes from a manufacturer employing hundreds of operatives in an industrial centre many miles away, who produces them by the million at a tithe of the price the old blacksmith charged who was a craftsman and laboriously fashioned them with his own hands. The local carpenter (who made furniture among other things of wood) is now superseded by the huge cabinet making factories who produce many thousands of pieces of artistic design and merit, at prices which would appear ridiculous when compared with the figures asked in days gone by. The same applies in the case of the village weaver and cobbler who are now represented—each by huge factories employing thousands of operatives turning out cheaper and better products for many thousand times more people than of yore, whilst in the majority of instances, the local brewing plant has been superseded by the huge companies who now produce the staple drink for the country, and supply villages and towns alike.

It is purely the country's evolution which is working all the time for greater and cheaper production. The birth of the old time factory was due to individuals following the same occupation banding themselves together for greater protection, and by common action and intelligent control, they soon found that marvellous results could be obtained and the power of the individual craftsman "out on his own" gradually weakened in the face of the organised opposition—the result being all the time greater and, therefore, cheaper production and better conditions for the individual workers, owing to their collectivism and co-operation.

As the years move on, we find here and there one or two of these small factories who make the same line of goods beginning to realise that a great deal of effort is being wasted in competing against each other, which leads them to nowhere, and they agree to join forces in order to get the benefits of pulling together instead of pulling against each other, and later on we see at intervals some of the larger up-to-date factories and mills amalgamating for just the same purpose, and greater production for less effort once more follows the process. Now in the year 1918 this self same industrial combination which is being so much talked about as some new principle (a dangerous one by some) is nothing more than following exactly the same course that trade has been leading us along for the last six or seven centuries; the only difference is that we are trying to accelerate the rate of evolution.

The greatest war the world has ever known has so altered things that we find we have all at once to jump forward much quicker than usual, in order to make up the leeway between British methods and those of our great national trade rivals. The process of industrial combination has been evolved at a much greater rate by both Germany and America during the last generation, because they have been more alive to the power of co-operation and specialisation than we have; in other words, they have been brighter and quicker at taking profit from the lessons which past economic history teaches, and have duly profited by their study, and if we are to see British trade once more reigning supreme, we must "get a hurry on" in order to again catch up with them.

In conclusion, let it at once be realised that British manufacturers have all the time been following the doctrines and policies of combination in industry, as it is no new "cult," but they have not developed these doctrines to the same extent and so fast as our national competitors have done.—I am, &c.

Birmingham, May 27. HOWARD F. SMITH.

COAL ECONOMY AND NATIONAL HEALTH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Lord Moulton, speaking at the annual conference of the Institution of Gas Engineers, is reported as having urged that gas and electricity should be placed on an even footing, and charged for in proportion to the amount of energy (heat) supplied to the consumer. This would mean that a quantity of gas or a quantity of electric energy, each equivalent to the same quantity of heat units, would cost the consumer the same amount of money. On this basis, if electricity were charged for at 1d. per unit, then the price of gas would have to be about 12s. 6d. per 1,000 cub. ft.

Of the heat produced by the gas, only a substantially reduced proportion can be usefully applied to the needs of the consumer, whereas in a well designed electric fire or oven, there is very small waste of heat. This fundamental difference is due to the inherent necessity of maintaining a draught during the burning of the gas, which draught carries away, into the outside air, a varying proportion of the heat produced by the gas flame.

Owing to this inseparable waste in connection with gas-produced heat, it would appear that gas must always be sold at a lower price than electricity as measured by their respective *gross* heating values, because the *net* heating value of gas to the consumer is inferior to the *net* heating value of electricity. If Lord Moulton is correctly reported, he would seem to be advocating conditions that would give gas a very poor chance in the market, because it is inconceivable that anyone would use a gas fire on such terms of payment.

The framers of the new scheme for rationing coal gas and, electricity, have based their alternatives on sound lines, and whether intentionally or not, allowance is made for waste of gas-produced heat. We are permitted to purchase either 750 heat units from the gas works, or 273 heat units from the electricity works, but the *net* value of these to the consumer

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will not be in anything like the same proportion. A mere statement of this kind is valueless without some evidence to support it, and I will, therefore, cite, as an example, of the extraordinary economy of electrically produced heat, a test that I recently made of an electric furnace for tempering steel. I found that I was able to maintain the required temperature of 900°C. for one hour, with electricity equivalent to 6,000 heat units (exactly 5,971) whereas the gas furnace makers, for a furnace of the same size, require a consumption of gas equivalent to 75,000 heat units, which means that 69,000 gas-produced heat units must be blown away to waste in warming the wide world instead of the furnace. In this calculation I have assumed that the value of the gas is 500 heat units per cubic foot, which is a fair average value.

This brings me to the main point that the 75,000 heat units would call for the carbonisation at the gas works of about 30 lb. of coal against only about 6 lb. of greatly inferior coal used at the electricity works in attaining the same result.

Fortunately the fine quality coal used at the gas works yields coke and other valuable material for explosives and agriculture; and from the national point of view the gas-works to-day are most important. That is no reason, however, why we should use gas for heating and cooking in a wasteful manner, when it could be very much more efficiently and beneficially employed in developing power in a gas engine or boiler.

A few words should be spoken into the public ear from the point of view of national health. Gas fires have met with considerably advertised testimony from medical men, but these all insist that the gas fires must be "*properly fixed.*" In other words the flues must be kept clean, and free to carry away the products of combustion. In my own home, where I have electric fires, as well as the previously fitted gas fires, I have had to lengthen the flue pipes, and these should project at least 12 in. up the chimney. As originally fixed, the flue pipes terminated under, and did not project into the chimney at all, and the atmosphere of the rooms soon became oppressive and unhealthy. This objectionable feature has been largely remedied by the alteration.

I wish strongly to emphasise the view that the country is putting gas to the wrong purpose in using it for heating and cooking, and we are thereby wasting coal.—I am, &c.,

London, June 11. C. ORME BASTIAN.

NOTES ON THE DESIGN OF ELECTROMAGNETIC MACHINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As you inform me that there is a difficulty in reproducing the above article in monograph form, owing to the paper shortage, will you kindly draw attention to the following corrigenda:—

Vol. LXXIX., p. 737, col. 2, line 11 from bottom: read πDn instead of $T_1 Dn$, and for eq. 4, read $E=\frac{\Sigma' m e}{\sqrt{2}}$.

Vol. LXXIX., p. 774, col. 1, line 6 from bottom: delete $\sqrt{2}$ from $\frac{16}{\pi^2\sqrt{2}} qnI$.—I am, &c.,

London, June 6. S. PARKER SMITH.

Trade Parliaments and Their Work.

By E. J. P. BENN.

VIII. SCIENCE AND EDUCATION.

So far, in building up the case for Trade Parliaments, I have dealt only with that portion of their work which may be described as reconstruction work—matters which will require to be settled the moment that hostilities cease, and which must consequently be studied well in advance. But when the reconstruction or transition period is over there will still be plenty of regular work left to occupy the energies and attention of Trade Parliaments. The subject of the relation of science to industry furnishes an excellent example of the need for co-operation between the various manufacturers engaged in a trade and between those manufacturers and the labour unions. There has recently been established a new Government Office known as the Department of Scientific and Industrial Research, which is charged with the duty of rendering such assistance as may be possible to industry. During the two years of its existence this Department has already been inundated with requests for help and guidance on scientific problems arising in connection with various trades. The Department has already issued two annual reports which are full of interest for the student of industrial development. They are, of course, particularly useful as a statement of the policy which the Government is pursuing in connection with this important question. A grant of a million sterling has been made for this purpose, and from this the Research Department is able to offer financial assistance on a pro rata scale. Progress has been so rapid that there are already seven research associations with articles in draft and approaching completion; ten others are beginning to draft articles, and eleven more trades are considering the formation of research associations.

As the first of the great industries to move in this direction we may take cotton as an example of the rest. A provisional committee of research and education for the cotton industry was formed by the trade, and has been at work for some time on the constitution of a cotton research association. In connection with the work of this committee a series of articles appeared in the "Manchester Guardian" which constitutes quite the best statement of the case for scientific research in industry that has yet been published. These articles attracted so much attention that the committee arranged for their publication in pamphlet form, and this pamphlet is available at the offices of the Cotton Committee, 108, Deansgate, Manchester. The cotton industry appears to have awakened to the fact that it is being carried on to-day exactly as it was 50 years ago, and that no improvements in machinery worth the name have been introduced since the days of Arkwright, and, worst of all, that neither masters nor operatives have between them any very great knowledge of the scientific properties of cotton or of the prospects of its increased cultivation or manufacture. What applies to cotton applies to almost every one of our trades. No industry can hope to prosper for long which is not supplied with a continual stream of new knowledge. Scientific research, as conducted by the Cotton Association, will be a very different thing from the sort of research that has hitherto been conducted in a small way by various enterprising manufacturers. To get the best out of research it needs to be conducted on a large scale. It is not suggested that there should be any interference with the manufacturer who keeps his own laboratory for the purpose of improving his information with regard to the details of his own business. But it is a fact, that quite in addition to anything that can be done in this way there is the need for the considered attention of the best scientific brains to the main problems of every trade. Every industry pays enormous sums of money for its fire insurance. One or two trades have been so impressed with the total amount spent in this way that they have thought it well to establish their own special insurance offices. Fire insurance is universally recognised as one of the necessary expenses of business, as manufacturers require to be assured that if they are overtaken by a serious fire they will be in a position to repair the damage. It is estimated that a sum far less than that spent upon fire insurance would provide each trade with an insurance that is far more necessary to it—an insurance against the risk that American laboratories or Japanese universities, or German technical skill will not one day rob the trade of everything it possesses. So urgent is this question of science and industry that the Scientific and Industrial Research Department is now occupied in promoting special research associations in most of the leading trades. The Department and the trades have all agreed that it is impossible to wait for the establishment of proper self-governing bodies which could take over these functions. But it is obvious that if a complete system of trade self-government is evolved from the present discussions, then the research associations now being formed will become part of that system of government.

Education is another kindred subject with which little progress can be made until our trades get together and decide to tackle it. We spend to-day in one way and another something over £1,000,000 a week in education. Of this vast sum a proportion is expended on technical and trade education. There are many thousands of trade schools up and down the country. Every educational authority has arrangements of some sort for teaching the technique of the leading trades in its locality. Several of the modern universities have special departments of interest to particular trades. The Board of Education subsidise many hundreds of technical classes and technical institutes, and yet, with one solitary exception, there is no single case on record of any official connection between our trades and our technical education. It is perfectly true that most of these educational facilities are arranged by committees upon

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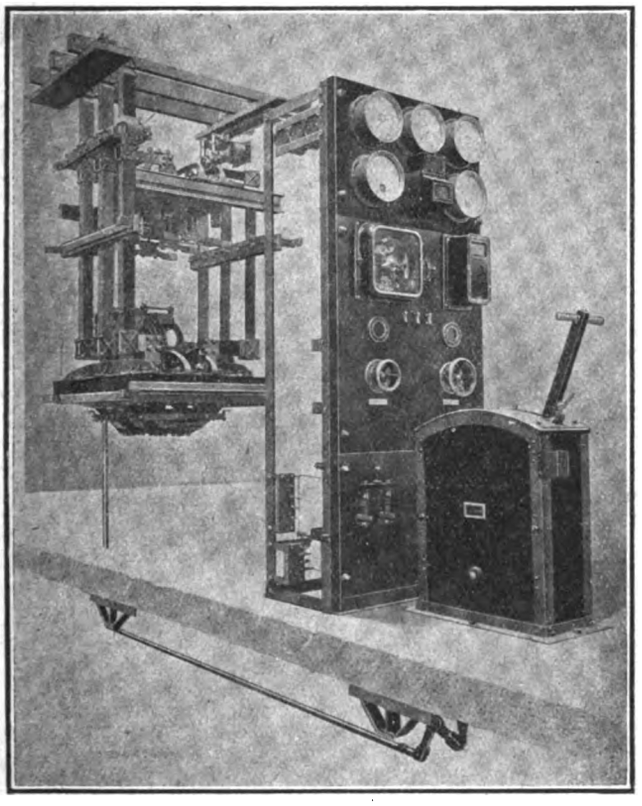
which so-called experts are invited to sit. Thus the Education Committee of one of the counties may invite the opinion of one or two leading electrical engineers in establishing classes for education in electrical theory and practice. But apart from this haphazard connection there is, as I have said, only one case of a trade as a trade taking any official interest in the boys and girls who are presently to form that trade. This solitary exception is the School of Mines at Trefoys, which is maintained by the mineowners and the miners. They have together consented to a levy upon every ton of coal produced in their district, and thus formed a fund out of which the School of Mines is carried on.

If our trades are to be fitted in the future to meet the competition of an educated and progressive world, they must obviously put their heads together and see that they are provided with a continuous supply of recruits specially fitted for the business of their lives. When that complete system of trade self-government for which some of us are pleading so earnestly is established upon a proper footing, each Trade Parliament will have powers to raise a levy for the purposes of education, and technical education will at last stand a chance of being of real service to our industries.

(To be continued.)

6,000 Ampere 3-Phase Alternator Switchgear.

Advances are continually being made in the size of control apparatus to meet the ever increasing size of generating units. At one time it was commonly thought that the limit for manually operated three-phase oil switches would be about 3,000 amperes. Recent improvements have, however, rendered 6,000 ampere switches capable of operation with perfect ease. The illustration shows a remote mechanically operated



A 6,000 AMPERE SWITCH.

switchboard recently made by Messrs. Ferguson, Pailin & Co. (Ltd.), Higher Openshaw, Manchester, embodying such a switch capable of carrying continuously 6,000 amperes at 650 volts.

An oil switch has to perform two separate and distinct functions: to carry the normal rated current without excessive heating and to break the maximum possible short-circuit current at its particular location on the system. A switch with adequate "carrying" capacity may entirely fail through inadequate "breaking" capacity caused through shortness of break, low head of oil, or inability to withstand the mechanical stresses which accompany the rupturing of the circuit. Similarly a switch with adequate "breaking" capacity may entirely fail through inadequate "carrying" capacity.

It is difficult to combine these functions in the one switch and retain ease of operation when dealing with very heavy currents and the solution found was to provide two switches in parallel, one to carry the current and the other to break it.

Over 90 per cent. of the current is carried by the main switch, which has massive brushes and contacts but a comparatively small travel. The "Snap" switch has lighter contacts and carries the balance of the current, but has a large travel as well as being particularly robust mechanically to break the heavy powers dealt with. This arrangement facilitates the manual operation of the switch in that the heavy mass has a small movement and the light mass has a large movement. The "Snap" switch is timed by the operating mechanism to make circuit first and break circuit last, so that all arcing takes place on the "Snap" switch, and there is no fear of injuring the main contacts. Strictly speaking, no oil is necessary for the "main" switch, but it is provided to assist in cooling same. Furthermore quick break plunger arcing contacts are provided in case of accident to the "Snap" switch.

It is imperative to eliminate as much magnetic material as possible from the main switch to prevent heating due to eddy currents, and the main support consists of a 3-in. slate slab with a heavy gun-metal frame. The connections leading out of the switch, as shown in the illustration, are of the strip type, the main brushes making contact directly on to the end of the strips, which are riveted and sweated to massive contact blocks.

The "Snap" switch is provided with three separate elliptical tanks capable of withstanding heavy internal pressures without permanent distortion.

The lever arrangement is of the automatic free-handle railway signal type with shunt trip-coil. Great assistance is rendered in closing the switch by the use of two long powerful springs attached to the fixed handle system. In moving the fixed handle lever forward to engage with the freehandle lever ready for reclosing, the springs are extended and the energy stored is given back on the return movement. This reduces the power necessary to close the switch so much that an average woman can perform the operation with ease and there is no difficulty with synchronising. The dimensions of the switch may be gauged from the height of the control board, which is 7 in. to 9 in. The complete switch with its lever box weighs about 1½ tons. The connections and 'bus bars are held very rigidly in mica insulated slate blocks with gun-metal saddles to prevent the bars whipping together or being thrown out of their supports on short circuit.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 SPECIFICATIONS.

117 LEVIN, I. H. Electrolytic apparatus for the generation of oxygen and hydrogen. (3/6/16.) 107,366.

1,588 BRITISH ELECTRIC TRANSFORMER CO. & BERRY, F.E. Electric furnaces and transformers for use therewith. (31/1/17.) 115,247.

1,674 FAULKNER, V. C. Electric furnaces for melting or refining non-ferrous alloys. (2/2/17.) 115,248.

4,341 DAVIDSON, J. M. X-ray localisation. (26/3/17, Cognate application, 10,325/17 115,251.

5,009 WOLSEY MOTORS (LTD.) & WARDELL, T. Controlling the current in connection with electromagnetic gear boxes of automobiles. (10/4/17.) 115,458.

5,230 LA VALETTE, H. DE. Electric couplings. (28/3/17.) (Addition to 105,227.) 114,429.

6,132 JOHN, W. J., & JOHN, J. Electric cutout or protective arrangements for electrical systems. (1/5/17.) 115,263.

6,343 DONOVAN, W., & DONOVAN, G. O. Combined electric switches and couplings. (4/5/17, Cognate application, 8,585/17) 115,275.

6,508 CROMPTON & CO. & PENSABENE, N. High-frequency alternating-current dynamos. (8/5/17.) 115,475.

6,530 PIRELLI & Co. Electric cables containing several conductors. (28/6/16.) 108,464.

6,542 STERLING TELEPHONE & ELECTRIC CO., BELL, F. G., & DAVEY, W.C. Electrical signalling systems. (8/5/17.) 115,280.

6,556 B.T.-H. CO. & WEDMORE, E. B. Fusible electric cut-outs. (8/5/17.) 115,479.

6,584 RANSOMES & RAPIER & LEWIS, R. S. Electro magnetically-operated brake mechanism for cranes or the like. (9/5/17.) 115,485.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W.1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain of the Week.—Capt. E. G. Fleming.

Next for Duty.—Capt. W. Hynam.

Saturday, June 15.—Commandant's Parade at headquarters, 2.15, for drill in Hyde Park. Dress: Service dress, drill order. Haversacks and waterbottles, with rifles and side-arms. Every member should endeavour to attend this parade.

Monday, June 17-Saturday, June 22.—Drills as usual.

Sunday, June 23.—Commandant's Parade at Waterloo Station, 8.45 a.m., for work at Esher. Dress: Service dress, drill order. Haversacks and water bottles with rifles and side arms. Midday and tea rations to be carried.

SPECIAL NOTICES.—All drills will take place at headquarters, unless otherwise stated.

The M.O. will attend for the examination of recruits on Thursday evening at 6.0.

Summer Camp.—Arrangements are now being made for this Camp to start on Aug. 3.

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Legal Intelligence.

Landlord's Fixtures.

On the 29th ult., Mr. Justice Rowlatt heard the case of Furley v. Truscott, which raised the question whether electric light fittings put up by a tenant were the property of the landlord or the tenant. Plaintiff claimed an injunction to restrain defendant from removing the fittings from a house at Canterbury, of which he had been tenant under a lease. It appeared that the electric installation was in the house when defendant took it, but the fittings being obsolete, were removed and stored for the landlord, and others were put up in their places at the tenant's expense, and he claimed the right to remove them. On the other hand, plaintiff contended that under the terms of the lease they, with all other fixtures, became his property, including the electric bulbs and pendants.

His Lordship observed, with regard to the bulbs, that the landlord might just as well claim that a tenant could not remove candles from candlesticks if they were fixed to the wall, or hats from a hat rack if similarly fixed.

After hearing arguments on both sides, his Lordship said that plaintiff was entitled to succeed. The matter turned entirely upon the construction of the lease, and especially upon the construction of the covenant which provided that the tenant should surrender and yield up the fixtures which at the date of the lease or at any time during the term "shall be thereon." The word "fixtures," as he understood it, meant something other than chattels. Although the globes, shades and bulbs might be the tenants' property, the lamps themselves, if they were in any way attached to the freehold, were not. The tenant's fixtures, too, became the property of the landlord, unless they were removed during the tenancy, and in this case they were not so removed. Moreover, in their case the words of the covenant excluded the right of the tenant to remove any fixtures. Plaintiff was entitled to succeed in his action, but the tenant was entitled to claim all the bulbs, shades and globes. Judgment was accordingly entered for the plaintiff with costs.

Parliamentary Intelligence.

SHEFFIELD CORPORATION BILL.

This Bill, which consolidates previous Acts of the Corporation and confers additional powers for constructing new tram routes, the carrying of goods and minerals, &c., was passed by the local Legislation Committee last week.

In support of the tramway clauses Mr. WEDDERBURN said the Corporation wished to carry animals, goods, and minerals on their system. Many authorities already possessed those powers, and in cases where such were granted witnesses had proved that they worked excellently. Among the obvious advantages of the proposal were economy of road space, of wear and tear of the thoroughfares, and of road energy in the form of petrol and other means of locomotion.

The CHAIRMAN (Sir Wm. Middlebrook) said the Committee welcomed consolidation of Acts in large centres. In the case of Sheffield, something over 50 Bills, extending over 70 years, existed, and the consolidation would be an advantage. As the result of a perusal of the Bill he was prepared to recommend the adoption of certain clauses on which there could not possibly be any question.

The preamble, so far as the tramway portion was concerned, was found proved, and the clauses were adjusted.

SHROPSHIRE, &c., ELECTRIC POWER BILL.

Last week the Shropshire, Worcestershire and Staffordshire Electric Power Bill was read a third time in the House of Lords, and on Tuesday it was read a second time in the House of Commons.

Lord HYLTON, on behalf of the Board of Trade, said he could not yet make an announcement of the general policy to be adopted towards undertakings of that kind.

Industrial Councils.—In reply to a question the Parliamentary Secretary to the Minister of Labour (Mr. Bridgeman) stated in the House of Commons last week that two joint standing industrial Councils had now been formed in the building and pottery industries respectively. The completion of negotiations for the formation of several other Councils might be looked for in the near future.

Commercial Topics.

Income Tax Allowance for Obsolescence.

On Monday the Parliamentary Committee representing manufacturing organisations had an interview with the Chancellor of the Exchequer on the subject of the allowances to be made in the Finance Bill for the depreciation of plant and machinery, the depreciation of buildings and the right of appeal to the Board of Referees.

Mr. Bonar Law agreed that a new Treasury White Paper should be framed granting to manufacturers full allowance for obsolescent assets. For the first time allowance will be made for depreciation in the value of buildings, and the right of appeal demanded will also be conceded. The necessary amendments have been made in the Finance Bill, which was considered on the report stage on Tuesday

Water Power Development.

At the recent meeting of the Industrial and General Trust, the chairman (Ald. Sir Geo. Touche, M.P.) referred to the question of water power development.

Sir Geo. Touche stated that although the old attitude of indifference to the development of the nation's industries was breaking down, it still lingered in some quarters. An illustration of it could be found in the recent fate of the Water Power Bill of the British Aluminium Co., whose development they had assisted financially in times past. Owing to the opposition of a few Scottish Peers and their friends the Bill had been temporarily withdrawn, although it was regarded favourably by the Board of Trade and the Ministry of Munitions. The fuller development of what the war had proved to be an essential industry had thus been delayed. The scheme would have submerged only a few hundred acres of inferior deer-grazing land and marshy ground. On the other hand, it would have supported a new village of from 6,000 to 8,000 people, helped to develop a key industry, given permanent employment under healthy conditions, and, if authorised now, would have been ready to absorb labour during the difficult period of demobilisation.

* * * *

Bonus System in America.

The U.S.A. Congress recently had under consideration the navy and army appropriation bills, which included proposals to prohibit or diminish the payment to public employees or to employees of private establishments under government control of any cash reward, premium or bonus for superior service.

On the other hand, in the opinion of the Engineering Council these methods if applied with due regard to wages, surroundings, health and safety of the employee, will increase efficiency and production. It is vital to the winning of the war that no legislation or other measure should be adopted which may interfere with highest efficiency and maximum production, but that every proper means should be taken to increase efficiency and production.

The question has not yet been settled, but it is probable that the views of the Engineering Council will prevail.

* * * *

Good Lighting and Safety.

In connection with the administration of the Workmen's Compensation and Employers' Liability Acts, accident investigators of insurance companies have proved that many accidents formerly ascribed to "carelessness," "falls," &c., are directly due to inadequate lighting. The public is more or less familiar with curves showing the increase of the accident rate with the decrease of the number of hours of natural light each day throughout the year.

These curves strongly indicate that artificial light influences the safety of industrial workers, but do not specifically prove it. It has remained for the insurance companies to gather the evidence in a manner which leaves no doubt. With their highly specialised organisation, which seeks to get at and remove the cause of industrial accidents, they have indicted poor lighting for causing directly and indirectly an enormous number of deaths and maimed and injured bodies. A well lighted factory is given preference for group insurance and a poorly-lighted one is penalised from 2 to 5 per cent. of the premium, and insurance is made only on condition that the lighting be improved. Insurance companies have an indisputable argument for better lighting, which is based upon experience. As an instance in point, the State of Wisconsin (U.S.A.) has (through its Industrial Commission) accumulated data from which it is estimated that for the year 1915 sufficient time was lost in Wisconsin factories, due to industrial accidents, to be equivalent to 6,300 workmen being unemployed for a whole year. The salary value of these men for that time is £600,000. During that year workmen received £200,000 as compensation for injuries. If we agree that of the total of this loss, amounting to £800,000, one quarter thereof can be attributed to poor lighting, then we have a loss from bad lighting of approximately £200,000. This large sum, it is estimated, would be many times sufficient to pay for improved lighting in every manufacturing plant in the State of Wisconsin. No more striking illustration could be given of the actual value of good illumination, and how it pays insurance companies as well as factories to avoid accidents through the provision of ample light.

Electricity Supply.

Extensions.

Belfast.—The L.G. Board has sanctioned the borrowing of £310,750 for extensions of the electricity undertaking. A temporary loan of £90,779 is to be raised for the first part of the proposed extension.

The Electricity Committee is now able to enter into contracts for the supply of current to the two local shipbuilding yards. The contracts will be for a period of 10 years after the first year of peace. If at the end of this time either party wished to terminate the agreement, 12 months' notice must be given. It is expected that in 1919-20 the Committee will be able to generate about 42,000,000 units of current, but already there are orders for supplying 34,000,000 units.

Colchester.—Application has been made for sanction to a loan of £5,950 for a new generating set.

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Dublin.—Mr. P. C. Cowan will shortly hold a L.G. Board inquiry into the application of the Corporation for sanction to borrow £175,000 for the electricity supply department.

Newcastle-under-Lyme.—The Council has decided to raise a loan of £3,000 at 5 per cent. for linking up the electricity undertakings of Newcastle and Stoke-on-Trent.

Stalybridge.—The Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board has applied to the L.G. Board for sanction to borrow £8,000 for its electricity supply undertaking.

Walsall.—On Monday the Council authorised the extension of the electric supply mains, at an estimated cost of £4,200, in order to give a supply of current to the Holly Bank Colliery, which is outside the borough.

General.

Accrington.—At the last meeting of the Council Ald. T. E. Higham, chairman of the Electricity and Tramways Committee, announced that during the past 12 months the profit on the electricity undertaking was £2,169, against a deficit of over £10,000 in the previous year.

Blackburn.—A sum of £1,200 is to be advanced to the electrical engineer (Mr. P. P. Wheelwright) for the purchase of War Savings Certificates in connection with the scheme of weekly subscriptions for certificates by the employees of the electricity department.

Bolton.—The borough electrical engineer (Mr. W. J. Wood) has been authorised to purchase an electric vehicle from the Electromobile Co.

Burnley.—The salary of Mr. T. B. Nutter, chief assistant electrical engineer, has been increased to £250 per annum.

Electrical Power Engineers' Association.—We learn that since the inauguration of the West Yorkshire Section at Leeds on March 27 the Committee has met on seven occasions.

These meetings have been well attended, and to ensure proper consideration of the vital points with which the Association is concerned seven sub-committees have been at work on the following subjects: (1) Drafting rules of the Association; (2) Whitley Report; (3) propaganda work and publicity; (4) salaries; (5) membership; (6) social and Papers; and (7) the formation of other associations with similar or allied objects, and to enter into negotiations with them so as to avoid dissipation of strength by formation of a number of associations. These sub-committees have already done considerable work. The Rules Sub-committee have had nine meetings and had prepared draft rules. These have been approved by the General Committee, and are now under discussion by the National Executive Council. The total membership of the Association is over 1,000, and the West Yorkshire Section alone has 104 members. All engineers engaged in the production, transmission, distribution or utilisation of electrical energy are invited to join. The secretary of the West Yorkshire Section is Mr. P. Furness, 6, Ashgrove, Earlsheaton, Dewsbury.

Glasgow.—The chief engineer of the electricity department (Mr. W. W. Lackie) proposes to reduce the number of emergency men employed in connection with the various generating stations and sub-stations, and the Electricity Committee has authorised him to purchase two second-hand petrol cars for the effective utilisation of the reduced staff.

Hull.—The City Engineer has been instructed to purchase an electric vehicle at a cost not exceeding £1,165.

Linking-up in South Wales.—An interim report has been issued by the Joint Committee for the Inter-connection of the South Wales and Monmouthshire Electric Supply Systems.

The area dealt with extends from the northern boundary of Glamorganshire to Penarth in the south, and from the town of Monmouth in the east to the town of Carmarthen in the west. The whole of the county of Glamorgan and portions of the counties of Monmouth and Carmarthen are included in the district which has been subdivided into four groups—viz., (*a*) western district (from Neath westward); (*b*) south-eastern (Cardiff, Penarth, Newport, Pontypool and South Wales Power Co.); (*c*) central district (South Wales Power Co. and adjacent undertakings, including Rhondda, Pontypridd and Merthyr); and (*d*) undertakings the interconnection of which would not be justified at present (Brynamman, Carmarthen and Chepstow). Deducting the latter, and also Merthyr, Rhondda and Ebbw Vale Urban Councils, 17 undertakings are dealt with in the report. Statistics and curves are given which show gross and net capital expenditure, plant capacity, maximum demand, units generated and sold, costs, &c. The following is a summary of the conclusions of the Committee:—

In regard to group (*a*), the interconnection of Llanelly, Swansea and Neath offers considerable possibilities, not only as to interchange of load, but further development of the respective supply areas through which the interconnecting mains would pass. The load of Llanelly, which is rapidly developing a power load, might be considerably helped by Swansea in the daytime or vice versa. The following standards should be adopted: Three phase, 50 periods, 6,600 volts for generators (mostly employed in the stations concerned), 6,600 volts or multipoles thereof for transformers, overhead lines, &c., and for cables, the insulation of overhead mains to be suitable for at least four times the above working pressure. It is thought that the interconnection of the particular undertaking referred to is a reasonable proposition. Other undertakings, such as those of Ammanford and Brynamman, which are comparatively small, might be connected at a later date. In regard to the south-eastern group, alternative methods are given of linking up the Cardiff, Newport and South Wales Co. undertakings—viz., sub-stations with frequency changers situate at the central position in order to meet the requirements of the three undertakings, or the installation of frequency changers either in the Cardiff or Newport power stations, with a direct link between Cardiff and Newport, the South Wales Co. to link up direct with Cardiff and Newport. The question of joint working has also been considered and alternative methods of carrying out this proposal submitted. In regard to Penarth and Pontypool, the question of taking a bulk supply presents no difficulties and is desirable. The Committee think that the undertakings of the central district can only be interconnected by making use of the South Wales Power Co. Linking up for week-end supply might be advantageous, although greater economy would be effected if the smaller stations took a supply in bulk. The Committee think that the whole of the area considered by them is a very large and difficult one to deal with. The question of linking up the whole of the electricity undertakings, owing to some of them being so remote from others, whilst feasible, is not at the moment considered altogether practicable; but the question will be dealt with at some future date. It is considered that at the moment the cost of linking up the western area with the other areas would be prohibitive and far outweigh any advantages that might be obtained by so doing.

Portishead.—The Urban Council has consented to an increase in the charge for electric power being increased to 3½d. per unit and for light to 7d. a unit.

The increase is to be limited to the period of the war and six months thereafter. The local supply company wanted to make the charge 4d. and 8d. respectively.

Rathmines.—The Urban Council has appointed a committee to inquire into the financial position of the electric supply undertaking with authority to employ such expert assistance as may be necessary.

Torquay.—For the year ended Dec. 31 there was a net deficit of £1,572 on the electricity supply undertaking, after providing for war allowances and new services.

Income was £19,639, and after paying working expenses, the gross profit was £4,476. Interest required £1,682 and sinking fund £2,899, allowances to employees on war service £637, and new services £866. The outstanding capital is £44,741.

Trade Unionists and Electric Power Supply.—On Tuesday a deputation from the Parliamentary Committee of the Trade Union Congress waited upon the President of the Board of Trade for the purpose of discussing the recommendations in the report of the Electric Power Supply Committee.

The deputation strongly protested against the provision for the election of representatives to the District Boards by the votes of large consumers. It was urged that, whatever was done by Parliament to carry into effect those recommendations, the control of the generation and supply of electricity should be in the hands of the public, and not the companies.

Sir A. STANLEY pointed out that the principle of State control of the generation of electricity was provided for in the report, and the deputation asked that labour should be represented upon the proposed Board of Electricity Commissioners and also on the District Control Committees.

In reply, Sir A. STANLEY said that no doubt due consideration would be given to their representations when the bill for embodying the Committee's proposals came to be drafted.

Wolverhampton.—A supply of electricity is to be given to the Brotherton Tubes & Conduit Co. for power purposes.

Electric Traction.

Bournemouth.—The Corporation tramways made a net profit of £26,342 on the past year's working, of which £20,000 has been placed to renewals and £5,000 to relief of rates.

Revenue was £132,319 (an increase of £18,000). Passengers carried were 20,454,597 (increase 2,500,000).

Darlington.—In future the minimum fare of 1d. will be charged on the tramways.

Sheffield.—The Tramways Committee has purchased second-hand tramcars from the London County Council at £7,500.

Tramway Fares.—The Select Committee on Tramways (statutory requirements) has issued its report:—

The Committee has confined its investigation to the question of principle, being of opinion that examination of individual cases would have involved a prolonged inquiry. Evidence was tendered by the Tramways and Light Railways Association (representing Companies, and by the Municipal Tramways Association (representing Municipal Tramway undertakings). Full opportunity was afforded for other evidence to be tendered, but none was forthcoming. All Tramway and Light Railway undertakings are injuriously affected by increased working expenses due to the war, wages having risen from 60 to 100 per cent., and the advance in cost of materials varying from about 100 per cent. to over 200 per cent. on pre-war rates. In addition, the increased cost of fuel and consequently of power, coupled with restrictions on supply should be taken into consideration, and an Order in Council, dated Dec. 21 last, amending the Defence of the Realm Regulations in respect

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of tramway materials and plant, definitely indicates substantial interference with the operation of these undertakings. The larger revenue earned by many tramways does not compensate for the constantly advancing working costs; but in most of the large towns, where the tramway systems are generally owned by the municipalities, there is still a margin, since the fares charged are in most cases lower than the statutory maximum. The plea for immediate relief is put forward on behalf of the undertakings which are now charging maximum fares and yet are unable to pay their way. Statistics showed that out of 80 municipal undertakings, only 28 are charging maximum fares to ordinary passengers and 44 are charging maximum workmen's fares; the remainder are therefore more fortunately placed, or they are showing perhaps tenderness towards the passenger as distinguished from the ratepayer.

The Committee is satisfied that some possibility of relief should be afforded to those undertakings which cannot increase their revenue to compensate them for the abnormal working expenses occasioned by war conditions. Although in the case of municipalities deficits can be made good out of the rates, the Committee agrees with the principle that the passenger should not be carried at a loss. The Committee therefore recommend that the Board of Trade should be empowered by general legislation to permit the temporary modification of statutory requirements with regard to the charges for the conveyance of traffic on tramways and railways constructed wholly or mainly on public roads in the case of undertakings whose financial circumstances are proved to the satisfaction of the Board to have been injuriously affected by causes arising out of the war. The word "temporary" should be interpreted as covering a period limited to the duration of the war and two years after its termination.

Imperial Notes.

Canadian Water Power.—A Canadian Power Board has been formed with Mr. Meighen (Minister of the Interior) as chairman, for the purpose of investigating the fuel and water power resources of the Dominion and to develop all possible sources of supply, in order to make Canada independent of the United States.

Electric Power Pooling in Canada.—By a recent Order in Council, the distribution of power among essential industries is provided for without regard to existing contracts.

Under the pooling arrangement manufacturers engaged in the production of munitions or on Government contracts which obtain power from the Ontario Hydro-Electric Commission, or from any company selling Niagara power developed in Ontario, will be obliged to meet the extra cost of generating steam-power. With steam-generated power costing $90 per horse-power, compared with about $25 for water-power, all munition plants will be forced to pay rates higher than those of their contracts with the Ontario Hydro-Electric Commission and other sources of Niagara power. The Toronto Power Co., which has a steam plant in Toronto, has been ordered to operate on a 24-hour basis, under which condition it can turn out only about 13,500 H.P. Coal is now available to run this plant, through an arrangement with the Power Controller of the United States.

According to the "Board of Trade Journal," the Power Controller (Sir Henry Drayton) has directed the Ontario Power Co. to supply 27,000 H.P. to the American Cyanamid Co., of Niagara Falls, Ontario. No more hydraulic power is said to be available at present.

Electrical Progress in New Zealand.—H.M. Trade Commissioner in New Zealand gives the following particulars of the plant installed at the Lake Coleridge hydro-electric power station.

The turbines are Swiss, the electric generators and oil switches British, and the transformers American. Energy is generated at 6,000 volts, and transmitted at 66,000. The present plant capacity (4,000 kw.) is to be trebled. A Swiss turbine for a new 4,000 kw. set has been installed and the generator will be British. The American insulators used are not regarded favourably, and it is probable that insulators will in future be obtained from Great Britain.

Most of the electric ovens supplied by Christchurch Council are American, and are said to heat more quickly and cheaply than British ovens and to be more convenient, as they do not necessitate stooping. The irons, chafing dishes supplied are also practically all American.

The city electric supply works garage, keep in order and charge electric vehicles at £26 a year. It is expected that a big business will be done in electric vehicles when more charging stations are available.

Miscellaneous.

Building After the War.—The Committee of the Ministry of Reconstruction, which is making an inquiry from local authorities, builders, architects and others as to the probable demand for and supply of building materials during the reconstruction period two years after the war, has extended until the 1st prox. the date upon which the inquiry forms are to be returned.

The Committee hopes that any authority, person or firm contemplating building works immediately after the war who has not received one of the Forms of Inquiry, will apply either directly or through an architect to the Secretary of the Building Materials Supply Committee, 6a, Dean's-yard, Westminster, for a form. Wherever possible, approximate quantities of materials needed should be furnished, especially in the case of building-stone and bricks, steel and timber. Materials needed for repairs, maintenance, &c., form the subject of a special imquiry, and particulars of these are not needed at present. Unless the Committee is made fully aware of the prospective needs of consumers, it will not be possible to estimate how far the available supplies will meet the demand, and its efforts to secure co-ordination may thus prove unsuccessful.

Chartered Institute of Patent Agents.—The Institute has authorised its fellows to make an additional charge of 10 per cent. on the scale of fees recommended by the Council to cover the additional expenses they have to incur in consequence of the war.

Dye Companies' Amalgamation.—A scheme has been arranged for the amalgamation of the undertakings of British Dyes (Ltd.) and Messrs. Levinsteins (Ltd.). A new company will be formed to carry on the combined undertakings.

Education Bill.—Further progress has been made with the Education Bill during the past week.

Clause 10, upon which there was considerable discussion, was added to the Bill on Tuesday. The clause relates to compulsory attendance at evening classes, and certain amendments were accepted by the Minister of Education, Dr. Fisher. At the end of the sitting the Committee was discussing clause 13, which deals with the out-of-school employment of children of day-school age.

Electric Furnaces for Small Castings.—According to "Engineering," the Michigan Steel Castings Co. (of Detroit) has been using two electric furnaces of the Héroult type for over two years for making small castings for automobile trucks, &c.

The average weight of a casting is 20 lb., though the weight may vary from ½ lb. to 200 lb., or even 2,000 lb. Before adopting electric furnaces, which the president of the company (Mr. R. F. Flintermann) thoroughly recommended at last year's meeting of the American Electrochemical Society, the company had used crucibles. The crucibles were expensive, lacked uniformity and contaminated the steel with carbon. The electric furnaces (one of 6 tons, the other of 3 tons) gave a superior steel, the superiority being attributed to the low content in sulphur and in oxides and slags. The furnaces were originally lined with magnesia. The rising cost of magnesite induced the company to use acid linings, and the results have been encouraging, especially when working the "reverse-duplexing process." By this method part of the metal is melted and refined in a basic furnace which can be run at comparatively low temperature, and sulphur and phosphorous are eliminated. It is claimed that there is less trouble with the slag in acid furnaces. Mr. Flintermann did not claim that electric-furnace steel was free from blow-holes (as Girod and others have asserted); but long, thin section castings, such as cross-members on engine supports, had inclined to develop shrink cracks when made in the converter, and there was no trouble from that cause with the electric furnaces, which had been running continuously since their installation.

Libel on Public Official.—At the Central Criminal Court last week Mr. Justice Darling fined Mr. Henry Murray £100 for publishing three defamatory libels concerning Sir William F. Marwood, joint permanent secretary of the Board of Trade, and also ordered defendant to pay the costs of the prosecution and to enter into his own recognisances of £500 to be of good behaviour for two years. The libels had reference to the attitude adopted by the Board of Trade and Sir William Marwood to the scheme for a central clearing house for railway goods traffic proposed by Mr. A. W. Gattie. The defendant had pleaded not guilty and also put in a plea of justification, but, after hearing the evidence, he withdrew his pleas and also the statements made by him in regard to Sir William Marwood. Defendant's counsel (Mr. Hastings) said defendant had never had any intention to attack anybody, and so far as Sir William Marwood was concerned there was no charge against his personal integrity.

Order Under Military Service Act (1918).—An Order issued on June 6 withdraws as from June 22 every certificate of exemption from military service granted, or renewed wholly or partly, on occupational grounds to men who are within any of the descriptions specified in the schedule to the order.

Amongst those affected are the following classes of tramway employees. All Grade 1, category A, born in or after 1880; traffic inspector, chief storekeeper, parcel superintendent, born in or after 1883; driver, engineman (including driver of works locomotive). If the man is the only man of his occupation in his shift his certificate of exemption is not withdrawn by the Order. Steam boiler foreman; born in or after 1885: mechanic, electrician or electrical fitter, or other skilled man maintaining or repairing plant or tools, born in or after 1875, all other workmen.

Tenders Invited.

Cables.

WARRINGTON Electricity and Tramways Committee require tenders by noon June 18 for the supply of h.t. lead-covered and medium-tension rubber-covered cable. Specification, &c., from the Borough Electrical Engineer.

Meters.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. July 3 for the supply of 21 electric meters for power circuits. Specification from Commissioners' Office, Spencer-street, Melbourne.

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Appointments Vacant.

The Council of the University of Hong Kong require a professor of electrical engineering (salary £600 per annum, with quarters or allowance of £100) and two lecturers in civil and mechanical engineering (£400 per annum, with quarters for residence). Applications to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, Westminster, S.W., by June 28. *See an advertisement.*

A chief engineer is required for King's College Hospital, London. Salary £400, rising to £500 per annum by annual increments of £25, plus war bonus of 12½ per cent. Applications to the Secretary, King's College Hospital, Denmark Hill, S.E. 5, by June 19. *See an advertisement.*

An electrical draughtsman is required for diagram lay-out and record work by controlled shop, with high-tension and low-tension three-phase system. *See advertisement.*

The Governors of the Birkbeck College, London, invite applications for the post of principal. Salary £800, rising to £1,000. Particulars from the Clerk to the Governing Body, Bream's-bdgs., E.C. 4.

An assistant, preferably with experience of tramways and supervision of mains work, is required by Keighley Corporation. Salary £200, inclusive of bonuses, &c. Applications to the Borough Electrical Engineer by June 17.

Two switchboard attendants are required by the Blackburn Corporation electricity department. Applications by June 24 to the borough electrical engineer (Mr. P. P. Wheelwright), Jubilee-street, Blackburn.

Business Items.

The Benjamin Electric (Ltd.) will remove their offices and works on the 14th inst. to Northumberland Park, Tottenham, N.17.

Messrs. Pyne, Hughman & Co.'s London office (at 329, High Holborn, W.C.) will be discontinued as from 22nd inst., after which date the firm's business in the United Kingdom will be conducted by their agents, Messrs. Gladstone, Wyllie & Co., to whom communications should be addressed, at 36, Lime-street, London, E.C. 3. Telegrams: "Wyllie, Grace, London"; Telephone: Avenue 89.

Motor-operated Oil-break Switches.—The British Thomson-Houston Co. (Ltd.), of Rugby and London, have recently issued list No. 4,171A, dealing with motor-operated oil-break switches.

Municipal Accounts.

Blackpool.—The accounts of the electricity department for the year ended March 31 show a net profit of £5,083 (compared with £357 in the preceding year).

Income was £57,941 (increase £11,000), and working expenses were £31,432 (against £28,768 in previous year). After providing for interest and sinking fund, the net profit was as mentioned above. The output of electrical energy was 6,375,398 units (increase 417,913).

Manchester.—The accounts of the tramways department for the year ended March 31 show gross capital expenditure £2,237,827. The total amount of sinking fund is £727,383, and sinking fund applied in reduction of debt £726,461.

Revenue was £1,119,861 (compared with £978,677 in previous year), and working expenses were £630,219 (£598,743), and war service allowances, bonuses, &c., £156,936 (£91,023), leaving gross profit £332,706 (£288,910). Interest required £64,123 (£61,091), redemption of debt £65,335 (£63,358), and after providing for capital charges for street improvements, rent of tramways and outlay on leaseholds, there was a balance of £184,058 (£144,932). £73,227 (£39,525) has been placed to renewals fund, £10,830 (£5,406) paid as income tax, and £100,000 (the same amount as last year) contributed in aid of rates. Average total revenue per car mile was 14·496d. (12·773d.), and working expenses were 8·158d. (7·814d.) Passengers carried were 239,231,547 (217,735,224) on the electric cars, and 1,682,822 (1,416,760) on motor buses. There are 195 miles of track in operation.

South Shields.—The electricity department's accounts for the year ended March 31, 1917, show total capital expenditure £227,717 (increase £2,619), of which £116,407 has been repaid.

Revenue was £32,370, compared with £30,738 in previous year), working expenses were £18,829 (£17,223), leaving gross profit £13,541 (£13,515) sinking fund required £9,827 (£9,317) and interest £5,409 (£5,226), and net deficit was £3,000 (£1,876), which Mr. H. S. Ellis (borough electrical engineer) points out has been met without unduly increasing the reserve, while the tariffs have not been increased over pre-war rates.

Mr. Ellis says in his report, in spite of increases of £1,606 in working expenses and £801 in income tax, works costs have been reduced from 0·57d. to 0·56d. per unit, and total costs from 0·912d. to 0·909d. per kelvin. Kelvins sold were 4,921,944 (4,423,154), maximum load was 2,298 kw. (2,247 kw.), and load factor 24·4 (22·5) per cent. The question of linking up the Sunderland and South Shields undertakings have been discussed, but the cost of cables, &c., make such a scheme prohibitive at present. Negotiations with the Newcastle Electric Supply Co. fell through owing to the fact that the two supplies were of a different nature.

The electric tipping wagon has fully justified its existence, and without some form of self-propelled vehicle the department would have experienced considerable difficulties in dealing with the ashes at the electricity works. During the 12 months ended Aug. 28, 1917, the distance run was 5,070 miles, the number of loads was 2,516 and the total weight carried was 3,475 tons. The total cost of running, including electricity, labour, maintenance, insurance, licences and interest and sinking fund on the original cost of the vehicle (£830. 10s.) was £340 for the year. It would have cost £463. 6s. to hire horses and carts to do the work on the basis of 2s. per load.

Companies' Meetings and Reports.

Submarine Cables' Trust.

The 47th ordinary annual meeting of the certificate holders was held on June 5, 1918, under the presidency of Sir JOHN DENISON-PENDER, K.C.M.G.

The SECRETARY (Mr. Sidney Collett) having read the notice convening the meeting, and the minutes of the last annual and special meetings having been taken as read,

The CHAIRMAN said: Gentlemen, our total receipts for the year ended April 15 last amounted to £27,694, as against £29,304 in the previous year. After deducting £1,733 for expenses (which is practically the same as last year's figures) and adding £66 brought forward we had an available balance of £25,988. This balance has been dealt with as follows: £14,802 has been distributed to our certificate holders in half-yearly interest at the rate of 6 per cent. per annum net. With the surplus of £11,186 we have acquired 93 certificates at or under £120 per certificate, exclusive of the coupons of reversion. Thirty-six of these were purchased in the open market, nine were acquired by tender, and 48 were drawn on May 1 last in the presence of a notary. These operations absorbed £11,093, leaving £93 to be carried forward. The position now is that we have acquired 1,820 certificates out of the original 4,200, leaving 2,380 still to be drawn. The fall in our receipts is almost entirely due to the periods at which the Eastern Telegraph Co. and Eastern Extension Telegraph Co. increased their dividends from 7 to 8 per cent., the effect being that our receipts for 1917 were somewhat unduly swelled Those companies had hitherto been in the habit of paying interim dividends of 1¾ per cent.; and, at the beginning of our 1916-7 year, they decided to pay 8 per cent. for the year instead of 7 per cent., as in former years, by distributing a final dividend of 4¼ per cent., after which they commenced increasing their interim dividend to 1½ per cent., with a final dividend of 3½ per cent., so that in the year this alteration took place we received an extra amount in the final dividend, together with the larger interim dividends, making 8¾ per cent. for that particular year. On the other hand, you will notice there is an increase in our receipts from the Central & South American Telegraph Co. of £202. This is accounted for by the distribution which that company made of new shares, on which we are now receiving the full dividends. A question has been raised with regard to our liability on this issue of shares to British income tax, but our contention is that they are not subject to any such tax, but the question is not yet settled. The Mackay Companies have increased the dividend on their common shares from 5 to 6 per cent.; while the West India & Panama Telegraph Co. are paying 1s. per share against 6d. last year. These two last-named increases do not, in the aggregate, represent very much, but they are in the right direction, and they are all to the good. A small reduction in the receipts of the dividends from the American Telegraph & Cable Co. and the Anglo-American Telegraph Co. is accounted for by income tax. There is also now an American income tax, which has affected our receipts from American securities; but we are in correspondence with the American Revenue Department on this matter, and it is possible that we may obtain exemption, as we are not domiciled in America. I may add that the present market value of the securities of the Trust shows an appreciation over capital of £194,000, or £50,000 better than this time last year. I now move that the report and accounts be adopted.

Sir ALBERT J. LEPPOC CAPPEL, K.C.I.E., seconded the resolution, which was carried unanimously. On the motion of Mr. W. HIBBERDINE, seconded by Mr. ADYE, Messrs. Deloitte, Plender, Griffiths & Co., and Messrs. Gane, Jackson, Jefferys & Freeman were elected auditors.

LONDON & SUBURBAN TRACTION CO. (LTD.)—Lord Stuart of Wortley, in moving the adoption of the report at the meeting last week, said the income from dividends and interest receivable was £39,145 less than it was in 1916, and that the balance available for dividends was £41,136 less. The passengers carried by the tramway companies in 1917 exceeded by so much the number carried in 1916 that it more than offset the decrease in passengers carried by the omnibuses in which they had an interest. The cause of the diminished net revenue and consequent diminished distribution on the preference shares was the ever-growing costs of operation. The total wages paid by the operating companies (exclusive of the omnibus undertakings) amounted in 1913 to £330,000 and in 1917 to £403,500. Steps were being taken to rehabilitate London United Tramways finances. The Commissioner of Police for the Metropolis had at last stated his willingness during the war to license women as tramcar drivers. They had to face a probable diminution of revenue from the effects of the new Lighting, Heating and Power Order and their tramway undertakings had also been called upon to assist in securing the necessary economy in coal consumption by curtailing the consumption of electricity used

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in the propulsion of the cars. That economy could only be obtained by reducing the services given. They had raised their charges for electric current to tariff consumers, and they were now negotiating with the long term consumers with a view to securing from them a fair return for the valuable services rendered to them. They could also do something in the way of increasing their tram fares. The efforts to reduce wasteful competition between their tramways and the omnibuses of the L.G.O. were much nearer realisation than they had ever been before.

MIRRLEES, BICKERTON & DAY (LTD.)—For the year ended March 31 the net profit, after providing for depreciation, directors' fees and excess profits duty, is £23,958, and with £570 brought forward the total is £24,536. The directors recommend a dividend at rate of 10 per cent. (tax free) on the ordinary shares, to place £5,000 to reserve and to carry forward £2,120.

NEW GENERAL TRACTION CO. (LTD.)—The past year's revenue amounted to £18,575 and general expenses to £1,191. Debenture interest absorbed £5,707, and the profit was £11,039, to which is added £8,070 brought forward, making £19,109. The directors recommend that £10,480 should be appropriated to payment of a 4 per cent. dividend (less tax), the balance of £8,629 being carried forward.

SIEMENS BROS. & CO. (LTD.)—Mr. G. Murc Ritchie, who presided over the 37th ordinary general meeting on Tuesday, stated that the past policy of the company had been continued throughout 1917, during which the business exceeded that of 1916 by about one-third. The expansion in output occurred principally in insulated wires and cables, ebonite and batteries, but the development in automatic telephony which was foreseen by the company before the war was continued on a considerable scale. They were equipped to provide both large exchanges for public service and smaller private exchanges of 25 to 500 lines, and notwithstanding the demands for war work, they had found it possible to complete a semi-automatic exchange at Port Adelaide (1,000 lines) for the Commonwealth of Australia, which had been working quite satisfactorily for 18 months, and a full automatic exchange for Grimsby (1,300 lines), which would very shortly be handed over, and to make good progress with a full automatic exchange for Stockport (950 lines). Many private exchanges of from 25 to 200 lines had been established in munitions factories and had given every satisfaction. Some 1,154 of the company's employees had joined the Colours, including the only son of their colleague Mr. George Chauvin, managing director. The expansion of the business has caused a considerable increase in the number of their employees. Before the war they employed about 4,000 persons, of whom 1,100 were females, the number was now over 5,600, including 2,000 females. Proof of the happy relationship existing between the company and its employees was afforded by the long service of many of them. A continuous service of 50 years with the company was not uncommon—in fact, three had reached their jubilee of service with the company this year. The profit of £208,524. 13s. 10d. showed a substantial increase over that of the preceding year, attributable to the very much larger volume of business done. An interim dividend of 10 per cent. (tax free) had been paid, but no further distribution for 1917 could be considered until the Government claim for excess profits duty had been adjusted. After obtaining counsel's opinion, they found it necessary to reconstruct the accounts of the Dynamo Co. for 1914, 1915 and 1916. There were other matters also affecting the assessment to excess profit duty which had to be dealt with. In the balance-sheet the most important item on the assets side was the entry of £764,524 for materials, manufactured goods and work in hand. That was more than double the corresponding pre-war amount. The increase was due to the growth of expenditure on orders in hand, the value of which exceeded a million and a half on Dec. 31 last. Another important item was the company's holding of the whole of the issued capital of Siemens Brothers Dynamo Works (Ltd.), namely, £200,000 in shares and £200,000 in debentures. At the outbreak of the war the share capital of Siemens Bros. & Co. amounted to £600,000, with £150,000 in 4 per cent. debentures, nearly all the shares and about one-third of the debentures being held by Germans. Moreover, the German shareholders had supplied about £1,350,000 of additional capital to meet the requirements of the growing business of Siemens Bros. & Co. and Siemens Bros. Dynamo Works. In accordance with the provisions of the Trading with the Enemy Amendment Act, 1916, the whole of the German interest in the shares and the additional capital before mentioned was vested in the Public Trustee, who took steps to realise it by sale to a British buyer. Tenders were called for and on Dec. 14 last a sale was effected of the share capital of Siemens Bros. to Messrs. C. B. Crisp & Co. An important provision of the contract of sale was the issue to the Public Trustee by the company of debentures to the amount of £1,330,000, to bear interest at the rate of 4½ per cent. per annum, in order to provide for the repayment of the capital (other than share capital and the participation in the 4 per cent. debentures) employed in the business by the former German proprietors. The company agreed with the Public Trustee that he should have the right, after the conclusion of peace, to call upon the company at one year's notice to redeem such debentures. On the completion of the arrangements between the Public Trustee and the British purchasers of the German-owned shares the Board was reconstituted. Since the new Board was formed attention has been given to many questions concerned with the development of Siemens Bros. into a great national manufacturing asset, and little time has been available for discussing a scheme of re-arrangement of the share capital. The subject has, however, been under consideration, and the Board recognise the advisability of so changing the capital arrangements as to make them conform with the ordinary practice of British companies. The Board may at an early date ask the shareholders to approve a scheme for enlarging the share capital to £1,500,000, or to an even greater sum, in shares of £1 each. The re-adjustments of the capital of the two Siemens companies were subject to negotiations which must be conducted with the authorities. The main features of the Dynamo Co.'s trading for 1917, compared with 1916, was an increased turnover in the United Kingdom and a decrease overseas. The value of unexecuted orders at Dec. 31 last was £1,145,000. Prior to the war the company employed 3,389 persons, of whom 328 were women. It now employed 2,439, including 650 women. Since the entry of the new directors into office negotiations had been set on foot with other British companies doing similar industrial business with the object of bringing such manufacturers together for the reduction of unnecessary competition and the avoidance of duplicating machinery staffs, workshops and offices. The advantages arising from such industrial alliance would make it possible to carry out complete installations within the allied group. Alliances of that nature had been arranged with Messrs. Dick, Kerr & Co. and others were in contemplation.

SOUTH WALES ELECTRICAL DISTRIBUTION CO.—Mr. W. Gascoyne Dalziel, who presided over the annual meeting last week, stated that the output showed an increase of nearly 23 per cent., and after payment of all working expenses, interest on prior lien debenture stock, and making provision for depreciation of new plant, they earned the full interest on the original debenture stock, and were able to carry forward a small balance. That was the first time in the history of the Company that the whole of the interest on the original debenture stock had been earned in the 12 months during which it accrued. Negotiations had been completed for a further increase of output, the new business including supplies to several important industrial and colliery companies. Electrical supply undertakings such as theirs were now being looked upon not only by large users of power, but also by the Government, as a necessary factor in the industrial life of the nation, and, whilst it would be premature to draw any conclusions at present as to what would be the outcome of the various schemes proposed, he thought it probable that many of the disabilities and handicaps under which they had hitherto laboured would be removed.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—The gross earnings for the year 1917 amounted to £793,669. 16s. 8d., and the gross maintenance and other charges in Argentina and London were £528,251. 11s. 10d., leaving a profit of £265,418. 4s. 10d. Deducting interest on debenture stock, dividend on preference shares to Dec. 31, 1917, and interim dividend on the ordinary shares (£72,100) and adding amount brought forward (£6,989. 11s. 8d.), the available balance is £200,307. 16s. 6d. The directors recommend a final dividend of 5s. per share on the ordinary share capital, making, with the interim dividend paid in November last, a return of 8 per cent. for the year, tax free (£81,000); a sum of £2,000 is devoted to the staff provident fund; £60,000 placed to reserve, and £40,009 to reserve (war contingencies) fund, leaving £17,307. 16s. 6d. to be carried forward.

City Notes.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—A quarterly dividend of 1½ per cent. has been declared on the fully-paid cumulative preference shares.

CANADIAN GENERAL ELECTRIC CO. (LTD.)—A quarterly dividend of 2 per cent. has been declared for the quarter ended June.

VULCAN BOILER & GENERAL INSURANCE CO. (LTD.)—An interim dividend of 9 per cent. (4s. 6d. per share), less tax, has been declared on the ordinary shares.

The Round Table.

By "kVA."

Bon mot of the I.M.E.A.: "Where *is* my chairman?"

* * * *

For the first time since the war the I.M.E.A. Convention is to be held out of London. This is a great compliment to President Watson, who will welcome the members next Thursday at the Town Hall, Manchester.

* * * *

The electrical industry is greatly honoured in the knighthood of Mr. T. O. Callender. I understand that the new knight, whose bonhommie is his chief characteristic, wishes to be known as "Sir Tom," and not "Sir Thomas."

* * * *

The Hun never had a sense of humour even before the war. He now sees only methods of frightfulness in our old friend the electric shocking coil. Evidently Fritz disagrees with such treatment if the following is to be believed:—

"The drastic method for nerve troubles adopted in several German military hospitals is of such a character that, according to a Munich telegram to the "Koelnische Volkszeitung," regular revolts against it have occurred, the hospital wards being demolished. The hospital at Rosenheim was burned down, presumably owing to incendiarism by a patient so treated. An electric current is employed, and so great is the pain that many of the patients tremble and often scream before the actual application, and under the effects of the current their shouts are often heartrending. Patients have often run away from the doctors applying the treatment. A whole series of questions on the subject are now being put by members of the Reichstag.

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CONTENTS.

NOTES 139
Arrangements for the Week 141
Modern Development of Large Hydro-Electric Power Schemes. By G. Fred. Holmboe, B.Sc. Illustrated 142
The Teaching of Physics in Schools 147
Trade Parliaments and Their Work. By E. J. P. Benn 148
Capital and Labour and the Government 149
THE ELECTRICAL TRADES AFTER THE WAR 150
The Electrical Industry After the War 151
Engineering and Iron and Steel Trades 152
CORRESPONDENCE 153
British Made Magnetos 154
Power Supply Engineers' Association 154
Volunteer Notices 155
PARLIAMENTARY INTELLIGENCE 155
LEGAL INTELLIGENCE 155
Commercial Topics 156
Electricity Supply 156
Tenders Invited 157
Companies' Meetings and Reports 158

Notes.

A British Magneto Industry in Being.

ON another page we refer to a visit of a Press party last week to several of the works of manufacturers of the British Ignition Apparatus Association. In the first place we would like to record our satisfaction at the co-operative spirit which has brought together many old rivals, and established a new industry which ought never to look back. It is not necessary for us to detail the circumstances under which the German magneto monopoly arose and firmly established itself in every country where motor cars, aeroplanes and gas engines were manufactured. At the outbreak of war the authorities discovered that a "key" industry was in enemy hands, and in a manner typically British they proceeded to investigate and found that one firm, Messrs. Thomson-Bennett (Ltd.), were practically the only makers of magnetos, and their output did not exceed 100 machines per week. Considering such a state of affairs, it is remarkable that the entire industry of motor-car and aeroplane production did not break down. Presumably, large stocks of enemy magnetos were available, and whilst these were being exhausted the British magneto industry was brought into being. This industry has succeeded, as is evident from the fact that 300,000 magnetos have been produced for war purposes alone. This is an astounding achievement, and shows what British engineers can do. It may be recalled that Germany was obsessed with the idea that she was the only country that could build successful magnetos, and she circulated the story that there was something peculiar in the air of Stuttgart, whence the Bosch magnetos emanated, and thus the product was unobtainable in any other part of the world. Such a fable is typically German, but the British manufacturers can now settle themselves to living it down. We are glad to assist in refuting such extravagant claims, and to put on record the far more interesting fact that magnetos for all purposes are now available from British factories, and that their design and efficiency are above reproach. We must congratulate the Associated Manufacturers upon the results so far obtained, and we are confident that with the approach of peace conditions they will meet all magneto requirements and compete with all rivals in the markets of the world. The capital now invested in the industry is 10 millions, and there are at present 5,000 employees among the associated magneto makers.

The Teaching of Physics in Schools.

LAST week an interesting discussion was held at the Physical Society on "The Teaching of Physics in Schools." It is, perhaps, well to distinguish in this connection between boys of 12 to 15 years of age and those that are older. We doubt if the importance of the younger class has been sufficiently recognised. It is true, of course, that no serious work can be expected from such juveniles, but it must be remembered that the mind at that age is very receptive, and it is highly desirable that there should be a rapid enlargement of ideas. It is general knowledge rather than precise information that is needed, and from that point of view the teaching should rather be descriptive than by means of measurement. We do not think there is anything much less inspiring than the determination, for example, of specific gravity and the use of all the time-honoured hydrometers which are never employed in practice. Practically work of this kind only leads to the idea that physics is an uninteresting subject.

The Boy's Point of View.

IT is essential that the point of view of the average boy himself should be borne in mind. There is little doubt that the schoolboy likes to see something happening. It is for this reason that chemistry may be more attractive than physics when it is a question of work in the laboratory, for in the mind of the schoolboy there is always a chance of an "explosion" in the chemical laboratory which lends fascination to studies in that department. Nor should we look upon such ideas as being due merely to idle curiosity, for it is only by maintaining interest in a subject that information is rapidly absorbed. The carrying out of measurements has little educative value unless the pupil is interested. For this reason it may be said that the determination of thermal capacity is not a suitable experiment, whereas the bubbling of steam into cold water is more instructive, because in this case the boy at once appreciates that something is happening. Fifty years ago there was more excuse for a wrong attitude in matters of this kind than at the present time, for now there are so many everyday applications of physics that many physical principles can be taught very easily. This is particularly the case with electricity. As examples of such applications we need merely mention the thermos flask, the electric bell, the telephone and the gramophone. From the point of view of producing a suitable mental response, lectures should, as far as possible, be of an experimental character. From this aspect probably a single course of Christmas juvenile lectures at the Royal Institution are of more value than a whole term of physics at an average school; but, of course, these lectures are of a very high standard and the same class of demonstration cannot be expected in schools. Nevertheless, there are many simple experiments which are instructive, and probably the only serious objection to such courses is the fact that the average examiner will hold totally different views. Unfortunately, the harm that examiners can do is considerable.

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Industrial Safety.

AT the Industrial "Safety First" Conference, held at the Mansion House on June 12, a resolution was passed putting on record the determination of the London "Safety First" Council to extend their operations to the industrial field. The Council has done a great deal of very useful spade-work in connection with the diminution of accidents through traffic in streets, and it is no doubt due in a large measure to their efforts that the number of accidents, which rose in a somewhat alarming manner in the period following the outbreak of war, seems now to be once more diminishing. There is ample scope for their efforts in the industrial field, and we have no doubt that the National "Safety First" Campaign which it is proposed to organise will have a useful effect in this country, as has been the case with similar efforts in the United States. Lord LEVERHULME, who presided, referred especially to the enterprising action taken by many American firms to encourage care on the part of their workpeople—a matter of great importance in the United States, where, notwithstanding such efforts, the accident rate in factories is considerably higher than in this country. A point of importance referred to by Mr. G. H. ROBERTS, Minister of Labour, was the common ground such action affords for masters and men. He suggested that the organisation of safety measures might well form one of the matters to receive attention from the Joint Industrial Councils proposed in the Whitley Report. Such councils, he urged, had a much wider field of action than the mere settlement of disputes regarding wages, and the elimination of accidents can only be effected by co-operation between the employer and employee. At such a time as the present, when the death-roll of the war is so heavy, and the circumstances under which much industrial and munitions work is done at home are necessarily more hazardous and inimical to health than in normal times, there is a special reason for advocating safety measures. We wish the new movement every success.

Water Power in India.

WHILE so much discussion is taking place regarding electric power development in this country, it is most instructive to obtain particulars of undertakings elsewhere. On the Continent, especially in Germany, a great deal appears to be contemplated in the near future, and the more remote parts of our Empire are also giving the question serious consideration. The Paper by Mr. ALFRED DICKINSON, recently read before the Royal Society of Arts, describes a large and most interesting development in India, the Tata hydro-electric undertaking, which is to produce 100,000 H.P. by hydraulic methods, in valleys which from time immemorial have been dry for nine months of the year. Large lakes have been formed by constructing dams across three valleys, from which water is conducted in an open duct 4½ miles long. The full scheme provides for 86,000 H.P., divided into eight main sets of 12,000 H.P. each, and eight step-up 10,000 kw. transformers, each of which weighs as much as 24 tons, and requires 8 tons of oil. Transmission is made from the power house at Khopoli to the island of Bombay, a distance of 43 miles. Various native States (Kashmir, Patiala, &c.) have hydro-electric installations on a relatively small scale, but the possible future developments far exceed anything yet undertaken. Thus, by constructing a dam across a valley in the Western Ghats water from the Koyna river could be harnessed to produce 300,000 H.P. continuously; the author has also been investigating the possible use of the irrigation lake at Periyer in the Madras Presidency. In the discussion, Sir FRANCIS YOUNGHUSBAND referred to the vast water-power located in the great rivers coming down from the Himalayas, and remarked that to harness the Indus itself would not prove a greater task than that undertaken at Niagara. India, in short, is a land of great electrical possibilities, and there is no doubt that its industrial development will ultimately demand the full development of its water-power.

Engineers and Appropriate Military Service.

THE manner in which engineers have not been used in the most appropriate way in military service during the war is notorious and lamentable. Young engineers of the greatest promise have been sent into the firing line and have lost their lives, and in this way the country is the poorer. The authorities are now beginning to realise that it may be better to employ engineers as engineers. This point of view will no doubt appeal very strongly to the older men who are now being called up. Many of our readers are probably already aware that the Council of the Institution of Civil Engineers has taken steps to provide its members with certificates indicating their qualifications, so as to secure, if possible, suitable allocation of their services. It appears to us that this is a very desirable step, and we suggest that the Council of the Institution of Electrical Engineers might do well to consider the desirability of issuing similar certificates to its members in order that their professional status may be maintained under military conditions.

Government Dealings with Capital and Labour.

THE relations of the Government with Capital and Labour are far more intimate at the present time than they were before the war and more intimate than they will be after the war terminates. It is well, therefore, that when the Government finds it necessary to deal with problems affecting either Capital or Labour that they should adopt the most direct methods of negotiation. Hitherto various methods have been adopted. In a manifesto which has been issued by the Industrial Reconstruction Council, and which we give on another page, it is suggested that the Government might establish the principle of co-operation in such dealings to a greater extent, and should adopt the uniform practice of consulting only joint bodies representative of both employers and workpeople. The principle is stated that any commercial industrial matter ought not to interest the Government unless it interests both Labour and Capital. While we think it may be difficult to adopt this principle at the present time when joint councils have been formed in only very limited numbers, there is nevertheless a very strong case for the view that the Government should negotiate only with such councils where available. The results so obtained would be on a much more representative basis and more satisfactory than when negotiations are carried through with either Capital or Labour alone.

The Rockefeller Foundation.—We have received the Report of the Rockefeller Foundation for 1917. The Foundation appears to be undertaking a great deal of valuable public health work and medical education in various parts of the world. Special prominence is naturally given to those aspects of the work which have an immediate application to the war, and we notice an account of the special courses at the War Demonstration Hospital, which are attended by many officers in the United States Army and Navy. Much research is undertaken on such matters as mental diseases, infantile paralysis and tuberculosis, and there is an interesting account of the study and treatment of special occupational diseases in Ceylon, China and elsewhere. Extensive campaigns are now being undertaken in combating malaria and yellow fever, and the scope of the work is rightly designated as international.

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Therapeutic Action of Ultra-Violet Light.—The portion of the ultra-violet spectrum that is most useful for therapeutic work has been the subject of some discussion, and a communication by Mr. C. A. Schunck to a recent issue of the "Journal" of the Röntgen Society throws some light on this subject. The effect was studied by observations of the influence of a specified exposure on the forearm and appeared to be greatest in the region 2,350–2,500 $\mu\mu$. The limitations of the region are somewhat indefinite, and there is also the possibility that the most effective wave-lengths may vary according to the exact nature of the therapeutic treatment.

Birthday Honours.—In addition to the list given in our last issue, the following honours have been conferred:—

C.B.E.—Mr. Charles Ashton Lister, J.P., Chairman of M. L. Magneto Synd. (Ltd.) and Director of R. A. Lister & Co. (Ltd.).

M.B.E.—James R. Schofield, principal and director South Wales Wireless Training College; Dempster Smith (Mirrlees, Bickerton & Day); Lt. Cyril J. Strother, technical officer (wireless duties) R.A.F.; John Hy. Ward, acting first assistant electrical engineer, Department of Director of Dockyards and Repairs, Admiralty; Chas. Arthur White, principal, Aston Technical School, Birmingham; John Edgar Williams, chief electrical engineer, Public Works Department, Sudan Government.

O.B.E.—Mr. John Moxon, chairman of the Newport (Mon.) Electricity and Tramways Committee, is a recipient of the O.B.E. Mr. Moxon is also vice-chairman of the Parliamentary Committee, chairman of the Newport Harbour Board and secretary to the board of management of the Newport National Shell Factory.

Glasses for Protecting the Eyes from Injurious Radiation.—Technologic Paper, No. 93, issued by the Bureau of Standards, Washington, summarises some researches by Dr. W. W. Coblentz and Mr. W. B. Emerson on various protective glasses. The Paper contains a considerable amount of new data on the spectral transmission of glasses suitable for protecting the eyes from injurious rays, *e.g.*, euphos, fieuzal, akopos and noviweld glasses. An appendix is added which gives the transmission of the radiations from a gas-filled tungsten lamp; a magnetite arc, and a quartz mercury vapour lamp through various glasses, thus showing in a condensed table the protective properties afforded by these glasses. Those interested may obtain a copy by addressing a request to this Bureau.

The "Faraday House Journal."—The "Faraday House Journal" for the Summer Term (1918) contains a readable series of editorial notes on educational topics. "Education After the War," a subject that is being much discussed, being one of the points dealt with. Some criticism is levelled at the proposal to make English practically a compulsory subject in all examinations, but we think it will be agreed that facility to express their thoughts clearly is very desirable in technical students, and an accomplishment that is too often wanting at present. Stress is laid on the function of an educational system to discover ability, which is emphasised in the Report of Sir J. J. Thomson's Committee. Other matters dealt with include the apprenticeship system, vocational bureaus and school science. There is also an abstract of Mr. H. L. Ballard's Paper before the South African Institute of Electrical Engineers on Three-Phase and Ward-Leonard Equipment. We note references to the doings of many old Faradians in the war, and a list of present students who have been allowed to suspend their course temporarily.

Obituary.

Prof. F. BRAUN.—The death of Dr. Ferdinand Braun occurred at a Brooklyn hospital on April 14 last.

Prof. Braun was born in Fulda, Germany, in 1850. He became professor of physics at the University of Marburg in 1876, and in 1880 he accepted a call to Strasburg. In 1883 he was appointed professor of physics at the Technische Hochschule, Karlsruhe, and in 1885 he went to Tubingen, returning in 1895 to Strasburg University, where he remained until he went to the United States in 1914 as a witness in litigation between the Marconi Wireless Co. and the German company which built and operated the wireless station at Sayville. Prof. Braun's early work related to the oscillations of elastic strings and rods, but the greater part of his later work was electrical, more particularly in connection with wireless telegraphy. He constructed the cathode-ray tube, which is known by his name, for the study of high-frequency currents. Much of his work was concerned with wireless telegraphy and kindred subjects. In 1898 he showed that rapid electric oscillations which are conducted through water or moist earth can be used at considerable distances for signalling purposes. In 1900 Prof. Braun wrote a Paper describing his wireless telegraphy, and in his brochure on "Wireless Telegraphy through Water and Air" (Leipzig, 1901), he gave some of the results of his work. Later, he showed how, by means of two receiving wires, wireless messages could be received when they come from a determined direction, while those from another direction could be excluded, and in 1902 he proved how this was possible with wires placed in an oblique position. In the winter of the same year he invented a method which permits the energy of the sender to be increased at will. In January, 1904, he succeeded in producing by means of ordinary light waves the effect produced by Hertz with electric waves, thus giving the first direct proof that ordinary light consists of electric waves. Shortly after he showed that very fine isotropic dielectric strata behave as double-refracting crystals. In 1905 he successfully concluded his experiments, which extended over some years, as to the practicability of sending wireless messages principally in one direction, and in the autumn of 1906 he described a new form of detector for electric waves. In December, 1910, he received (with Mr. Marconi) the Nobel prize for physics; and in the summer of 1910 he showed that with very fine transparent gratings only the electrical components parallel to the gratings are deflected.

DEATHS ON ACTIVE SERVICE.—The following deaths are reported:

Sec.-Lieut. B. Ritsen (M.G.C.) is presumed to have fallen in action. He was at one time a Faraday House student; from 1905 to 1907 was an engineer at Necaxa, in the service of the Mexican Light & Power Co., and was afterwards engaged with Callender's Cable & Construction Co. until the outbreak of the war On Oct. 9 last he was in command of a section taking up ammunition to the guns at the front. He went forward to reconnoitre and never returned.

We regret to learn that Capt. H. E. Turner, late mains superintendent at Hull, has been killed in action. Capt. Turner had been awarded the Croix de Guerre, and was also a Chevalier of the Belgian Order de la Couronne.

Pte. Geo. Mercer (Northumberland Fus.), also formerly employed in the Hull electricity depot, has also been killed in action.

Pte. Glyn Griffiths (Cheshire Regt.) is officially reported killed. Previous to joining the Army he was employed at the Pontypridd electricity works.

Gunner. G. F. Willett (R.G.A.), of the secretarial department, County of London Electric Supply Co., has been killed in action.

Personal.

Mr. Malcolm Leggett, F.C.I.S., has resigned his position as secretary of Pritchett & Gold & Electrical Power Storage Co. (Ltd.). Communications should be addressed to him, c/o Chartered Institute of Secretaries, 59A, London Wall, E.C. 2. Mr. Leggett was secretary of the Electrical Power Storage Co. for several years until its amalgamation with Pritchetts & Gold in 1915.

Capt. A. V. Sinclair, engineer-in-charge at the Swansea municipal electricity works, and who enlisted on the outbreak of war, has received his discharge on account of ill-health, the result of gassing and trench fever. The Borough Electrical Engineeer has been authorised to avail himself of the services of Capt. Sinclair on suitable work in connection with the department.

We are informed that Mr. R. W. Willis, A.M.I.E.E., electrical engineer on the staff of the Director of Electrical Engineering, Admiralty, has been appointed to represent the Director in Manchester in regard to work in progress in the north-west area of England.

Mr. H. M. Schofield, of the secretarial department of the County of London Electric Supply Co., has received his commission as a Flying Officer in the R.A.F.

Arrangements for the Week.

FRIDAY, June 21st (to-day).

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

9.30 a.m. At the Town Hall, Manchester. Council meeting.
10 a.m. Resumed discussion on "Electric Power Supply."
11.30 a.m. Annual General Meeting.
3 p.m. To re-assemble if necessary to complete any adjourned business.

THURSDAY, June 27th.

ROYAL SOCIETY OF ARTS.

4 p.m. At John-street, Adelphi, London, W.C. Annual General Meeting.

FRIDAY, June 28th.

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Papers to be read on "A New Method of Measuring Alternating Currents and Electric Oscillations," by Mr. I. Williams, M.Sc., and "A Demonstration of Coupled Vibrations," by Prof. E. H. Barton, F.R.S., and Miss H. M. Browning, B.Sc.

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Modern Development of Large Hydro-Electric Power Schemes.

By C. FRED. HOLMBOE, B.Sc.

Summary.—The extent to which a hydro electric plant fulfils its expectations depends largely upon previous careful investigations of the conditions. This is particularly the case in regard to the amount of water available. The author outlines the procedure that should be adopted, and in conclusion he gives details of three cases of very cheap water-power development.

I.

The electro-chemical and electro-thermal industries require large quantities of power per unit of produced goods, and consequently the cost of the power represents a substantial proportion of the total production cost. There are special branches of the electro-chemical industry in which the cost for power is up to 90 per cent. of the total production cost, including depreciation, maintenance, raw material, labour, power, overhead charges, &c., and a proportion of 50 to 60 per cent. is not uncommon. The rapid development of the electro-chemical and thermal industry has, therefore, been followed by an equally rapid progress in the building of large power stations, and preferably hydro-electric power schemes, as the power produced by water is, up to the present time, far cheaper than any other known form of energy.

The branches of the electro-chemical and thermal industry which largely depend upon cheap power are : electro-iron and steel works, aluminium, carbide, cyanamide, fixation of nitrogen from the air, carborundum (silica of carbide), gold, lead, tin, zinc, magnesia, sodium, alkali, hydrogen, &c.

The price of water-power varies considerably, and is largely dependent upon local conditions and the size of the plant. The most economical plants erected up to the present are, so far as the author's knowledge goes, in Switzerland, Norway, Sweden and Finland. In Canada the cost of power is usually somewhat higher, and in the United States higher again than in Canada. This depends partly upon the value of the land which in Canada and the States must be submerged in order to obtain the necessary water-reservoirs for regulating the waterflow, and partly upon the fact that the machinery is more expensive in the States than in the other countries mentioned.

As a rule plants with high falls of 1,000 ft. and more are more economical in construction and running than plants which only utilise 50 ft. to 100 ft. fall, because the amount of water to be handled per kilowatt is so very much less, and consequently the reservoirs, canals, tunnels, pipes, &c., can be smaller in proportion.

II.

The construction of large hydro-electric power stations has brought about a number of new problems which, during the last few years, have had to be solved. For instance, the question of dimensioning the reservoirs in right proportion to the power required and the variation in volume of water per day, month, year and over periods of years, the friction losses in canals, and particularly tunnels, the periodical rise and fall of the water-level in intakes at varying load, the friction losses in pipe-lines, as well as the critical rise in pressure in big pipes due to varying load, and last, but not least, the right size and type of turbine to suit the particular requirements of the plant. Some of the first big plants built had to suffer from the fact that these problems had either not been sufficiently considered when designing the plant, or because the difficulties which might occur were unknown at the time the plants were constructed.

I will, in the following, deal quite briefly with a few of the more important points mentioned, leaving out the technical details of turbines, pipes and intakes.

1. *Amount of Water Available.*—The calculation of the amount of water available can be based either upon the meteorological observation of the rainfall in the catchment area of the river, or by direct measuring of the waterflow in the river. The latter method is by far the safer, as by basing the calculation of the rainfall on the catchment area, several unknown figures have to be taken into account, which makes the calculation more or less uncertain. It is, however, essential for both methods that observations of the flow of water or the rainfall should have been carried out regularly for a long time—at least 7-8 years, better 20-25 years—in order to obtain sufficient reliable material upon which the size and design of reservoirs, tunnels, pipe-lines and machinery can be based.

Unfortunately, in most countries a regular observation of the actual flow of water in rivers has not been carried out, so that in most cases the amount of water available for production of power must be based upon the material obtained from the meteorological observatories.

Strictly speaking, only rainfall observations taken in various places of the catchment area can be used for the calculation of the water supply from the area. Such material is, however, very rarely available, and in most instances the calculation must be based upon observations taken a distance away and at an altitude different from that of the catchment area.

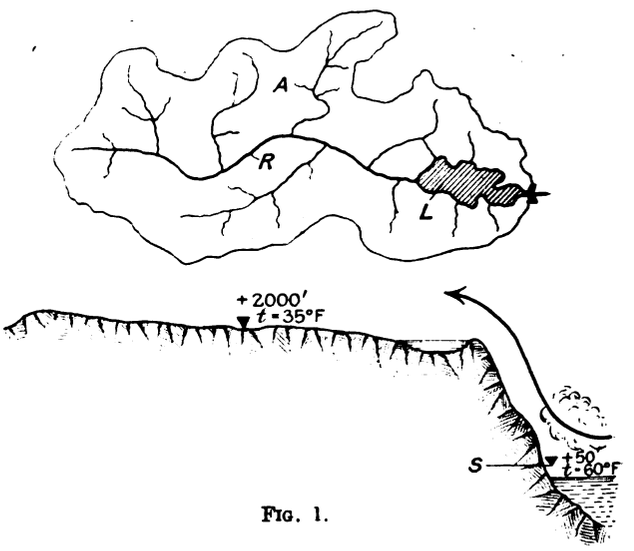

FIG. 1.

Take Fig. 1 as an example. *A* is the catchment area of a river, *R*, the average altitude of which is 2,000 ft. above sea-level. At *S*, 50 ft. above sea-level, the rainfall meter is situated. The mean temperature at *S* is about 60°F., whereas the mean temperature at 2,000 ft. altitude is about 35°F. If the prevailing wind is entering the district in the direction of the arrow it is obvious that the rainfall must be very much greater in the catchment area than at the observatory, the main reason being that 1 cubic ft. of air at the same degree of humidity can hold more than double the amount of water at 60°F. than at 35°F.

The author would like to quote two examples from his own practice in relation to this point. One power station, whose catchment area is similarly situated to that shown on Fig. 1, was designed to produce 40,000 kw. continuously ; the calculation was based upon the rainfall observed at sea-level. To-day—after the actual flow of water has been carefully investigated—the station is producing between 80,000 kw. and 100,000 kw. continuously per year (of 8,760 working hours), because the rainfall at 2,000 ft. altitude was as an average 100 in. per year, whereas at sea-level it was found, on measuring, to be only 48 in.

In another case the amount of water drained from a catchment area of 130 sq. km.* was calculated to be 15 m.³/sec. by unity drain factor. Seven years' actual test showed an

* The author has used, as a matter of convenience, the metric system throughout this article.

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average available quantity of water equal to 25 m.³/sec. or 1·67 times the amount expected. The reason was the same as for the first-mentioned case: the rainfall was measured at sea-level, whereas some districts of the catchment area were more than 3,000 ft. above sea-level.

If A (Fig. 1) represents the catchment area in square kilometres and h the actual rainfall in metres, within the catchment area, the amount of water Q available in cubic metres per second by unity drain factor is:

$$Q_1 = \frac{A \cdot h \cdot 10^6}{31{\cdot}5 \cdot 10^6} \text{m}^3/\text{sec.}$$

where $31{\cdot}5 \cdot 10^6$ is the number of seconds per year (8,760 hrs. × 3,600 secs.).

This amount of water will, however, not be available, as some water will be lost:—

1. By evaporation;
2. Consumed by plants;
3. Through underground formation of the rock, &c.

In order to obtain the actual volume of water Q we must multiply Q_1 by the drain factor σ:

$$Q = \sigma Q_1 = \sigma \frac{A \cdot h}{31{\cdot}5} \text{m}^3/\text{sec.} \quad \ldots\ldots\ldots \quad (1)$$

σ varies with the geological character and the vegetation of the catchment area between 0·65 and 0·9.

It is very often advisable to compare the estimated volume of water with actual tests made in other districts or countries with about the same geological, geographical and meteorological conditions, and this can be done by estimating the specific flow of water from the catchment area. This figure is mostly given in litres per second per km.² and is found from formulæ (1) to be

$$q = \frac{Q \cdot 10^3}{A} \text{ litres per second per km}^2.$$

In many countries where the value of water-power has early been recognised, the volume of water in the more important rivers has been systematically and continuously measured and the results published.

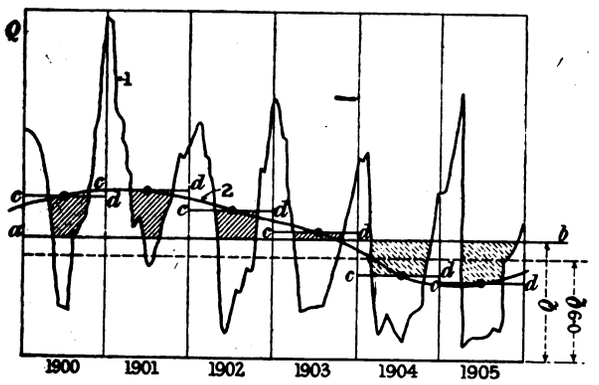

FIG. 2.—CURVES SHOWING VARIATIONS IN FLOW.

For instance, the Norwegian Government, through a specially appointed Water Board, has for many years measured the rainfall and the flow of water in the principal rivers and published the results yearly. The publications give the volume of water per month, the observed maximum and minimum, as well as the mean volume.

Table I. shows as an example the maximum, mean and minimum specific volume of water in four Norwegian rivers:—

Table I.

Name of river.	Catchment area in sq. km. A.	Litres per sec. per km.²		
		Max.	Mean.	Min.
Klaraelv	1,709	58	13·7	3·2
Fedeelven	211	593	47·5	3·8
Aurlandselven	714	798	49·5	2·5
Blaaelven	152	800	138·0	4·0

It is hardly necessary to point out that actual measuring of the volume of water passing through the river is the only way to obtain reliable figures on which to base the calculation of the amount of power that can be obtained. Particularly in cases where the water in the catchment area in autumn, winter and spring is accumulated in the form of snow and ice, this method is the only reliable one.

When the volume of water in the river is estimated or measured, it is advisable to make a diagram of the variation in the flow of water as an average per week, per year and over a period of years (if possible 20-25 years). Fig. 2 shows an example for six years. The curve 1 represents the average weekly variation, the line c-d and the curve 2, the average flow per year, and the line a-b the average flow over a period of years.

It is clearly shown on this figure that if the power supply is based on an average volume of water equal to Qm.³/sec. it is necessary to provide for one or more reservoirs to store the water during periods when the water supply is in excess of requirements, so that this stored water can be used at such times, as the supply is less than the estimated average. If the size of the reservoir is such as to allow for an average volume of water being used equal to Qm.³/sec. over 8,760 hrs. per year for a period of, say, 20 years, this regulation is called a 100 per cent. regulation. Very few plants, however, are

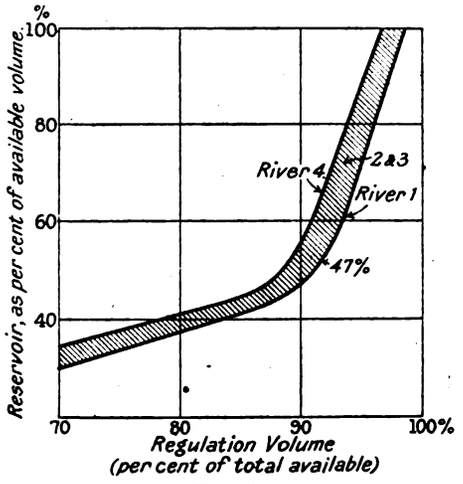

FIG. 3.

built for such an extensive regulation, as the cost involved is generally not justified.

2. *Water Reservoirs.*—In order to reduce the cost of the reservoir it is general practice to utilise lakes or the natural valley-formation of the land in the catchment area, as storage basins. The ideal position of the reservoir is, as shown in Fig. 1, the point L, where the water is to be taken through canal, tunnel, or pipes to the power house. If the lake is higher up in the river it will not be possible to accumulate the whole available amount of water in the reservoir. In many cases it is necessary to utilise a large number of lakes in the main catchment area as reservoirs, and each lake, with its own catchment area, must then be treated separately.

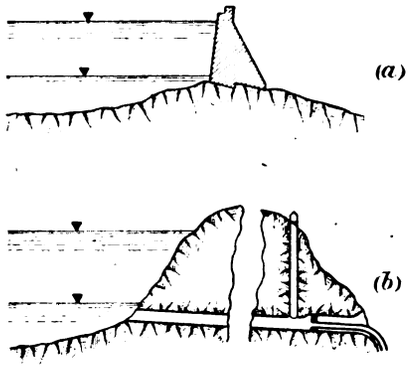

FIG. 4.

The economical utilisation of the natural formation of the land, lakes and valleys, as reservoirs, requires great skill and experience on the part of the engineer, as generally large expenditures are involved in the construction of dams, &c., for this part of the plant, and consequently the economical success or failure of the whole scheme may depend upon how it is designed and carried out. As to the size of the reservoir, this can easily be estimated from the curves shown in Fig. 2.

As the rainfall varies not only from month to month, but also from year to year, it is, as previously mentioned, necessary to base the calculation of the size of the reservoir on the

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waterflow during a series of years. The amplitude of the yearly variations has a period of from four to seven years (very rarely below or above), so that the time between maximum and minimum yearly supply of water is about 2 to 3½ years. In the example, Fig. 2, is shown a 3½-years cycle. The surplus rainfall in the years 1900-1903 must be accumulated and tapped for use during the " dry " years 1904-1906.

In order to find the economical limit of the regulation it is necessary to estimate the total cost involved for dams, tunnels, canals, &c., at various volumes of water per second.

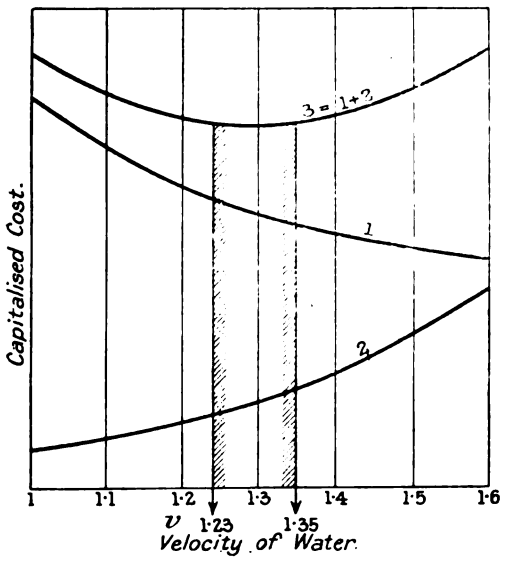

FIG. 5.

If Q represents the maximum volume of water per second, the calculations ought to be carried out for a mean flow of $0{\cdot}5\,Q$; $0{\cdot}7\,Q$; $0{\cdot}8\,Q$; $0{\cdot}9\,Q$; and Q m.³/sec. These calculations reduced per kilowatt output of the station will show that the cost increases rapidly with the size of the reservoir, and there are very few schemes which show that an extension of the regulation above 0·9 is economically justified.

As a rough rule it can be stated that in most cases the price of reservoirs must not exceed ½d. per cubic metre of water storage capacity. There are, however, cases where

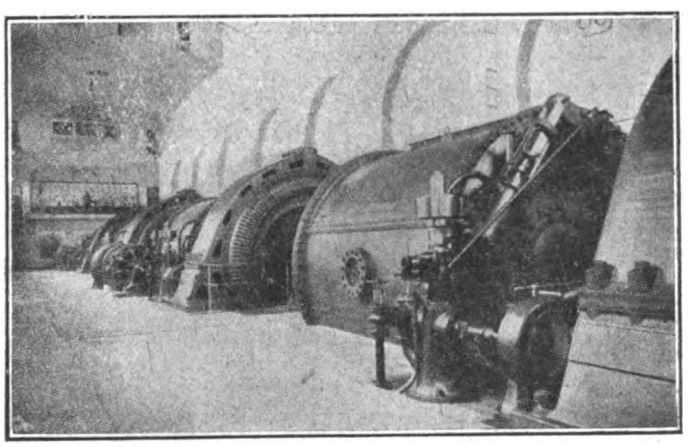

FIG. 6.—SVALGFOS POWER STATION.

power produced by steam or gas is exceptionally high, and consequently a comparatively high price for the water power can be obtained. In such cases a price for the reservoir equal to 1½d. to 2d. per cubic metre storage capacity may be justified.

The size of the reservoir in per cent of the available volume in cubic metres per year in relation to the regulation in per cent of the total available volume of water per year, is graphically shown in Fig. 3 for four different rivers. The curves are based upon continuous full load in 8,760 hrs. per year and on actual measured variation in the volume of water over periods not less than 10 years. If, for example, the river 1 carries 100,000,000 m.³ water per year, and the power house is designed for utilising 90,000,000 m.³ per year, equal to 90 per cent. regulation, the reservoirs must hold 47 per cent. of the total volume per year or 47,000,000 m.³ of water.

In cases where existing lakes are used for water storage it is necessary to survey not only the contour lines of the land around the lakes, but also the contour lines under the water in order to enable an exact calculation of the size of the available storage capacity to be made, when raising and lowering the M.W.L.

The capacity of natural reservoirs is always artificially increased either by building of dams or provision of tapping tunnels (Fig. 4, *a* and *b*) or by a combination of both systems.

3. *Tunnels and Pipe-lines.*—In the event of the water having to be taken through tunnels, which very often—if not as a rule—is the case for high-pressure plants, it is always advisable to make a very careful investigation as to the most economical section of the tunnel, or in other words, to find out the most economical water velocity in the tunnel. It is quite clear that by increasing the section of the tunnel the cost will at the same time be increased; on the other hand, the friction loss in the tunnel and the loss in power will decrease.

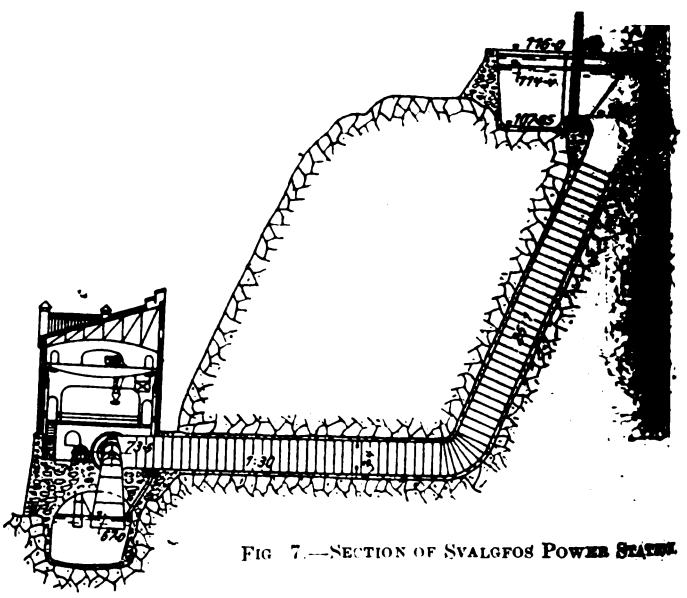

FIG. 7.—SECTION OF SVALGFOS POWER STATION.

By estimating the cost of the tunnels for five or six different velocities (Curve 1, Fig. 5), and at the same time fixing the loss in horse-power at these different velocities due to the loss in head by friction in the tunnel, and capitalising the value of the equivalent loss in power (Curve 2, Fig. 5) it is possible to construct two curves which, when combined, show the economical curve for the tunnel. Fig. 5 shows graphically the results of such calculations, and Curve 3 represents the combination of 1 and 2. It will be seen that for this particular tunnel the economical water velocity lies between 1·23 and 1·35 metres per second. The economical velocity will certainly depend to a large extent upon the value of the power, so that it pays to run the water through the tunnel at a higher speed for plants where the value of the power is low, and vice-versa.

There is also another limit to the velocity of the water in tunnels, and that is the influence of the velocity on the fluctuation of the water-level in the intake by varying load. As this is a big problem in itself it will not be dealt with in this article.

Finally, the section of the tunnel, in cases where small quantities of water have to be handled, is limited to the minimum section which can economically be excavated.

As to the loss in head due to friction in the tunnel, Prof. Bazin has given the following formula, based upon actual tests :—

$$f = \left[\frac{1+k\sqrt{\frac{U}{a}}}{87}\right]^2 \times \frac{U}{a} \cdot l \cdot v^2,$$

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where f=friction loss in m.

$U = \frac{\text{Wetted surface of the tunnel in m}^2}{\text{length of the tunnel in metres}}$.

a=tunnel area in m².

l=the length of the tunnel in metres.

v=mean water velocity in m . /sec.

k=the coefficient of resistance.

For k Prof. Bazin gives 0·4 to 0·5 for tunnels lined with concrete and 1·75 for unlined tunnels excavated in rock.

The author has had the opportunity to check this formula on two large tunnels with unlined sections, and found that the value for k given by Prof. Bazin is very reliable. On working back from the actual measured loss in head the author found that with a water velocity of 2·05 m. per second k=1·7; with a velocity of 0·24 k=1·64, and with a velocity of 0·8 m. per second k=1·85.

From these three tests it seems that the coefficient varies within about the limits of 1·65 and 1·85, and that 1·75 may be looked upon as a very good average figure for technical calculations, based upon a water velocity between 1 m. and 2 m. per second.

The same method which is used for estimating the economical velocity in tunnels can be applied to pipe-lines, as in this case also a curve can be constructed which shows the minimum cost of the pipe at a minimum loss.

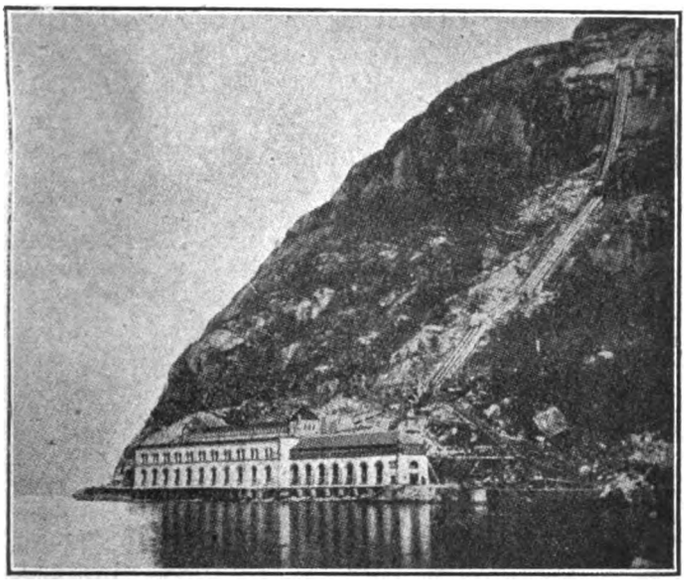

FIG. 8.—POWER STATION AT TYSSO.

The friction loss in a pipe with a diameter between 1 ft. and 5 ft. can be estimated from the following formula :—

$$f = \frac{\beta l}{d} \cdot \frac{v^2}{2g},$$

where l=the length of the pipe in metres.

d=the diameter of the pipe in metres.

v=water velocity in m./sec.

g=9·81 m./sec.²

β=0·016 for welded pipes.

β=0·02 for riveted pipes.

The results of tests carried out on a large pipe-line is shown in Table II. As the diameter of the pipe decreases in steps towards the power station, the mean velocity (v mean) as well as the maximum velocity (v max.) of the water in the pipe is given in the schedule.

Table II.—*Tests of Pipe-Lines.*

Water velocity in m./sec.		Loss in head through friction, in metres.	
v max.	v mean.	Measured.	Calculated.
1. Welded pipes :	l=709·34 m.		
6·82	3·74	6·09	5·98
5·31	2·92	2·97	3·64(?)
2·80	1·54	1·06	1·05
1·65	0·90	0·35	0·35
2. Riveted pipes :	l=220·5 m.		
3·30	2·97	1·24	1·32
2·76	2·47	0·81	0·91
1·45	1·30	0·36	0·25
0·83	0·75	0·09	0·08

Considering the great difficulties involved in carrying out tests on such a very large scale, it must be admitted that the difference between theoretical calculations and the actual tests is very small.

III.—COST OF HYDRO-ELECTRIC POWER STATIONS.

The total cost of hydro-electric power stations, including dams, canals, tunnels, pipes, power-houses, turbines and generators, varies considerably, and is to a large extent dependent upon the natural formation of the land surrounding the river, the variation in the volume of water passing through the river at different times, and, finally, upon the height of fall which can be utilised.

The total capital cost before the war varied between £5 and £50 per horse-power, measured at the bus-bars of the generator switchgear. A few years ago £50 per horse-power was looked upon as the maximum limit, and a scheme which showed a higher cost was considered as not fit for development. To-day, however, with the high prices for coal, which are not likely to be reduced to pre-war prices, it may be profitable to utilise even falls which can be developed only at a price considerably higher than £50 per horse-power.

In the following is given a short description of three plants which have been built during the last 10-15 years, and which,

FIG 9.—POWER PLANT AT TYSSO.

to the author's knowledge, are amongst the cheapest plants ever built. In the cost given is not included either compensation for the right to submerge land in order to obtain reservoirs, or any compensation for interference with water transport, fisheries, &c.

I. *Svalgfos Power Station*, Norway, belonging to the Norwegian Hydro-Electric Power Co.

1. *Hydrological Data.*

Catchment area, about	3,100 km.²
Specific volume of water	32 litres/sec./km.²
Average " "	100 m³/sec.
Regulated " " 75 per cent.	75 "

2. *Water Turbines* (twin-Francis turbines).

Net fall	46·5 m.
Number of units	4
Output per unit	10,500 B.H.P.
Total output	42,000 "

3. *Three-phase Turbo-Generators.*

Output per unit	15,000 k.v.a.
Power factor	0·67
Pressure	10,000 volts.
Revolutions per minute	250

Figs. 6 and 7 show a section through, and an interior view of the power-house.

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The scheme was started in the autumn of 1905 and completed in October 1907. The total amount of power is transmitted by means of overhead transmission lines, direct, without static transformers, to a large factory situated at a distance of about 3 miles from the power house.

The total cost of the plant was, in round figures, as shown in Table III.

COST OF PLANT.

1.	Preparatory work, survey, &c.	£5,625
2.	Temporary barracks for workmen and engineers, constructions of roads, &c.	9,615
3.	Main dams, canals, tunnels	87,785
4.	Foundations for turbines, generators, power house	13,325
5.	Power house (building only)	7,250
6.	Four water turbines each 10,500 B.H.P., and two exciter turbines with accessories	17,900
7.	Four generators each 15,000 k.v.a., and two exciter dynamos with complete switchgear	33,000
8.	Three miles overhead transmission, 10,000 volt, 40,000 H.P.	21,000
9.	By-pass (around the dams) for timber	4,400
10.	Sundry expenditure, experts' fees, &c.	7,400
	Total cost	£207,300

The total expenditure is, therefore, just below £5 per horse-power output of the plant, or £7 per kilowatt.

II. "*Tysso*," *Norway*.—This plant was originally in the possession of the Norwegian Hydro-Electric Power Co., who built the first section of the plant (1906-1908) for a total output of 28,700 k.v.a. The data from the first building period is as follows :—

1. *Hydrological Data.*

Catchment area, about	378 km.²
Specific volume of water, about	80 litres/sec./km.²
Average ,, ,, (total)	30 m.³/sec.
Regulated ,, ,, 70 per cent.	21 ,,
Size of reservoir	250 million m.³

2. *Water Turbos.* (Pelton wheels.)

Net fall	400 metres.
Number of units	7
Output per unit	4,620 B.H.P.
Total output	32,340 ,,

3. *Three-phase Turbo-Generators.*

Output per unit	4,100 k.v.a.
Pressure	12,000 volts.
Revolutions per minute	375

The total cost of this station was about £5. 10s. per e.h.p. delivered at the switchboard.

A few years after the power scheme was started it was sold to the well-known captain of industry, Mr. Ragnvald Blakstad, who is also well known in this country. Mr. Blakstad more than doubled the size of the station and increased the regulation to about 80 per cent. This extension was completed in 1914, and the total capacity of the old and new plants was :—

7 units each 4,100 k.v.a. = 28,700 k.v.a.
4 units each 12,000 ,, = 48,000 ,,

76,700

The 12,000/14,000 H.P. turbines are double wheel, double nozzle Pelton turbines, designed for 400 m. effective head and 250 revs. per min.

The direct connected three-phase alternators are wound for 12,000 volts pressure. Three of these machines, as well as the switchgear, were supplied by the British Westinghouse, Manchester.

The cost of the extension per horse-power did not differ very much from that of the plant first erected, although the extension was carried out when prices for material and labour were higher than at the time of the first building period.

Figs. 8 and 9 show the "Tysso" plant after completed extension in 1914.

III. *Trolhattan*, in the River Gota Alf, Sweden, belonging to the Swedish Government.

1. *Hydrological Data.*

Catchment area	5,570 km.²
Specific volume of water	63 litres/sec./km.²
Minimum ,, ,,	350 m.³ sec.
Main canal, &c., designed for	250 ,,
Regulated	71·5 per cent

Machinery installed during the first building period ended 1911 :—

2. *Water Turbos.* (Twin-wheel Francis turbines.)

Net fall	30·5 m.
Number of units	4
Output per unit	10,000 H.P.
Total output	40,000 ,,
Ultimate size of the power-house	80,000 ,,

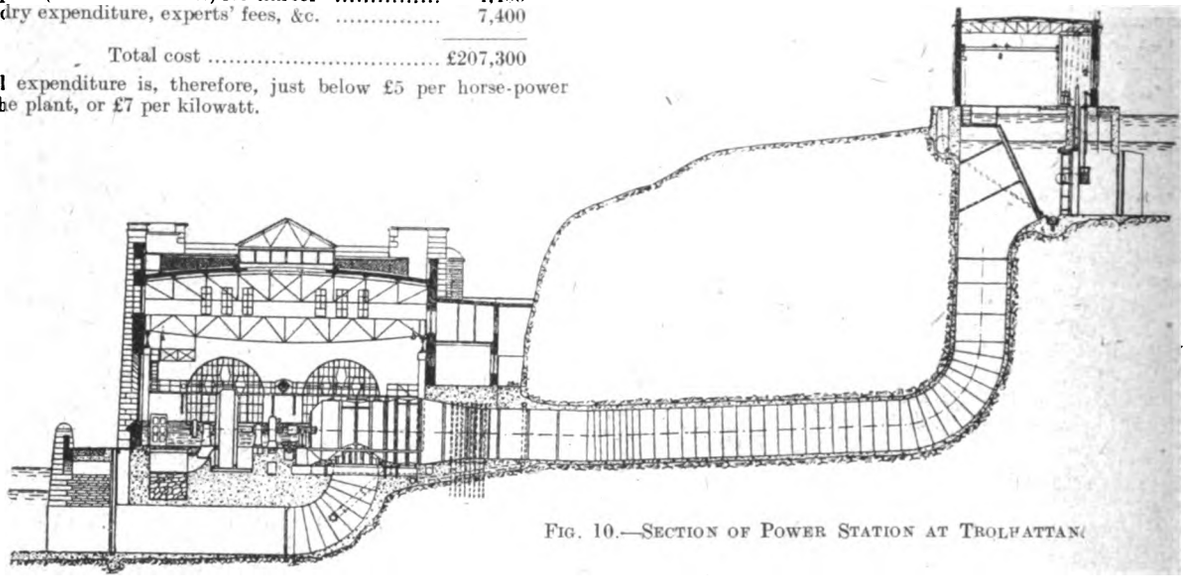

FIG. 10.—SECTION OF POWER STATION AT TROLHATTAN.

3. *Three-phase Turbo-Generators.*

Output per unit	11,000 k.v.a.
Pressure	10,000 volts
Revolutions per minute	187·5

Three independently driven exciters, each developing 350 kw. when running 410 revs. per min.

The station has been considerably extended since the completion of the first building period. On visiting this plant two years ago I was informed by one of the officials in charge that the total cost of the plant was below £5 per horse-power.

Figs. 10 and 11 show a cross-section through the turbo-generators and the intake, and an interior view of the power-house at Trolhattan.

It can easily be estimated that the power from these three stations can be sold at a price of 0·1d. per unit, providing the consumer is situated within a radius of a few miles from the power station, and that the power is used during 7,000 hours or more per year. Even this low price leaves quite a substantial profit on the capital invested.

The above-mentioned three schemes are interesting in so far as they doubtless represent some of the cheapest hydro-electric power plants in the world; but the list of cheap plants can easily be extended. The new large plant at Rjukan, Norway, developing totally some 240,000 H.P. and completed two years ago, does not cost more than between £5 and £6 per horse-power. The net fall is about 250 metres and the size of the units 16,500 k.v.a. at 10,000 volts and 250 revs. per min.

It is very doubtful whether we shall ever come back to these low prices again. A total cost of £10 to £15 per horse-power must to-day be looked upon as the limit, and even £20 to £30 per horse-power as very reasonable.

IV.

Within the borders of the British Empire there are doubtless waterfalls equal to a regular yearly supply of several million kilowatts. A detailed hydrological survey of the most important lakes and rivers is, therefore, of paramount importance to the country as a whole. This work, which must be carried out under the direction of the Government, should be organised

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and started as soon as possible, because it takes years before statistical material fit for practical use can be collected.

The subject has already received attention in the United States, Canada, Switzerland, Germany and Scandinavia, and the author believes also in Italy, France and Spain.

Also the engineering industry must prepare for the demand for hydro-electric machinery, particularly water-turbines.

The manufacture of water-turbines and accessories for hydro-electric power stations has, up to the present, been practically entirely in the hands of Switzerland, Norway,

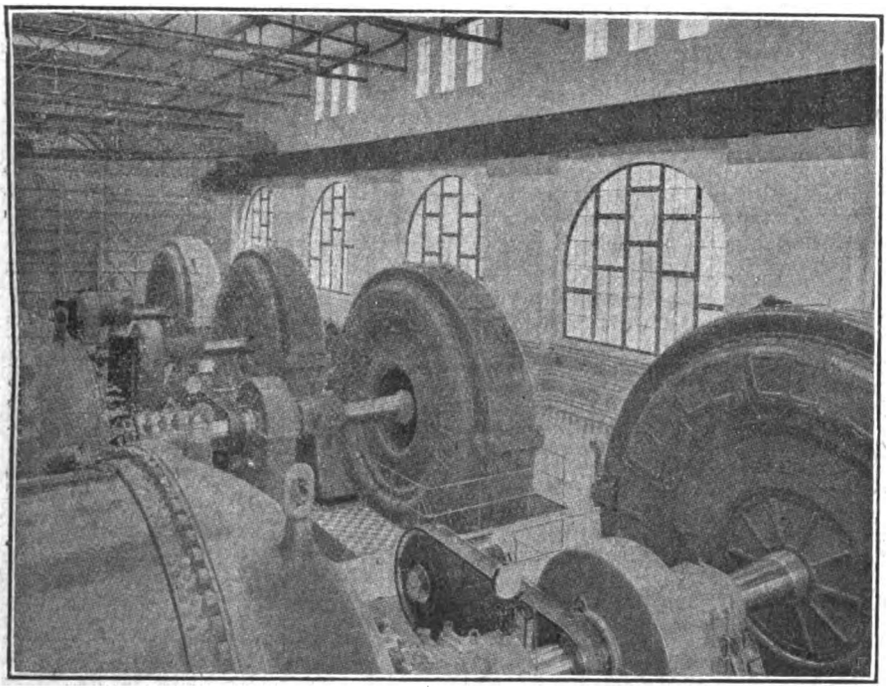

FIG. 11.—POWER PLANT AT TROLHATTAN.

Sweden, the United States and Germany. It is a remarkable fact that although there is a large and increasing demand for water-turbines in the British Colonies, the South American States, Italy, Spain, France, &c., there is to-day not a single engineering manufacturer in this country who can supply a medium size turbine with equipment. Also in this branch of the industry Great Britain ought not only to be independent, but also be able to supply this class of machinery overseas in competition with other nations.

The Teaching of Physics in Schools.

A conference on the above subject took place at the meeting of the Physical Society on Friday last. There were a number of contributions, some of which we give in abstract below

Sir OLIVER LODGE, in opening the discussion, remarked that when he was a boy there was no such thing as teaching of science in schools. He found some difficulty in reaching a conclusion as to the best system to adopt. There were many systems, and in all probability any system was good provided it was the result of knowledge and enthusiasm on the part of the teacher. It was necessary to discriminate between teaching for specialists and teaching science as a branch of general education. The latter was much more difficult. He thought it was desirable to take a wide scope without emphasising too much detail. There were two general methods; one was analytical, starting with such an object as the steam engine, and coming down to the principles upon which it depended. The other was the synthetic method, in which one started with principles and worked up. In the British Association report the analytical method was advocated rather than the synthetic. He thought it was better to go in for both, and to some extent this depended upon the age. With boys he thought it was necessary to start with principles, and to work up. For the purpose of education, biology was a much better subject than physics. In the case of physics, common objects (such, for example, as the top and the catenary) involved too much mathematics, and could not be simply explained, so they had to be avoided. Similarly, a simple explanation could not be given of such an ordinary phenomenon as the blue of the sky. In teaching, it was most important to make the subject attractive. He thought it was a good plan to give boys curves to plot depending upon certain properties, after which they might pass on to harmonic motion, &c. He felt that too much insistence was often made upon the carrying out of measurements. These were no good unless the pupil was interested in them.

In what follows we give a summary of some of the Papers contributed to the discussion.

EXPERIMENTAL DESCRIPTIVE PHYSICS.

Prof. R. A. GREGORY: The science teaching introduced into Rugby School about 60 years ago consisted of lectures and demonstrations. The late Prof. A. M. Worthington first showed that courses of practical work with simple appliances could be carried out successfully in school physical laboratories. The next stage was the syllabus of physics and chemistry put forward in 1895 by a committee of the Incorporated Association of Headmasters, in which measurement was insisted upon as the chief factor in scientific work and the basis of scientific reasoning, and it was desired to provide clear ideas of scientific method and reasoning rather than to cover a wide range of information. The adoption of the principles of this syllabus by the Oxford and Cambridge Local Examining authorities, and by other bodies has determined the character of school instruction in physics during the last 20 years. Precise laboratory work requires more time than didactic instruction. The actual ground covered must be less, though the mental training is better. Hence, secondary schools never pass the stage of determining specific and latent heats in their course of physics, and pupils leave school knowing nothing of the principles of such everyday instruments and appliances as field glasses, electric bells, telephones, periscopes, spectroscopes, dynamos, motors, incandescent and arc lamps, fuses, and many other applications of physical science met with in everyday life.

In recent years the teaching of physics has become almost entirely quantitative. Now it is important to provide training in scientific method, but it is even more important that every pupil should be given a sense of the wonder and value of scientific achievement. Much of the instruction in elementary practical measurements of length, area, volume, mass and density should be given by the mathematical staff, and not by the science staff.

Both Sir J. J. Thomson's Committee and the British Association Committee on Science Teaching in Secondary Schools urge the necessity of directing more attention to those aspects of science which bear directly on the objects and experience of everyday life. Every opportunity should be taken to counteract the present tendency towards remoteness from practice by descriptive lessons in which everyday phenomena are explained and the utility of discovery and invention is illustrated. The section of the British Association report dealing with principles and methods of science teaching states the main points to be borne in mind as follows: ". . . (1) to train the powers of accurate observation of natural facts and phenomena and of clear description of what is observed; (2) to impart a knowledge of the method of experimental inquiry which distinguishes modern science from the philosophy of earlier times, and by which advance is secured; (3) to provide a broad basis of fact as to man's environment and his relation to it; (4) to give an acquaintance with scientific words and ideas now common in progressive life and thought."

The most urgent need at the present time is to devise suitable courses in which these principles are followed. If the Physical Society can produce a practicable scheme of work suitable for all pupils up to about 16½ years of age, and secure the adoption of the scheme by the examining bodies which will award the First School Certificate, a valuable service will be rendered to teachers and to education.

PHYSICS IN STATE-AIDED SECONDARY SCHOOLS.

A. T. SIMMONS: In Secondary Schools the age of nearly all the pupils ranges between nine and 17 years. In general the study of experimental physics and chemistry is undertaken from 12 to 16 years of age, the average amount of time devoted to science being four hours a week. The time is usually equally divided between physics and chemistry; in some schools one subject only is studied during the last year.

The first year is commonly devoted to preliminary measurements, such as those of length, area, volume and mass, but this is now sometimes regarded as transferred to the mathematical course. The second and third years comprise easy experimental work in hydrostatics, statics, dynamics and heat, and a few experiments in light and electricity may be introduced. Pupils in the fourth year are commonly preparing for the external examinations requiring either (*a*) heat, light and sound; or (*b*) electricity and magnetism.

Most pupils leave school when this examination of matriculation standard has been passed, so that the average boy or girl passes out into

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the world completely ignorant of electrical science, and has no knowledge of its manifold applications.

School courses of physics assume that work done in school is preliminary to a fuller course which will be entered upon after school days are over: but only a small fraction of the pupils proceed to colleges of university rank and continue the study of science in this way.

The task before the Physical Society is therefore to decide what parts of physics every educated citizen should know, and what steps should be taken to make it easy for the secondary school pupil to acquire this knowledge at school. One improvement desirable is the substitution of a more general course of physics for the more detailed and quantitative study of a few constituent parts of physics, but this assumes that university authorities will accept such a general course for their matriculation examinations.

Full use should be made of the enthusiastic eagerness with which the young pupil first enters the physical laboratory. What is provided in physics in most schools to feed this young enthusiasm? Instead of handling simple apparatus and *doing interesting things* he finds himself working over again problems with which he has been concerned in the mathematics classroom. Exercises which require only paper and simple mathematical instruments should be transferred from the science course to the scheme of mathematics. The work of the physical laboratory should begin where the use of water and the balance are necessary. Care must be taken to provide the young beginner with variety and interest. Measurement may be easily overdone in these early stages, and it is desirable to introduce a succession of everyday topics like pumps, syphons, floating bodies, &c., the principles of which could be studied from working models.

The Training of Teachers of Physics.

Prof. T. PERCY NUNN: Physics is more than the sum total of known physical truths and physical methods. It is a historic way of intellectual life, a living and growing tradition of interest and inquiry, and our object in teaching physics should be to initiate the pupil into that way of life and that great tradition.

The first requirement in the training of the teacher is that he shall have learnt physics in this sense himself. The teacher should also have not only a technical but also a critical or reflective knowledge of his subject; he needs, therefore, to understand the true nature of the materials with which he is to work. Scepticism of the instruments of scientific progress is a vital part of the business of science. The teacher's preparation should include, therefore, a critical study of the history and nature of physics. The professional training will include an apprenticeship to the practical arts of exposition, class management and laboratory management and a liberal course in "methodology"—*i.e.*, a discussion of the distinctive aims of science teaching and of its place in education, the proper scope and character of the curriculum in differing circumstances, the principles that should determine the order and methods of treatment at different ages of the pupil, and a comparative study of the best methods of teaching the more important items in the physics course, is also important.

The training, according to the Board of Education, may be given either entirely in a secondary school or in a training college. Neither plan can be really satisfactory, and Sir J. J. Thomson's report advocates a middle course—*i.e.*, that the student shall spend one term in a training college or university training department, and two terms as a student-teacher in a secondary school. This compromise still fails to provide for effective correlation between the theoretical work of the training college and the practical work of the school, but it recognises the necessity of combining the two factors which the Board's schemes divorce. Training colleges only should be to the teaching profession what the Staff College is to the Army: centres where the experience of the profession finds its clearest and most conscious expression, laboratories of pedagogical research and clearing houses of educational ideas, foci of educational thought and enthusiasm.

The Teaching of Physics at Osborne and Dartmouth.

Mr. C. E. ASHFORD: At Osborne the education is framed to meet the fundamental requirements of the average naval officer, who, however, may specialise in varying degree. Cadets should develop into men of action rather than students, ready to learn for themselves by observation and experiment. They must be many sided, keen on everything, from machinery to strategy; they must possess or cultivate the power to make instant decisions, and an aptitude for improvising means to meet novel conditions; they must have their knowledge at call, and not merely know where it is to be found; they must face facts and abhor prejudices. Such an analysis suggests that experimental science should be an admirable discipline for them.

Cadets enter Osborne at 13 and normally end their general education on leaving Dartmouth about 17. After this they take a technical course of eight months in special cruisers, and then go to sea as officers. The course in physics begins with hydrostatics. Cadets also begin at once in the laboratories and engineering workshops.

The rapid alternation of theory and actual practice throughout the course is favourable to both.

During following terms the subjects taken are statics, heat, magnetism and direct-current electricity, kinetics and hydrostatics. The time devoted to them is roughly three or four hours a week in lectures, one hour for preparation and two in the laboratory. There is more applied than pure physics in those subjects that are dealt with. Practically every cadet who enters Osborne takes the passing out examination, and is put through the full course. The practical nature of this compound of pure and applied physics with engineering seems to appeal better to the average boyish intelligence than does pure physics alone. The abler cadets of each batch are given work that is more difficult and more generalised and abstract, as a foundation for the specialist courses which they will take later.

Many problems have presented themselves; one is the question of text-books. A text-book written for the prescribed course, however, gives no practice in extracting items of knowledge from the mass of irrelevant material; in this respect we must sacrifice speed of progress for ultimate gain.

The relation of mechanics to physics is another difficulty. At Osborne and Dartmouth cadets are concerned from the first in their engineering with mechanical ideas, and it is necessary to start serious work in statics as part of the science course earlier than would seem advisable on other grounds, and to introduce kinetics as soon as cadets are at all ready for it. The method of teaching must be adapted to their special needs.

Several methods of teaching the earlier stages of electricity have been tried; that which has proved most satisfactory is a term's work of a qualitative and unsystematic kind, dealing with the behaviour of such things as electric bells, dynamos, motors, induction coils, primary cells, resistance coils, &c. Then follows the electrolytic measurement of current; next the electrostatic voltmeter, using voltaic and not frictional electricity. With the ability to measure current and P.D., Ohm's law can be verified, and the conception of resistance deduced. It has been found that this process results in an absence of the confusion between current and P.D. which is common among beginners.

The Place of Physics in the General Education of Boys up to the Age of 16.

Mr. C. L. BRYANT, after some preliminary discussion of the functions of science in general education, presented abstracts from "Science for All," a scheme of work drawn up by the Association of Public School Science Masters, designed to require a minimum of six hours for two years. A summary is given of the ground covered in the scheme, which comprises subjects included under general science, mechanics and hydrostatics, heat, light, magnetism and electricity.

Trade Parliaments and Their Work.

By E. J. P. BENN.

IX. Statistics.

Scientific research as a subject which should be taken in hand by every trade is fairly well understood, and the day is past when it is necessary to indulge in any very elaborate arguments and to prove that our industries are in need of a closer acquaintance with science. Statistical research is every bit as important, but this branch of co-operative action is not so well understood. When Trade Parliaments are the rule and trades have got into the habit of working together and begun to see the advantages which arise from a close study of the interests of the whole as well as their individual interests, one of the most engrossing topics of discussion will be this matter of statistical research. Twenty-five years ago the average English business man regarded the chartered accountant as an up-to-date fad that might be useful to the company promoter or the Yankee, but that he was far too busy to bother with. The chartered accountant was, in fact, classed with the telephone and the typewriter as a matter below the serious attention of the manufacturer, who was busy with what he then regarded as the more serious side of trade and industry. We have lived to see that folly disappear and the day arrive when even the smallest tradesman is not content unless his annual accounts are promptly produced and properly certified. The advance in industry in the lifetime of the last two generations is in no small measure due to a greater appreciation of the value of accurate accountancy, but statistics go far beyond what is properly called accountancy. The modern business possesses not only a counting-house which is charged with the function of recording completed transactions in £ s. d., but it possesses also various statistical systems which have nothing to do with the counting-house proper. Stock records, costing systems, comparative figures, charts showing increases and decreases, every item of expenditure or revenue worked out in percentages, overhead charges reduced to a part of the cost of every article turned out, and so on. In fact, the present generation has advantages from an intimate knowledge of the exact workings of individual businesses which have been the principal cause of the increase of production and the decrease of price, which has been the tendency for years past. The next move in this important evolutionary process is to extend the knowledge thus acquired from individual businesses to whole trades. This step is a natural one and, indeed, has already been taken to some extent in some of our more progressive industries.

The bedstead trade was probably the first to understand the value of statistical research. The first bedstead combine was built upon a costing system which was the result of the combined wisdom of all its members. The immediate result of the introduction of that system was the rapid reduction in the cost of bedsteads. Most

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readers can well remember the old iron bed with solid sides and ends, and weighing some hundredweights. When the bedstead makers began to get out figures showing the amount of metal in each of their patterns their attention was turned to the waste of material in this respect, and the result was the utilisation of angle iron instead of solid bars, and much stronger beds, containing only a fraction of the metal, were immediately put upon the market.

Printing is another trade in which a co-operative costing system has been introduced. The Master Printers' Association now publishes most detailed schedules from which any printer can ascertain what are his true costs, or, at all events, what they should be Statistical research does not, however, stop at the costing system. Dr. Ripper, the Vice-Chancellor of the University of Sheffield, has published a diagram which shows in a very graphic manner the advantages of statistical research by whole trades. He presupposes an article which is made by two firms which involves four processes, and which is put upon the market at a sovereign. Under the old competitive system both firms were convinced that they were producing this article in the most economical way because both were able to market it at the same price, but inquiry shows that the first firm had a very economical way of performing the first and third processes and a very extravagant way of doing the second and fourth processes, while the second firm had discovered quick ways of accomplishing the second and fourth, and were entirely out of date in their methods with regard to the first and third. The result of the inquiry was that each firm adopted the best two methods of the other two, and the article, instead of costing a sovereign, was promptly marketed at 12s. 6d.

This was a very simple case in which two firms were involved and four processes; but, as with most articles of commerce, there are large numbers of firms and, perhaps, forty processes, the possibilities of economy by means of comparative statistics are very much larger than is generally realised. The National Pottery Council, the first of the Joint Standing Industrial Councils under the Whitley Report, has adopted among its objects the preparation of statistics as to costs, markets, materials, stocks, wages, and average profits, and it is hoped that each Trade Parliament will undertake similar duties.

In touching upon this subject it is very necessary to emphasise, for the satisfaction of the timid, that the introduction of any such system of statistical research would not in any way interfere with the liberties or the secrets of individuals. The suggestion is that a chartered accountant should be appointed as a sort of auditor-general to the trade, and that he should collect his information in much the same way that the income tax surveyor collects his figures to-day. The chartered accountant could, of course, be trusted to treat the figures with professional secrecy, and he would publish from month to month the averages which he was thus able to work out. The result would be that the trade would discover that the materials used in a given line averaged, say, 40 per cent. of the total cost. The manufacturer whose own figures showed 45 per cent. would know at once not only that he was 5 per cent. above the average, but as the average was the result of his own figures and others, that somebody was doing even better than 40 per cent. This would be the only stimulus required to make that manufacturer look into matters more closely, and general economy would be the result.

There is, as I have said, no end to the possibilities of trade statistics. Information as to stocks in different parts of the country would probably disclose the fact that certain districts were regularly overstocked with certain goods and explain the peculiar variations that occur in prices in different localities. When the auditor-general for a trade had exhausted the possibilities for statistical research at home he could begin to collect information with regard to the same trade abroad. Traders might in this way secure the inestimable advantages that have accrued to the pottery trade in America as a result of the detailed comparison that has been made between the figures of that industry in England, Germany, and the States.

Statistical research must be looked to to provide the bulk of the economies out of which the increased wages, for which labour is rightly asking, must come. The war has done a great deal to teach us the value of statistics in business. Wherever Government controls have been established the most elaborate methods of statistics and comparison have been introduced, and traders have become accustomed to supply information at the bidding of Government Departments—information which has often been secured for totally different reasons from those which will apply in the future. But the habit having been formed, and some of its advantages having been noted, it is now up to the trades themselves to arrange the preparation of proper statistics for their own benefit The effect of statistical research upon what is known as the Labour Question must be most beneficial. It will, in many trades, entirely dispose of all the rubbish that is talked about excessive profits. Syndicalistic agitators have a way of selecting some firm that is more than usually successful, and perhaps paying a high rate of interest upon its capital, and holding up this firm as an example of the average profits of employers. Employers generally know how unfair this practice is and how systematically it is adopted. There are very few trades which, on the average, produce more than an adequate return upon the capital invested in them, and the agitator of the future, when proper statistics are prepared, will have to change the basis of his argument because figures to answer his principal charges will be available. If the trade union demand that the rate of wages shall be such that the average worker shall earn a decent living is a just one, then it is equally just to ask that the rate of profit shall be measured, not by the brilliant exception, but by the average employer.

(To be continued.)

Capital and Labour and the Government.

The following manifesto has been issued by the Industrial Reconstruction Council:—

Co-operation between Capital and Labour is undoubtedly the most urgent industrial question of the day, and many agencies are at work with a view to the establishment of better relations between these tw great forces of industry.

An exceptional opportunity now occurs to take a practical step in this direction.

For the duration of the war the Government is directly interested in every branch of trade and industry, and each department of State is in constant touch with manufacturers, trade committees and associations of all kinds.

The practice of different departments varies considerably. Some set up *ad hoc* committees for their own purposes, others consult leading experts, others again have appointed joint committees of employers and employed.

In our opinion these innumerable connections between the Government and the trades give an opening which may never occur again to establish the principle of co-operation between Labour and Capital upon a sure and sound foundation.

Our suggestion is that the Government should adopt the uniform practice in all industrial and commercial matters of consulting only joint bodies representative of both employers and workpeople's organisations.

In this very simple way the Government has the power to bring about an active co-operation between Labour and Capital such as many interested parties have desired for sometime past.

In our view no industrial or commercial question ought to interest the Government unless it also interests both Capital and Labour. The union between Capital and Labour in the discussion of any matter which arose would materially strengthen the position of a trade against unnecessary restrictions, and, on the other hand, any orders made by the Government on the joint advice of both parties would be more likely to find general acceptance

Illustrations might be multiplied indefinitely. There must be many hundreds of trade committees in negotiation with different Government departments at the moment, and each case represents an ideal opportunity for practical co-operation between employers and employed. The effect of such a union on these committees should be to spread a different spirit throughout the industrial world.

The opposition to our proposal will probably come chiefly from employers who have not grasped the full significance of the new spirit in industry. As a matter of fact, employers no less than employed have a great deal to gain from such an arrangement. Their position in relation to the Government would be immensely strengthened by the co-operation of Labour in matters which many of them have hitherto regarded as outside the scope of joint action.

The opportunity for the course which we suggest will pass with the war, as the relations between the Government and trade are then expected to become less intimate. We therefore press for the immediate acceptance of the following principle:—

> That any commercial or, industrial matter ought not to interest the Government unlesss it interests both Labour and Capital;

and the consequent adoption of the following policy:—

> That the Government will undertake to obtain and, wherever possible, accept advice on these matters from bodies equally representative of both Labour and Capital.

WILFRED STOKES, *President.*	T. B. JOHNSTON.
ERNEST J. P. BENN, *Chairman.*	A. W. KIRKALDY.
W. RIPPER, *Treasurer.*	C. L'ESTRANGE MALONE.
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The Electrical Trades After the War.

A number of Departmental Committees were appointed by the Board of Trade in 1916 to consider the position of various trades after the war and to report on what steps should be taken to safeguard them. The reports of four of these Committees have just been issued and deal with the textile industries, iron and steel, engineering and the electrical trades. The remarks which follow refer to the last named, with which we are most concerned. An abstract of the Report will be found on another page.

Early in the Report it is stated that the electrical industry is a "key industry," being of great importance to this country. This view is now one that is accepted; it depends very largely upon the electricity supply section of the industry, as it is in this way that other industries become greatly dependent upon electrical energy. Thus the generation of electricity and its transmission in the United Kingdom receive first attention on the present occasion. To this part of the Report we need not refer in detail as it reflects very largely the views of the Board of Trade Electric Power Supply Committee, which were published two or three weeks ago. Section II. deals with electric traction, and the view is expressed that legislation should be introduced to remove certain existing evils, such as recurring periods of purchase, the settlement of rating questions, running powers, &c., and that unless such legislation is introduced the growth of tramways and light railways in this country will continue to be impeded. Something should certainly be done in this direction, though whether we may expect much further expansion in tramways and light railways, at least in the former, may, perhaps, be doubted. In regard to railways the position is very different. Here it is to be hoped that some eye to uniformity will be had in dealing with the electrification of our railways, for there is little doubt that electrification will come. On the other hand, it is dangerous to interfere too much in the early stages of development.

It is when we come to Section III., which deals with manufacturing, that we reach important matters illustrating British policy as compared with the policy of our competitors. We soon discover the unpleasant fact that of the aggregate initial capital of just over £15,000,000 invested by 32 firms in manufacturing electrical apparatus, no less than £3,125,000 has been written off. Another important statement is that the approximate annual value of home-made electrical machinery used in Germany before the war per 100 people was about £70, which should be contrasted with a consumption in this country of only £33. This leads to the view that foreign manufacturers appreciate the importance of conserving their home markets as a basis for the development of overseas trade, whereas we do not. It has been made clear to the Committee—a fact which was already pretty evident—that whereas Germany depended upon combination and has been very successful on this account, Great Britain has always discouraged combination, fearing a rise in prices to the detriment of the consumer. The Committee is convinced that this is but an idle fear. In addition to the desirability of combination the Committee has adopted the view that adequate fiscal protection is necessary, at least for a period.

We have often read of the better terms alleged to be given by our railway companies to the foreign importer and, therefore, it is of interest to read something of this aspect of the question which may be taken as authoritative. It appears that railway companies give the same rates to anyone and that these rates depend upon the amount of goods handled. If a firm can fully load up a number of trucks the rate is considerably lower than if odd lots are sent which have to be forwarded along with miscellaneous consignments of other kinds. This point of view has evidently been appreciated in Germany, and apparently also in other parts of Europe, with the result that goods usually pass through the hands of forwarding and collecting agents. These agents combine individual parcels so as to form 10-ton lots. By this means, and by bargaining with railways on the one hand and waterways on the other, the lowest terms are obtained. In conveying goods, for example, from Hull to Liverpool, the British railway company does not give the foreign agent any better terms than to the British, but since the goods come in a more convenient form the rates are lower, and in effect it becomes a preferential rate for the foreigner. Actually, however, this merely means that in Great Britain we do not take the trouble to adopt the methods which have been found to be profitable on the Continent. When it comes to shipping, however, it seems that there are advantages in favour of the foreigner, due chiefly to the fact that, in Germany, agreements to maintain rates of freight are not kept so scrupulously as they are by British lines. Thus it may be cheaper to ship to Hamburg and there tranship than to ship direct to a South African port.

One of the most important parts of the Report is that dealing with the interdependence between manufacturing and finance. It is pointed out that electrical industries are very dependent upon finance, and yet there has never been created any organised co-operation between British finance and British manufacture. As is well known it is often difficult to get a scheme financed in this country. Even when British financial support is obtained it does not follow that the British manufacturer will benefit. Our curious policy is set forth in the following sentence :—

> The British financier has not only lost any sense of obligation to apply British capital for the benefit of British industry, but has allowed his activities, whether as a capitalist or a company promoter, to be constantly exploited in the interests of German industry.

Against this we may contrast the method followed in Germany, which is outlined as follows :—

> In Germany the conditions are totally different. There, a thoroughly organised alliance, offensive and defensive, has been elaborated between manufacture and finance. Banks and manufacturing concerns have common directors, and on the boards of both there sit technical and commercial experts. The banks link themselves together to provide facilities for industrial expansion, and co-operate with each other and with the great manufacturers in forming subsidiary banks and financial institutions for special purposes. The German financiers do not, at the start, attempt to place an enterprise on the market as is the practice in England. Guided always by expert advice, they seldom touch a project in itself unsound. They find the money themselves or through their allied groups and, not afraid of the lock up, wait till success is shown before they unload on the public.

Comment is scarcely necessary, and the plain individual who is not connected with such matters will conclude that if we follow methods of this kind we deserve all we get.

We think the Report is of value as putting into cold print, in authoritative fashion, many things which have hitherto been hearsay, but have not been thoroughly confirmed. The position that is disclosed is far from satisfactory. To a large extent it is due to our national characteristic of individuality, on which we pride ourselves,

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but in this case individuality means that every man plays for his own hand. For the time being the result to any single individual may seem satisfactory enough when he secures something particularly cheaply to the disavdantage of his fellow countrymen. Every school boy knows that there is such a thing as playing a combined game, and that the boy who plays for his own hand is looked upon as undesirable. In the welfare of the nation as a whole, this becomes equally true in commercial dealings. To some extent this individualistic policy has been fostered by our principles of Free Trade, which have taught every buyer to purchase imported articles if cheap and not to trouble about the home producer. This has its advantages, but the disadvantages become obvious in due time. They have become evident enough in the case of the electrical industry. If we cannot, as individuals, support the efforts of our fellow countrymen, then it is probably time that we had something in the nature of a paternal Government to see that the industrial strength of the country is not sacrificed to wrong ideals, but is maintained at a proper level.

The Electrical Industry After the War.

The Board of Trade Committee appointed to consider the position of the electrical trades after the war has issued its report.

In a letter to the President of the Board (Sir Albert H. Stanley, M.P.) the committee states that it has heard evidence from the Institution of Electrical Engineers, the Incorporated Municipal Electrical Association, the Association of Electric Power Companies, the British Electrical and Allied Manufacturers, the Cable Makers and the Tramways and Light Railways Associations, from eminent consulting engineers, from electrical manufacturers, directors and engineers of important public supply undertakings, &c.

The committee is of opinion that it is impossible to give proper consideration to the future of the electrical trades without studying the position of the electrical industry as a whole. The national importance of this industry has never been realised either by Government or by the general public, and as a consequence both the industry and the country have suffered from legislative errors. Through the efforts of Faraday, Wheatstone, Kelvin, Swan, Hopkinson and many others, Great Britain was, and should have continued, first in electrical enterprise. The nation's pre-eminence in all branches of engineering provided a foundation upon which the new and closely allied electrical industry might have been naturally and quickly built up. In order, however, to bring electrical energy into practical use it was necessary to employ cables, the installation of which involved interference with streets, roads and private lands. Manufacturers of electrical plant have been held back while Parliament and local authorities debated how the distribution and use of electricity might be prevented from infringing conventional conceptions of public privileges and vested interests. Hence the progress of the industry has throughout been hampered by political considerations. The early history of motor traction on highways is an analagous instance of legislation which proved disastrous. The scientific replanning of our distribuiton of energy would effect a saving of no less than 50 million tons of coal per annum. This replanning would also reduce the cost of power for manufacturing, for the lighting of streets and houses, for the propulsion of railway, tramway and road vehicles, &c. The value to this country of the electrical manufacturing trade has not been sufficiently realised. The volume of this trade already amounts to 22½ millions sterling a year. Considerable as these figures are, they represent only a fraction of the trade which can be obtained if the blunders of the past be rectified. A world trade exists, and Great Britain must have her proper share. It is not too much to say that the war has demonstrated the safety of the Empire to be dependent on the employment of electricity. The emergency has proved the electrical industry to be a "*key industry.*"

Section I. of the report on electricity generation and transmission in the United Kingdom deals with the vital importance of cheap power to industry, and lays stress upon the existing obstacles to the development of electricity supply, &c. This portion is somewhat similar to the recent report of the Board of Trade Electric Power Supply Committee (abstracted in THE ELECTRICIAN of the 7th inst.), and need not be repeated here.

In section II., relating to electric traction in the United Kingdom, it is pointed out that the output of electrical energy for traction purposes is already nearly 1,000,000,000 units per annum. Much evidence was given to show that the Tramways Act, 1870, having been framed in the days of animal traction, is long since out of date; that the procedure under the Light Railways Acts, instead of being cheap and expeditious as intended, has proved to be the reverse, and that improved legislation is required. The committee concurs with the evidence that unless there be a complete revision of the present powers, the development and growth of tramways and light railways will continue to be impeded, with a consequent reduction in the demand for manufactured products. The electrification of railways demands consideration from a national point of view. Such an important development as the electrification of railways, which will certainly take place in the near future, should be carried out in accordance with some settled general principle, so that all main or local lines may be properly co-ordinated, and the power-stations placed in positions which will have regard to both military and civil needs.

SECTION III.—MANUFACTURING.

The manufacturing of electrical machinery and apparatus in Great Britain has been, with few exceptions, far from prosperous. Most of the companies have sustained serious losses, necessitating the writing down of capital. Tables have been put in evidence showing that 32 electrical firms, with an aggregate initial paid-up capital of just over £15,000,000, have been obliged to write off no less than £3,125,000. The tables further show that few of such companies have ever earned a satisfactory return on their capital. The notable exception has been cable making, which has been consistently successful in maintaining its lead, both in the quality of its manufactures and in financial results. On the other hand, the German electrical manufacturing industry has been very prosperous. The approximate annual values before the war of the total products of electrical plant, mains and appliances in Great Britain and Germany respectively are as follows:—

	Great Britain.		Germany.
Total electrical products.....	£22,500,000	...	£60,000,000
Exports	7,500,000	...	15,000,000
Imports	2,933,000	...	631,000
Consumption of *home-made* machinery	15,000,000	...	45,000,000

The approximate annual value of home-made electrical machinery used in Germany before the war per 100 people was about £70, which contrasted with a consumption in this country of only £33. Of the £22,500,000 manufactures in this country, a large proportion has been produced by concerns under foreign control, and in the case of British exports a proportion is known to consist of foreign manufactures re-shipped as British goods. Apart from legislative obstacles, there was another important factor, namely, that in the initial stages foreign countries possessed a pioneering advantage in the fact that their general industrial progress had not then reached so high a degree of development as had Great Britain in the application of steam engineering. On the Continent the introduction of the use of electricity coincided with the advance in manufacturing industries, and there was every inducement to employ the new agent, especially as it did not involve the scrapping of power plant still in good condition. Many of the greatest electrical inventions originated in Great Britain, and there is little doubt that, as in the case of steam, our lead would have been maintained had the prevailing conditions been equally favourable. Another factor retarding electrical progress in Great Britain has been the strength of the gas interests and the influence they exerted to stifle competition. Again, foreign Governments, appreciating the importance of conserving their home markets as a basis for the development of overseas trade, imposed protective duties, and exerted influence on State Departments to purchase native goods. The German Government has always been ready to help its manufacturers to extend their trade abroad. The policy of German manufacturers has been studiously directed not only to secure orders in this country under the open competition permitted by our fiscal system, but also to the effective destruction of British industry.

The importance of a close connection between finance and manufacture cannot be over-estimated. German financiers have always identified themselves with German industries, and it has been their custom, when providing money for a concession or contract, to enforce the use of German-made machinery. This applied not only to the original contract, but to subsequent replacements and extensions. Some British companies operating in South America have, owing to the influence of German finance, entirely ceased to purchase British goods. There is conclusive evidence of the existence of German control over companies ostensibly British, and that German control has also often been exercised, to the detriment of British interests, indirectly through companies incorporated in America, Switzerland and other neutral countries. For several years past there has been in Germany a consistent policy of amalgamation and association, and several establishments of world-wide importance have thus been built up. Only two or three German companies are seriously engaged in the electrical business overseas, and the competition which British manufacturers have to face is almost entirely with these houses. But these competitors, though few, have immense resources, with highly-trained staffs and competent workmen, their factories are well equipped, they have established branches all over the world, and maintain elaborate research laboratories.

In contrast with this policy of association, which has proved so successful both in Germany and in America, Great Britain has always discouraged combination, fearing a rise of prices to the detriment of the consumer. The committee is convinced that under properly organised combination or association the cost of production will be materially reduced, and that there is no reason to fear that enhanced prices will be charged to the

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consumer as a result of such combination. If electrical factories, which are unquestionably necessary on national considerations, are to be maintained in a state of efficiency, steps must be taken at the earliest possible moment to deal with the problem. This can be done either by amalgamation among the companies engaged in the industry or by the development of the practice of association for common purposes. An important advantage resulting from such combination would be the extension of standardisation. It is to be hoped that the Government will do its utmost in future to accept recognised standard plant.

While it is hoped that in the case of heavy plant, British standards may be acceptable abroad, makers must be prepared to adjust themselves to the needs of the country concerned. It cannot be expected that our export trade will compete successfully in the future unless the language, prices and measures current in each country are employed in the catalogue and descriptive matter issued.

Great emphasis has been laid on the unfavourable conditions of railway and steamship transport in this country as compared with those in Germany. It is the practice of the German Railway Administration to foster the full loading of all trucks forming its trains, special reduced rates being granted for lots of 10 tons and upwards. Further, concessions in rates are granted by the Railway Administration in Germany on all goods destined for export. British railways claim to give equal rates to all who bring equal traffic, and they are ready to arrange special rates with anyone having large quantities of goods for conveyance between specified stations. In regard to maritime transport, the case is even more unfavourable to the British manufacturer. The committee is of opinion that no railway rates on imported goods should be less per mile than the standard rate charged for similar British goods, and recommends that it be made impossible for any steamship, whether British or foreign, which makes use of British ports, to charge lower rates to foreigners than are made to British shippers for equal distances. The inadequate facilities for handling cargo at many of our ports should be remedied.

A better understanding between employers and employed is essential if the country is to take advantage of the business which will undoubtedly be forthcoming after the war. There must in the future be more harmony and sympathy between employers and employed, a general improvement in working conditions of the factories, and better housing.

Interdependence Between Manufacture and Finance.

The report states that while every industry requires for its development the outlay of new capital, that of electrical manufacturing is perhaps more dependent than any other on the help of a powerful financial system. So far as British joint stock banks are concerned, their liabilities to the public forbid their lending, except with a safe margin on security readily realisable. In default of assistance from the banks help must be sought from other great financial institutions whose immense aggregate wealth could, by organised co-operation, easily enable them to handle propositions too large for any of them individually, but such organisation has been wanting. The British manufacturer suffers from another disability. The British financier has not only lost any sense of obligation to apply British capital for the benefit of British industry, but has allowed his activities, whether as a capitalist or a company promoter, to be constantly exploited in the interests of German industry. In Germany the conditions are totally different. There, banks and manufacturing concerns have common directors, and on the boards of both there sit technical and commercial experts. The banks link themselves together to provide facilities for industrial expansion, and co-operate with each other and with the great manufacturers in forming subsidiary banks and financial institutions for special purposes. By these means, and by agreements with foreign concerns, the German manufacturers have secured a commanding influence in the electrical business in the neighbouring countries, notably in Russia, Italy, Belgium and Switzerland, and if measures are not taken in time this penetration will certainly continue to progress everywhere after the war. The attention of the committee has been drawn to the balance sheets for the year 1915 of the Allgemeine Electricitäts Gesellschaft, the Siemens-Schückert and the Bergmann Companies, which show cash balances of 6¼, 2½ and 1¼ millions sterling, respectively. This accumulation of funds is recognised as ready and available for peace products. The committee is strongly of opinion that the establishment of industrial banks is essential not only for the purposes mentioned in the interim report but to provide capital both for the re-organisation and expansion of the engineering industry.

Imperial Control of Sources of Electrical Energy.

The committee is impressed with the necessity for legislation, enacting that a company registered in Great Britain or its Dominions should, unless otherwise clearly expressed, be really British, and that no control, direct or indirect, should be exercised otherwise than by British subjects. It is suggested that in particular India and the self-governing Dominions should take stock of their facilities for generating electricity, whether from water-power, coal, oil or other sources of energy. The Canadian Government has already taken an active part in broad questions of this kind, more especially in connection with the water-power available from the St. Lawrence River. The committee urges that electrical supply ought to be considered as a matter of Imperial importance upon which other manufacturing trades, all forms of railway traction, munition works, &c., will largely depend, and that the Empire's available resources for this purpose should not be allowed to pass into alien hands or under alien control. The same considerations apply to the conservation of natural products and raw materials essential to our electrical manufacturing industries.

Summary of Recommendations.

The committee makes the following recommendations :—

A thorough reform of the legislation and conditions under which the generation and distribution of electricity are promoted and administered in this country which will involve modifications in the relevant Acts and Regulations : and a like reform of the legislation and conditions affecting tramways and light railways.

The prohibition of import enemy goods for three years after the conclusion of peace, subject to importation under licence in special circumstances after the expiration of the first 12 months.

The imposition of import duties sufficiently high to protect effectively the electrical industry.

The prevention of the sale in the United Kingdom of any imported electrical goods at prices lower than those current in the country of origin.

The recognition of the advantage of combination among manufacturers and official co-operation with such action.

The prevention of any concern engaged in the electrical or allied manufacturing industries, if controlled directly or indirectly by enemy capital, from continuing to trade within the Empire, unless it be specially authorised and its constitution made public, and the passing of legislation requiring that not more than 25 per cent. of the capital in any other electrical or allied undertaking shall be held either directly or indirectly by enemy subscribers or their agents.

The treatment as enemy products of all goods produced in foreign countries by concerns controlled by enemy capital or under enemy direction.

The exclusive acceptance of British tenders by State departments, public bodies and companies supplying electrical energy under statutory powers.

The adoption by Government departments and public authorities, so far as is practicable, of standard types and patterns of plant and apparatus.

The prohibition of transport discriminations operating to the detriment of British manufacturers, and the provision of improved transport and cargo handling facilities.

The promotion of a better understanding between employers and employed and the provision of better housing and working conditions.

The provision of extended banking facilities, preferably by the establishment of industrial banks.

The recognition of the permanent and ever-increasing importance to the Empire of the natural sources of power for the generation of electricity in the British Dominions, and the introduction of safeguards by legislation or otherwise to prevent these national assets from passing into alien hands or under alien control.

Certain further recommendations will be made in a supplementary report dealing inter alia with education, research, the decimal system and the Consular Service.

Engineering and Iron and Steel Trades.

Three other Departmental Committees, viz., the engineering, iron and steel and textile industries, have also issued their reports.

The committee on engineering recommends that the importation of enemy engineering products be prohibited except under licence for a minimum period of one year. To encourage trade between the Allies, that they be invited to consider the imposition of an additional duty over and above their normal duties to be levied solely against the products of the present enemy countries, such surtax to be subject to progressive diminution, and that this country do likewise. Raw materials to be admitted to this country duty free.

A Government department should exercise vigilance over the adequate provision of manufactures essential to the national safety, such as tungsten and magnetos, and the development of the supply of raw materials within the Empire for such essential industries should be supervised, encouraged and assisted by the Government, and steps to protect them taken whether by prohibition, tariff, protection or subsidy.

"Dumping" of goods should be prohibited by legislation. Government control of industries should be lifted as soon as possible after the war. Engineering manufacturers should be encouraged to work together in larger units.

Manufacturers must agree not to reduce prices for normal pre-war work or to cut piece rates by agreement or on the introduction of new processes or methods, and Labour must agree to withdraw all restriction of output and the old definition of skilled work in the light of present experience. Where it can be shown that female labour can be suitably employed no trade union regulations should hamper its employment. The revival of an apprentice system on a large scale should be encouraged on the basis of abolition of premium. A new Department of the Board of Trade should be formed exclusively for commerce and industry.

The patent and trade mark laws throughout the Empire should be harmonised.

All goods of foreign origin should be marked "Not British."

"Summer Time" should be permanently enacted.

An adequate supply of tungsten and wolfram should be obtained from within the Empire.

The Departmental Committee on the Iron and Steel Trades recommend that an organisation—co-operative in character—be formed among British manufacturers for obtaining adequate supplies of suitable ore, and an investigation should be undertaken by competent engineers of the hitherto unexploited deposits of iron ore in the United Kingdom, and

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a national selling organisation should be formed for marketing British iron and steel products in an efficient and economical manner. That British iron and steel manufacturers should be urged to form combinations for laying down large and well-designed new units for cheap production upon modern lines.

All imports of manufactured or semi-manufactured products of iron and steel from present enemy countries should be prohibited during the period of reconstruction; all ores and minerals necessary for the manufacture of iron and steel should be admitted free, and all other materials necessary for the manufacture of iron and steel to be admitted only in their natural or unworked state, and that no raw materials be sent to present enemy countries from British Dominions or Colonies, or from mineral or other resources under British control. Where national interests demand the relaxation of these regulations it is proposed that licences be granted.

Correspondence.

GERMANY'S INDUSTRIAL SYNDICATES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Whilst the question of industrial combination is occupying the minds of business men so much at the present time, it may be interesting to know that concentration of industries is going ahead at a very rapid pace in Germany. As a nation they evidently realise the urgency of such a course being taken, in order to enable their trade and industry to come out triumphant in the commercial struggle which will ensue directly hostilities cease.

The following trades and industries in Germany have combined—most of them during the last 18 months—and it must be admitted they represent some of the most important branches of human effort:—

The boot industry—March 17, 1917.

The boot trade soon followed suit on July 26 of the same year.

The soap industry came under the management of a huge national syndication on June 9, 1917, which has for its object the control of all classes of fatty acid washing materials; surely a far-reaching and powerful combination. Its capital is 40,000,000 marks.

The great German chemical industries have also syndicated, whilst another group of industries which represent dyeing and explosives have joined forces.

A bar iron syndicate and a pig iron union have been formed, and the existing steel works union are about to renew their agreements (which are just now expiring) for a further term of years.

Negotiations are at the moment pending to syndicate the rope, leather, enamelware, rolled wire and small iron goods industries, whilst other large combines recently formed or in process of formation are the tool and agricultural machinery (formed June 22, 1917), graphite (Aug. 4, 1917), brick industry (in process), gas and heating tube (in process) and toy industry (formed); and among other big fusions might be mentioned the mining, motor and machinery industries and a number of wholesale trades also, as well as the shipping trade.

Does not all the foregoing, therefore, point to the sinister proposition British manufacturers will be up against, as we over here would be quite unable to compete against these undertakings unless similar tactics are employed by us.

The individual British manufacturer with his relatively small purchasing power would be beaten on the first rung of the ladder, as he could not hope to raise his weak voice sufficiently to be heard when buying his raw material, whilst facing the huge amalgamations he would meet in the world's markets. Even, however, should he be fortunate enough to overcome the competition in the first instance, he would be subsequently beaten in the marketing of his finished products, as the German combines with their specialised production could undersell him every time.

To my mind the Board of Trade are doing valuable work in emphasising the necessities of combination to manufacturers all over the country, and it is to be hoped that British industry will show that it is capable of organising itself equally, if not better than our national competitors are doing.—I am, &c.,

Birmingham, June 12. HOWARD F. SMITH.

THE I.E.E. AND THE PROPOSED A.B.E.E.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We, the undersigned, corporate members of the Institution, protest at the action of the Council in spending Institution funds in financing the proposed A.B.E.E., as admitted in the secretary's letter of the 12th instant to Mr. Atkinson. It appears to us that this use of the Institution funds by the Council is *ultra vires* in view of paragraph 4 of the Memorandum of Association and of Article 56 of the Articles of Association.

The amount of the expenditure is probably not large so far, but the matter is one of principle. We believe the Council acted without realising their action was an infringement of the rules of the Institution, as we contend, and we think the secretary has been remiss in not keeping them better informed. We consider the Council should forthwith repudiate all liability in connection with the proposed A.B.E.E., and leave its promoters to foot the bill themselves, or else get their prospective members to do it.

The Whitley Report was issued in March, 1917, and the E.P.E.A. (of which we are also members) was established in the early autumn of the same year, with objects which the proposed Association of British Electrical Engineers appear to have made a very good copy of, even to registration as a trade union, which the Council of the I.E.E. at first refused to agree to (*see* technical press, April 5th, 1918).

The membership of the E.P.E.A. is considerable (over 1,000 and daily increasing), and includes already a considerable number of chief engineers and other senior executive officials in the power supply side of the industry.

The E.P.E.A. has had to pay its own preliminary expenses, but when certain London members in touch with the Council of the I.E.E. propose to form a rival Association to the already established E.P.E.A. the Council agree to pay the preliminary expenses of the proposed Association, including the hiring of halls for mass meetings and the travelling expenses of the promoters out of Institution funds.

In our opinion this shows a lamentable lack of impartiality on the part of the Council, and, what is more serious, that they are out of touch with the feeling amongst the majority of the younger members of the Institution.

We are told the Council wish to see one Association only representing the electricity supply engineers, and we concur in this wish. But why, then, do the Council foster the formation of another when there are already in existence two Associations—viz., the C.T.A.A., claiming to represent the senior members only amongst electricity supply engineers (and, therefore, a minority of the whole), and the E.P.E.A., who include in their membership all grades of qualified electricity supply engineers from top to bottom?

We suggest the Council's action has been hurried and ill-advised.

To suggest a conference composed of delegates from mass meetings (some of which have been held in centres where no definite steps towards organisation have yet been taken, and, therefore, where there is presumably no considered opinion) is surely putting the cart before the horse.

If the Council are desirous of harmony in this matter, it appears to us that, instead of holding mass meetings, the President might ask the existing Associations—viz., the E.P.E.A. and the C.T.A.A.—to meet him in conference, such conference to be on the basis of proportional representation of their respective memberships, say one representative for every 100 certified members.

The proposed Association of British Electrical Engineers (Supply Section) would not, of course, be entitled to representatives at this conference, as it does not exist except in a provisional sense. By means of this conference we think the Council would then be taking a course which would appeal to all fair-minded men as evidence of a genuine desire to obtain the considered opinion of those who have had the vision to take the initial step in the formation and organisation of the existing Associations.

Failing this, we think they would do better to let the various Associations, including those representing the interests of the manufacturing engineers, work out their own destiny in their own way, and, probably, of their own accord affiliate, and then possibly claim recognition from the I.E.E., seeing that a considerable proportion of the membership of the I.E.E. will undoubtedly be included in the affiliated Associations.

The work the I.E.E. has done in the past in its prescribed sphere of action we believe all reasonable men will agree, has

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been good (though opinions may differ as to whether it might not have been better and more energetic), and has made the Institution respected the world over, in spite of the tendency during recent years of some consulting engineers to use its meetings as advertising media in a most brazen fashion. It is a pity, therefore, that this respect should be endangered by actions which, in the opinion of many people, are hasty, ill-considered and by no means impartial, and which, if persisted in, will, we feel sure, weaken the Institution's influence for good in the electrical industry.—We are, &c.,

R. C. ATKINSON, A.M.I.E.E., A.M.I.C.E., A.M.I.Mech.E.
SIDNEY SIMPSON, A.M.I.E.E., Assoc.A.I.E.E.
R. D. SPURR, A.M.I.E.E.
P. FURNESS, A.M.I.E.E.
E. MORGAN, A.M.I.E.E., A.M.I.C.E.
A. R. CHAYTOR, A.M.I.E.E.

British Made Magnetos.

THE GROWTH OF A NEW INDUSTRY.

Through the courtesy of the British Ignition Apparatus Association, the technical and trade Press were given an opportunity last week to inspect a number of works which are devoted to the construction of magnetos for internal combustion engines of all classes, and especially for aircraft.

The object of the visit was to give evidence of the establishment since the outbreak of war of factories in which magnetos of efficient design and complete reliability in service are manufactured on modern mass production lines. With commendable courage and resource, a number of manufacturers have got together, and as a result of their co-operation, both in design and manufacture, a British magneto has been turned out which can be fairly claimed to be the equal, if not the better, of any pre-war foreign product.

The members of the British Ignition Apparatus Association are: British L. M. Ericsson Mfg. Co. (Ltd.), Beeston, Notts; British Thomson-Houston Co. (Ltd.), Coventry and London; British Westinghouse Electric & Mfg. Co. (Ltd.), Manchester; E.I.C. Magnetos (Ltd.), Birmingham; Fellows Magneto Co. (Ltd.), Park Royal, London; M-L Magneto Synd. (Ltd.), Coventry; R. B. North & Sons (Ltd.), Watford and London; Thomson-Bennett Magnetos (Ltd.), Birmingham; C. A. Vandervell & Co. (Ltd.), Acton Vale, London.

The works selected for inspection were those of Messrs. Thomson-Bennett Magnetos (Ltd.), Birmingham; the British Thomson-Houston Co. (Ltd.), Coventry; The M-L Magneto Synd. (Ltd.), Coventry; and Messrs. R. B. North & Sons (Ltd.), Watford.

The Thomson-Bennett, M-L and the North magnetos are of the "H" armature type, with the condenser fitted as an integral part of the armature itself. The B.T.-H. machine is of a distinctive design, in that there are no revolving conductors, the only rotating part is an inductor mounted on a non-magnetic steel shaft. The "armature," as it is termed, is a fixed element, and is made up complete with its condenser and neatly fixed within the permanent magnet just above the rotating member.

In the development of the design of an all British magneto no effort seems to have been spared to eliminate causes of failure due either to the design, the method of manufacture, the classes of insulated material or the quality of raw material.

The associated manufacturers appreciated at the outset the necessity for scientific research, and they have at their disposal the excellent laboratories of Messrs. Marks & Clerk, of Birmingham, where many valuable experiments have been carried out. These have been the more helpful because at this particular laboratory a quantity of research on the internal combustion engine has been undertaken during the past few years. The press party was shown round the laboratories, which are in charge of Mr. J. D. Morgan, who explained the working of several pieces of apparatus used in magneto and spark-plug research.

The associated manufacturers were able to demonstrate during the visit in question that they have realised the commercial importance of standardisation and uniformity of design, of interchangeability and of the reduction of the number of spare parts which it will be necessary for the dealer to keep in stock for all British magnetos. They can also show in the machine shop equipment a magnificent range of tools which have been designed and developed specially for this class of work. At the present time they are, in a number of cases, dependent upon outside sources for certain semi-manufacture parts, but arrangements are proceeding whereby one or other of the co-operating firms will turn out these parts with special tools for the Association

We do not propose to draw any comparisons between the works that we visited. Their equipment is quite modern, and the technical staff seems to us efficient to a degree Those in charge of production also displayed the ability to grasp the immense importance of apparently minor details. These are characteristics which previous to the war were presumed to belong exclusively to the German designer and workman.

At the moment we are not giving descriptive details of British magnetos; these particulars we shall publish on some future occasion. We are taking this opportunity of recording the establishment of a new British industry, and we must compliment the sponsors of it upon the results of their efforts.

Since the outbreak of war the associated firms have produced no less than 300,000 magnetos which are being used on war service alone. Equally noteworthy is the achievement of co-operation between firms who in pre-war days were rivals What we were shown last week clearly proves that the British manufacturer can do better than his foreign rival when he likes. What is most extraordinary is that it took a great European war to make him do it.

In conclusion, we would express our thanks to the Association for giving us this opportunity of seeing what it is doing. The entire visit was admirably arranged and carried through by Mr. E. H. Godbold

Power Supply Engineers' Association.

A mass meeting of engineers engaged in electricity supply (convened by the Yorkshire Section of the Institution of Electrical Engineers) was held at Leeds, on the 14th inst., to consider the advisability of establishing an Association of British Electrical Engineers.

Mr. W. LANG, President of the Yorkshire Section of the I.E.E. occupied the chair.

Mr. W. B. WOODHOUSE, who pointed out that the proposals of the Whitley Committee had received the approval of the Government and the Ministry of Labour was actively engaged in assisting in the formation of industrial councils, said the employers were being organised and the operative workmen were also being organised through their trades unions. The engineers who were responsible for the management and xeecutive duties were not fully organised: they had no organisation that covered the whole country and included every man. In the class of managing and executive engineers should be included all those engineers of good general education who had received a technical training and had had practical engineering experience and were engaged in responsible technical positions in the business of electrical supply. The men of the electrical engineering profession should be regarded as belonging to a profession as honourable and distinguished as that of doctors, dentists and accountants, and ought to be able to do what those three professions had done, that was close the door to the unqualified man. The first step was to form an association in which all well trained men at present engaged in the profession of electrical engineering should be included, and then to lay it down that in future they would not take any man into the association unless he was well trained. The Council of the I.E.E. thought that the existing qualification of membership of the Institution might well be used to divide the executive engineer from the working engineer. They wanted an organisation which would ensure for its members, as well-trained and fully qualified men, adequate pay, satisfactory conditions of employment and the social standing to which their qualifications entitled them. That could only be done if they got every engineer in the industry to join. The Council of the I.E.E. had discussed the matter with a provisional committee and it had been agreed that something ought to be done. Therefore, the Institution had organised meetings through the agency of the local sections. Meetings at Newcastle and Glasgow had decided to appoint delegates to attend a meeting to be held in London, where a final decision could be taken in consultation with representatives from all parts of the country. He moved: "That this meeting of electrical supply engineers of Yorkshire, promoted by the Yorkshire Section of the I.E.E., supports the formation of an association of British Electrical Engineers and appoints delegates to represent it at the mass meeting to be held in London under the chairmanship of the President of the I.E.E."

Mr. CAMPION seconded the resolution.

Mr. LUNN (Manchester) said the E.P.E.A., which had been doing such great work during the last six months, was being ignored. That association had covered practically the whole ground that Mr. Woodhouse had mentioned. The E.P.E.A. set out for status and were told that they were to be represented by the Electrical Trades Union. They resented that, and that was what started them as an organisation. The E.P.E.A. included many chief engineers and deputy chief engineers and assistants, and in the Northern Division alone had a membership of over 400 qualified engineers. They could not understand a protective organisation starting from the top; they felt that it should certainly start from the bottom. They had seen the manual worker receiving magnificent rewards in many cases, whilst the brain worker—the supervising worker—had been receiving nothing. That was one reason why they had started.

Mr. WEBBER (Keighley) thought that if they were going to have any success in getting the same grade as doctors and the legal profession, it must come through a national institution like the I.E.E.

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Mr. J. E. ELLIS (Morley) said there was a flood of new associations springing up, but there was only one which was formed on business lines, and for that reason had taken firm root. That was the E.P.E.A., of the local section of which he was proud to say that he was the chairman. From the scientific point of view the Institution had served its purpose remarkably well for the first few years of its existence when the business was struggling to develop and compete with cheap gas for lighting and power; but for the past few years it had failed to bring itself into line with the democratic feelings of the majority of its junior members.

Mr. W. F. MYLAN (Sheffield) suggested that delegates should be appointed from the meeting to consider the advisability of either forming a new association or recommending the members to join one of the associations in existence. He doubted whether it would be right to proceed with a new association which was going to be fathered by the I.E.E. He read a telegram sent to him stating that representatives of employees of a number of large firms strongly disapproved of a trades union formed under the supervision of the I.E.E., and declaring that as effective control by the members was essential for a healthy organisation it would be better to consider the possibility of independent action by all classes of engineers. He proposed the following amendment: "That this mass meeting of Yorkshire electrical engineers, called by the Council of the I.E.E. to support the proposed A.B.E.E., is not satisfied that this new association is being formed in the interests of the majority of the profession, as apparently the majority of those who have promoted it are senior members and some have, so recently as three months ago, been associated with reactionary policies directly antagonistic to the legitimate interests of the junior members of the profession who compose by far the majority of it; also bearing in mind the foregoing and the fact that in the past the Council of the I.E.E. has done nothing in the interests of the lower grades of the profession, and that there are already in existence two strong associations, the E.P.E.A. and the B.E.A.T.A., who have been actively at work for many months past and have already achieved a considerable measure of success with benefit to their members, who include all grades of qualified electrical engineers, this meeting strongly disapproves of the action of the Council of the I.E.E. in fostering the proposed A.B.E.E. instead of the existing associations, and is not prepared to endorse their action or support the proposed new association and hereby instructs the delegates to be appointed later at this meeting to attend any further meeting in London or elsewhere to represent this meeting and to make known its views. Finally this meeting pledges to itself to support the E.P.E.A. and the B.E.A.T.A."

Mr. HOWARD BROWN (Bradford) thought that if a new association was formed it should be controlled by persons elected by the members; and Mr. S. SIMPSON (Bradford) complained that though the existence of the E.P.E.A. had been widely published the association had been ignored.

Mr. CAMPION (Dewsbury) said if they had one section working against another it would be the very worst thing that could happen.

Mr. WOODHOUSE, in reply, said the Institution fully realised that the matter was one for the separate organisations to deal with, but they appreciated the fact that there should be one organisation of the whole engineering industry. The Institution did, in fact, appreciate how good the work of the E.P.E.A. was, but there were other organisations which had also done good work, but it would be invidious to pick out one of the existing associations and say that it represented the whole industry, because it was certain that no existing association could claim that. Therefore the London meeting would settle who should represent the whole electricity supply industry. The people who were going to manage the new association were the members of that association.

After a good deal of discussion the amendment was put to the meeting and declared carried by 66 votes to 28.

On the 17th inst. a meeting was convened by the Birmingham Local Section of the I.E.E. Mr. R. A. Chattock explained the objects of the proposed association, and a resolution in favour of the scheme was adopted. Messrs. P. T. Burgess, F. Forrest, C. Jones and J. T. H. Legge were appointed delegates to attend the London meeting.

A similar meeting was held at Bristol on June 14, when H. Faraday Proctor gave an explanation of the new association. A resolution approving of the scheme was passed, and Mr. W. J. Bache was elected delegate to the London meeting.

In addition to the Birmingham and Western Sections, resolutions approving the scheme have been passed at Newcastle and Glasgow.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W.1.
Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain of the Week.—Capt. W. Hynam.
Next for Duty.—Capt. W. Darley Bentley.
Sunday, June 23.—Commandant's parade at Waterloo Station, 8.45 a.m. Work: Revetments at Heywood. Dress: Service dress, drill order, haversacks and waterbottles. Midday and tea rations to be carried.
Monday, June 24, to Friday, June 28.—Drills as usual.

SPECIAL NOTICES.—All drills will take place at headquarters, unless otherwise stated.

The M.O. will attend for the examination of recruits on Thursday evening at 6.0.

Summer Camp.—Arrangements are now being made for this Camp to start on Aug. 3.

Parliamentary Intelligence.

POST OFFICE TELEGRAPHS & TELEPHONES.

Last week the House of Commons considered the vote to complete the sum of £26,141,304 for salaries and expenses of the Post Office, including telegraphs and telephones.

In the course of his explanatory remarks, the Postmaster-General (Mr. ILLINGWORTH) gave particulars of the extra work entailed by the war and the number of letters, parcels, &c., sent to the forces overseas. In regard to the telephone service, air raid warnings sometimes entailed as many as 10,000 to 20,000 telephone calls. His request for volunteers had been met in a ready manner by the operators, and 32 of them had been awarded the British Empire medal for meritorious services. The increase of the telegraph and telephone services and the postal work for the fighting forces grew larger month by month. He regretted that the penny post, which had been such an inestimable benefit to mankind, had been suspended.

AUTOMATIC TELEPHONE EXCHANGES.

The automatic telephone exchange, of which great expectations had been entertained before the war, had not been developed to the extent which one would have liked; but the Leeds exchange had been completed, and he had the pleasure of opening it for public service early in May. That was the largest automatic exchange in Europe, as it contained 6,800 lines, and its ultimate capacity would be in the region of 15,000 lines. He had no doubt that after the war the development of the telephonic system in that respect would be very considerable. For some generations there had been a general tendency to substitute mechanical means for human energy, and the adoption of mechanism in that connection would be useful. The proportion of wrong numbers called for by telephone subscribers was extraordinary. Now that the responsibility could be fixed on subscribers for giving wrong numbers, some of those who used to complain frequently that they were connected to wrong numbers would come to the conclusion that they were more to blame than were the operators. Mechanically, the working of the automatic exchange was quite successful.

The tunnel for the Post Office tube railways had been completed, but its equipment would not be started until the war was over, because materials and labour were needed for munition purposes and for the use of the forces in various ways. The more he saw of those railways the more convinced he was that Mr. Herbert Samuel was right in instituting that great scheme. It would save an immense amount of traffic on the roads and ensure more rapid transit of mails from station to station.

In the discussion which ensued the Postmaster-General was criticised for the delay in establishing an Industrial Council for the department. The Post Office should give a lead to other industries on this point. In reply, it was stated by Mr. Pike Pease that the subject would shortly come before the Cabinet.

THE MARCONI WIRELESS CONTRACT.

In reply to a question, the Postmaster-General (Mr. Illingworth) stated in the House of Commons last week that the Marconi Co. was informed in January, 1915, by the Postmaster-General that the principal reason which had actuated the Government in arriving at the decision to repudiate the contract with the company was the altered circumstances resulting from the war, and especially from the prospect that hostilities might be prolonged. He stated that, in the opinion of the Government, the present and prospective naval and military requirements, which were the governing factors in determining the scheme for the Imperial wireless chain, could be better met by means other than the construction of stations of the character and in the situations contemplated by the contract.

Legal Intelligence.

Kensington & Knightsbridge and Notting Hill Co.s' Arbitration.

On Friday the Court of Appeal (Lords Justices Pickford, Bankes and Warrington) commenced the hearing of the appeal of the Kensington & Knightsbridge Electric Lighting Co. from the judgment of Mr. Justice McCardie (reported in THE ELECTRICIAN of Jan. 25, 1918).

On the conclusion of legal arguments the appeal was dismissed with costs. A report of the case will appear in our next issue.

Workmen's Compensation.

At Preston County Court last week Judge Sturges gave judgment in a compensation action brought by a lathe hand (Mrs. B. Gilleard) against Messrs. Dick, Kerr & Co., for injuries to her hand caused by an accident. Concealing her tea can in the gear box of an adjoining machine to prevent it being stolen or used, she got her fingers trapped and damaged. The answer was that the accident did not arise out of the woman's employment, and that she was not authorised to tamper with the gear box in any way. Judge Sturges, who said he was bound by the decision of the Court of Appeal in a similar case, found for respondents.

Polytechnic School of Engineering.—The Hon. Sir Charles A. Parsons, K.C.B., M.A., D.Sc., F.R.S., has consented to fill the office of president of this School in succession to the late Mr. Charles Hawksley, past president of the Institution of Civil Engineers. The first president of the School was Prof. David Hughes, founder of the Hughes medal of the Royal Society.

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Commercial Topics.

Compulsory Arbitration.

The Whitley Committee on the Relations between Employers and Employed, have presented a further report, which deals with Conciliation and Arbitration.

The Committee pronounce against any system of compulsory arbitration, on the grounds that it is not generally desired by employers and employed, that it has not proved a successful method of avoiding strikes during the war, and that it would be less likely to be successful in time of peace. They also pronounce against any scheme of conciliation which would compulsorily suspend a strike or lockout pending an inquiry. The Committee advocate the continuance of the present machinery for voluntary conciliation and arbitration, and hope that the setting up of Joint Industrial Councils will tend to the growth of such machinery. They consider that there should be means for holding independent inquiry into the circumstances of a dispute and for making an authoritative pronouncement thereon without the compulsory power of delaying the strike or lockout. It is suggested that a Standing Arbitration Council should be established on the lines of the present temporary Committee on Production. To this Council disputants would be able voluntarily to refer such differences as they are themselves unable to settle. Single arbitrators should be available for less important cases; and it is further suggested that the Standing Arbitration Council should take means to secure the co-ordination of arbitrators' decisions. The Committee are opposed to the enforcement of awards and agreements by means of monetary penalties

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The Siemens Companies.

At the annual meeting of Messrs. Siemens Brothers & Co. (Ltd.) last week the chairman (Mr. G. Mure Ritchie) made an interesting statement as to the present position of the Siemens Companies, which are now completely under British control.

Mr. MURE RITCHIE said that during 1917 the past policy of concentrating upon the execution of Government orders had been adhered to, and the turnover exceeded that of 1916 by about one-third. In new departments automatic telephony had been given prominence, and all technical difficulties had been surmounted. The company was now installing both large exchanges for public service and smaller private exchanges. The profit of £208,524 showed a substantial increase. An interim dividend of 10 per cent. had been paid, but no final distribution could be considered until excess profits duty had been adjusted. The German share holdings in the company were sold in December, 1917, by the Public Trustee, and the company had issued to the Public Trustee £1,330,000 of 4½ per cent. debentures in settlement of the loan cash capital supplied for the former German share holdings. Since the appointment of the new board the directors had given their attention mainly to developing the undertaking into a great national manufacturing asset. At an early date they proposed to increase the share capital to £1,500,000 or more. A substantial portion would be held in reserve, but the proceeds of £400,000, if issued for cash, would be used to retire debentures. If a reconstruction were carried through on the lines proposed, the joint concerns (Siemens Bros. & Co. and Siemens Dynamo Works) would be capitalised at £1,000,000 in shares, £150,000 of 4 per cent. debentures and about £1,000,000 of 4½ per cent. debentures. The directors had opened negotiations with similar companies in order to bring manufacturers together for the reduction of competition and the elimination of duplicate machinery, workshops and offices in the interests of increased economy, cheaper production, greater efficiency and improved products. Such an alliance had already been arranged with Messrs. Dick, Kerr & Co. in regard to dynamo manufacture, and other alliances were contemplated.

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Industrial Councils and Trade Boards.

In a memorandum on Industrial Councils and Trade Boards the Minister of Reconstruction and the Minister of Labour indicate the modifications which it is proposed to make in carrying out the recommendations contained in the second report of the Committee on Relations between Employers and Employed on the subject of joint standing industrial councils.

It has not been found possible to adopt the whole of those recommendations, and the following are the modifications which it has been found necessary to make :—

As regards those industries which do not possess fully representative associations, it has been decided to recognise one type of Industrial Council only, and not to attach official representatives to the council, except on the application of the Industrial Council itself.

As regards unorganised areas and industries with no adequate organisation the relations between Trade Boards and Industrial Councils raise a number of serious administrative difficulties, due to the wide difference in the purposes and structure of the two types of bodies. It is not regarded as advisable that a Trade Board should formulate a scheme for an Industrial Council, nor is it probable that Trade Boards for unorganised areas will be set up in conjunction with a Joint Industrial Council.

The Ministers explain at some length the fundamental differences between Industrial Councils and Trade Boards. The former are voluntary, set up by agreement between employers and workers, and composed exclusively of their nominees. Their structure and functions vary much within wide limits and financially they are self-supporting. Trade Boards are statutory bodies set up by the Minister of Labour, by whom in practice the representative members are largely nominated, and who also chooses "appointed members" outside the trade concerned. The Boards' chief duty is to fix minimum wage rates, which are enforceable by law, and their authorised expenses are met out of public funds.

The new Trade Boards Bill was read a second time in the House of Commons on Tuesday. The Minister of Labour (Mr. Geo. Roberts) explained that the Bill gave power to his department to set up trade boards in any trade in which he considered such a step expedient, having regard to the wages paid in that trade, instead of only in a trade in which the rate of wages was exceptionally low. The trade boards would be given discretionary power to secure a minimum rate of remuneration for piece-workers and to fix differential rates for overtime and Sunday labour. The trade boards might act in the spirit of the Whitley Report by making recommendations to a Government Department with reference to conditions in a trade. His ambition was to see the whole of industry covered by industrial councils or wages boards.

Electricity Supply.

Extensions.

Barnsley.—Application has been made to the L.G. Board for sanction to borrow £3,000 to enable the Corporation to give a supply of electricity to Messrs. Wood Brothers' glass works.

Bedford.—The Corporation has received sanction to a loan of £5,713 for the electric supply undertaking.

Dublin.—An inquiry was held last week by Mr. P. C. Cowan into the application of the Corporation for sanction to borrow £175,000 for extensions of the electricity undertaking and £34,616 to meet the additional cost incurred on extra works, &c.

The Citizens' Association urged that the matter should be postponed until the policy of the Government as to the future of electricity supply was known, and a letter from Dublin Castle to the L.G. Board stated that "after considering all the possible sources of supply of electric power, it has been decided at the War Office that the power required at North Wall (about 250 H.P.) should be obtained from the Port and Docks electric installation, supplemented by a stand-by connection to the Port and Docks Board's mains from the Dublin United Tramway Co.'s power station at Ringsend. As both the Board and Tramway Company are prohibited from supplying current otherwise than for their own purposes, it is intended to issue the Army Council's formal orders under sec. 8D of the Defence of the Realm Act for the supply of the power."

The TOWN CLERK protested against the course adopted by the War Office.

Mr. H. MANGAN, city accountant, gave evidence regarding the borrowing powers of the Corporation; and Mr. FRED ALLAN, secretary of the electric lighting undertaking, said the Government had approached the Corporation not alone with a view to getting a supply for the hay-baling presses, but for the two dockyards. The Corporation offer would have given them sufficient supply for the three requirements at the one expenditure, but the net result of the whole thing, apparently, was that the War Department had incurred a very substantial amount of expense by taking it from the Port and Docks Board, with a stand-by from the Tramway Company, and the Admiralty had now ordered the supply from the Corporation for the two dockyards by the methods with which they could have supplied the three, the supply to be given within two months.

Mr. MARK RUDDLE, city electrical engineer, gave detailed evidence in regard to the necessity of the proposed extensions.

Kirkcaldy.—The Fife County Council has authorised the Fife Electric Power Co. to lay an electric supply cable from Halbeath to Burntisland.

Luton.—The borough electrical engineer (Mr. W. H. Cook) has prepared a preliminary report on extensions of the electric generating plant and mains.

Mr. Cooke estimates that an expenditure of about £80,000 will be necessary to obtain the additional plant, &c., required.

The Council has adjourned further consideration of the matter in order that the chairman and the engineer may interview the Government department concerned with a view to obtaining a contribution towards the cost.

Nuneaton.—The Council has received authority to borrow £412 for the electricity department.

Redcar.—The Tees Conservancy Commissioners have authorised the Cleveland and Durham County Electric Power Co. to lay under the breakwater railway three e.h.t. cables and a telephone cable to the site of Dorman, Long & Co.'s new works.

Swansea.—It has been decided to purchase two 650 k.v.a. transformers in connection with the supply to the Harbour Trust.

Whitehaven.—As the Council has now received the necessary permit for obtaining additional generating plant, it has been decided to proceed with the work as rapidly as possible.

General.

Bradford.—The salary of the city electrical engineer (Mr. T. Roles) has been increased from £900 to £1,000 a year.

The Electricity Committee recommended an increase of £200. The salary of the deputy engineer has also been increased by £100, to £550 per annum.

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Economy of Electric Cooking.—At a recent meeting of Weybridge Urban Council, the surveyor (Mr. J. S. Crawshaw) submitted plans of a proposed national kitchen, which would cost £256, of which amount one quarter would be given by the Government.

It was stated that both gas and electricity had been laid down for cooking purposes, and Mr. Brooker stated that they had come to the conclusion that gas was no good for the purpose; with electrical fittings they could produce 1,000 portions of food, which would be cheaper than gas.

Electrical Power Engineers' Association.—The first meeting of the Liverpool branch was held on the 14th inst., when Mr. F. E. Spencer (Birkenhead) was elected chairman and Mr. J. Hamilton (88, Porteleroad, Stoneycroft, Liverpool) honorary branch secretary. A committee of five was also formed.

Electric Power Supply Committee's Report.—The President of the Board of Trade (Sir A. Stanley) informed the House of Commons on the 12th inst. that the report of the Board of Trade Committee on Electric Power Supply was receiving careful consideration. It raised issues of great importance, but no time would be lost in dealing with the matter.

Grimsby.—The Electricity Committee has increased the salary of the deputy borough electrical engineer (Mr. A. S. Channon) by £50 per annum.

Leek.—The Urban Council has agreed to give a supply of electricity for lighting the Gas Works Motor Governor House and for power to motor blower and blacksmith's hearth.

Lighting Restrictions and Prices of Electrical Energy.—Many electric supply undertakings, especially those in residential districts, have found it necessary to obtain authority from the Board of Trade to increase the maximum statutory charge for electrical energy.

At Hampstead the Lighting Committee has reported that the operation of the "Lighting, Heating and Power Order" has had the effect of causing a reduction in the output of electrical energy, and consequent reduction in income without a corresponding saving in expenditure. The drop in the output involves a loss of £10,000 a year, and a further increase in the charges is therefore necessary. The maximum under the Council's provisional order is 7d. per unit, and it has been decided to ask the Board of Trade to allow an increase of the maximum rate to 1s. per unit.

At a recent conference of representatives of the London Borough Councils it was decided to make a joint representation to the Board of Trade on the subject.

Ramsgate & District Electric Supply Co. is also applying for an order to increase the maximum price of electric current.

Lincoln.—Sir John Snell has prepared a report on the municipal electric supply undertaking.

It will be remembered that about a year ago Messrs. Clayton and Shuttleworth erected an independent power station, as the Corporation was unable to meet the company's demands. In his report, Sir John Snell recommended the Corporation to acquire that station, to extend it, and to make itself responsible for the whole of the city's electric power. The total expenditure involved is about £250,000.

Electric Traction.

Belfast.—The tramway fares have again been revised and the stages shortened.

Bradford.—The result of the 50 per cent. increase in tramway fares is an increase of 32 per cent. in revenue.

For the first nine months after the alteration the receipts were £13,099, against £9,906 in the corresponding period of 1917.

Edinburgh.—The Tramways Committee received 27 applications for the position of tramway manager, and the following is the short list selected for interview by a special sub-Committee:—

Wm. Clough, general manager, Bury Corporation tramways; Fred Coutts, engineer and general manager, Paisley District Tramways Co.; Wm. J. M'Combe, tramway manager, Hull; R. Stuart Pilcher, general manager and engineer, Aberdeen Corporation tramways; and R. H. Wilkinson, general manager and engineer, Huddersfield tramways.

Glasgow.—The following increases of salary have been granted to officials of the tramways department:—

Mr. James Dalrymple, general manager, from £1,300 to £1,500; Mr. L. M'Kinnon, traffic superintendent, £700 to £750; Mr. J. Ferguson, chief engineer, £700 to £750; Mr. J. N. Wilson, secretary and treasurer, £525 to £600; Mr. R. F. Smith, accountant, £310 to £330; Mr. J. Grierson, civil engineer, £320 to £340; Mr. G. B. Masterton, chief draughtsman, £310 to £330; Mr. D. I. Liddell, outdoor traffic superintendent, £340 to £360; Mr. F. W. Christall, claims superintendent, £380 to £400.

Swansea.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation the Swansea Corporation Light Railways Extension (Revival and Extension of Time) Order, 1918.

The Health Committee has decided to purchase two electric vehicles, at a cost of £1,228, for the collection of house refuse.

Women Tramcar Drivers.—Dover Corporation has decided to employ women tramcar drivers, who will be paid the same rate of wages as men.

If necessary, Sheffield Corporation will also employ women drivers under similar conditions.

Foreign Notes.

Brazilian-Argentine Trade.—A Brazilian industrial delegation recently arrived in Buenos Ayres to make arrangements for an exhibition of Brazilian products.

The members of the delegation are mostly merchants and industrialists, and include Dr. Carvalho Brito, director and president of the Minas Geraes Electricity Co. It is desired to increase the trade between the two countries.

Electric Tractors in New York.—Recently there was introduced a three-wheel electric tractor unit, designed to replace a team of horses, while otherwise employing existing truck equipment.

One of these units is a three-wheel model, propelled by the forward electric wheel, and is of a length about equal to a pair of horses. The speed when loaded is approximately 50 per cent. faster than that of a team, and about 100 per cent. when running empty. This unit is expected to accomplish the work of two teams and drivers. The plan is to use one tractor in connection with two wagons, no change being made in wagon construction, other than to remove the tongue and the whippletree, and to substitute therefore a suitable flexible or bale connection, which will enter into the coupling at either side of the electric tractor. It is said that a number of these electric tractor installations are already working very satisfactorily.

Hydro-Electric Power in Spain.—A Spanish company has been formed with a capital of 150 million pesetas (about £6,000,000) for exploiting the Falls of the Douro.

The falls are near the point where the river forms the frontier between Spain and Portugal, and are estimated to be capable of generating 350,000 H.P. Power will be distributed in Madrid, Bilbao and throughout Galicia for industrial purposes, and it is also expected that the scheme will have an important effect in hastening the electrification of the railways through the north and east of Spain.

Swedish Exports Prohibition.—The export from Sweden of glass tubes and rectangular glass jars for accumulators and manufactures of wax is prohibited.

Tenders Invited.

Meters.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. July 3 for the supply of 21 electric meters for power circuits. Specification from Commissioners' Office, Spencer-street, Melbourne.

Telephone Material.

The Deputy Postmaster-General, Melbourne, requires tenders by 3 p.m. July 2 for g.i. wire and gal. steel stranded wire (schedule 1,436), copper wire (h.d. enamelled covered and twisted pair), copper sleeves (schedule 1,449), and telephones and diaphragms (schedule 1,450) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications, &c., from the General Post Office, Melbourne, Sydney, Brisbane, Adelaide, Perth and Hobart.

Appointments Vacant.

The Council of the University of Hong Kong require a professor of electrical engineering (salary £600 per annum, with quarters or allowance of £100) and two lecturers in civil and mechanical engineering (£400 per annum, with quarters for residence). Applications to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, Westminster, S.W., by June 28. *See an advertisement.*

An electrical draughtsman is required for diagram lay-out and record work by controlled shop, with high-tension and low-tension three-phase system. *See advertisement.*

Two switchboard attendants are required by the Blackburn Corporation electricity department. Applications by June 24 to the borough electrical engineer (Mr. P. P. Wheelwright), Jubilee-street, Blackburn. *See advertisement.*

Several technical assistants are required in testing department of wireless telegraphy. *See advertisement.*

An advertiser requires three skilled electricians for conduit work.

An electrical manufacturing firm in the Midlands advertises for an assistant with a knowledge of d.c. machine design.

Bankruptcies.

Claims against Wm. Dilworth Birkett, factor of electrical goods, Arnside, Windsor-avenue, Whitley Bay, Northumberland, are to be sent by June 27 to Mr. C. Woollett, 21, Moseley-street, Newcastle-on-Tyne.

Claims against Fredk. Griffin, electrical engineer, &c., 315, Regent-street and 14, Little Portland-street, London, W., must be sent by July 2 to Mr. W. P. Bowyer, Bankruptcy-buildings, Carey-street, London, W.C. 2.

A supplemental dividend of 1¾d. in respect of the business carried on by Alfred Ernest Felgate and Wm. Storey, electrical engineers, 1½, Queen Victoria-street, Reading, and a first and final dividend of 1½d. in respect of the separate estate of Alfred Ernest Felgate, are payable at 14, Bedford-row, London, W.C.1.

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Companies' Meetings and Reports.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The gross profit for the year ended March 31 amounts to £237,906, compared with £226,745 for year 1916-1917. After deducting general expenses and amount written off sundry assets (£28,685) there remains £209,221, and with £97,598 brought forward the total is £306,819. Deducting debenture stock interest (£90,798) there remains £215,841. The directors recommend that £21,172 be placed to reserve, that a dividend of 6 per cent. for the year be paid upon the cumulative participating preference stock (£42,765) and a dividend of 3 per cent. for the year upon the ordinary stock (£39,788, leaving to be carried forward £112,116. The net profit shows an increase of £9,249, compared with the preceding year. The aggregate receipts of the associated companies show an advance, but the wages paid and the cost of materials have also increased, and larger provisions have been made for future repairs and maintenance. In the metropolitan area war conditions generally have had a prejudicial effect. With £3,828 in respect of debenture stocks purchased and cancelled and £21,172 to be transferred from revenue the reserve will amount to £450,000. The investments now stand at £4,262,957. 17s. 3d., and yielded a revenue of £210,361 representing an average of 4·93 per cent. for the past year on the amount at which they appear in the balance-sheet, as compared with 4·79 per cent. for the preceding year.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.—Mr. E. Garcke, who presided over the meeting on Monday, said that the year under review had been one of considerable activity in all departments. Notwithstanding the difficulties of manufacture there a record output. The demand for Brush Ljungstrom turbo-generator sets and auxiliaries had increased so rapidly that to keep pace with it they had been compelled to arrange for a large extension of their machine-tool equipment. The British Ljungstrom Marine Turbine Co., who controlled the marine propulsion rights of that turbine, had made excellent progress, and details had recently been published of the first British-built vessel equipped with plant of that type, the whole of which (both steam and electrical) was built at their works. Other important similar orders were now in hand. The gross profit on trading was £89,000, compared with £68,800 in the preceding year. After payment of debenture interest and placing £8,000 to depreciation, the balance (including £13,800 brought forward) was £38,000. It was proposed to place £12,674 to general reserve, to apply £12,629 dividends on the ordinary stock, and to carry forward £12,699. The excess profits tax for 1916 having been adjusted, the directors felt justified in recommending a distribution. They were anxious, however, not to pay a larger dividend than they felt confident could be maintained, and therefore they suggested that the present distribution of 12 per cent. should be regarded as in respect of the two years in which the dividend had been earned, and that the declaration should be at the rate of 6 per cent. per annum for each of those two years.

JAMES KEITH & BLACKMAN CO. (LTD.)—The net profit for the year ended March 31 was £30,539 (against £33,609). A dividend at rate of 10 per cent. and a bonus of 5 per cent. (both tax free) are recommended. A sum of £9,267 is being placed to reserve and £16,252 carried forward.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—Sir John Gavey, C.B., who presided over the annual meeting last week, stated that the growth of the system, which was temporarily checked on the outbreak of the war, had since then continued steadily to expand year by year, until it has now almost reached its normal pre-war figure of annual increase. It had only been possible to meet the increased demand for telephone service owing to the fact that considerable reserves both in the shape of underground conductors and exchange switchboard equipment had been provided prior to 1915. The only two sources of supply on which they could now draw were Great Britain and the United States, and as the needs of the war encroached more and more on the manufacturing industries of both countries, there was little prospect of much alleviation of their difficulties. After giving an analysis of the report and accounts, he said they were paying a final dividend of 5s. per share (tax free), after allocating £2,200 to staff provident fund, £60,000 to reserve fund account, and £40,000 to reserve (war contingencies) fund, £17,308 will be carried forward. During the year, without any canvassing, 13,400 new telephone stations had been connected to their system; 8,180 had discontinued the service, leaving a net increase of 5,220 (against 3,986 during 1916), bringing their total stations up to 65,788. The telephone traffic had greatly increased of late, and in the city of Buenos Ayres alone the increase had been some 13 per cent., more than in 1916. New exchanges have been opened at Villa Ballester and Lanus, just outside the capital of Buenos Ayres, and in three other distant suburbs of the city improved types of switchboards had been installed. They had unfortunately, however, not been able to bring into service the new common battery equipment ordered in 1916 for the Belgrano exchange. The bulk of the material had safely arrived, and it was hoped the end of the present year would see the switchboard in service. A considerable amount of underground duct work had been carried out during the year. In the province of Cordoba, where the system was really an isolated one, they had opened and had in hand quite a number of small exchanges in various parts of the province, all of which were or would be joined up to the city of Cordoba. The automatic systems in the cities of Rosario and Cordoba were working very satisfactorily, and continued to give good service, and in the former city they had under consideration the conversion to automatic working of a sub-exchange, known as Iriondo, so that before very long the whole of the city of Rosario would have automatic telephone service. It was thought that the final results of the whole harvest in Argentina would be good, and altogether the position was considerably better than it was last year. During last year Argentina had had more than its share of labour troubles. The company's own staff had remained loyal, and by so doing they had rendered services of inestimable value to the community. In October last one of their directors (Mr. J. E. Kingsbury) paid a long-needed visit to the other side. He came safely through all the difficulties and dangers which now beset those who travel by sea, and brought back with him information of considerable value to your board. The opening period of the new year showed a notable increase in the monthly addition to the number of subscribers. If they could succeed in obtaining the additional switchboard equipment and cables required the results should be excellent. Of those engaged in military service, two had been badly wounded. Lieut. R. E. Petley, who gained the Military Cross in July, 1916, is a prisoner of war in Germany, and they looked forward to his recovery and return to the service of the company, in which he received his early training. Major Quilter, who joined the Forces on the outbreak of war, has been in France for some considerable time, and he is safe and in good health.

City Notes.

BRITISH INSULATED & HELSBY CABLES (LTD.)—At an extraordinary meeting on Monday the resolutions were confirmed for capitalising the undivided profits and increasing the capital to £1,500,000 by the creation of 500,000 new ordinary shares of £1 each.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.) The share register will be closed from the 6th to the 13th prox. inclusive. The directors have declared a first quarterly interim dividend of 3s. per share, payable (tax free) on the 15th prox., in respect of profits for the year ending 31st December, 1918.

SHAWINIGAN WATER & POWER CO.—A dividend of $1¾ (or at rate of 7 per cent. per annum) has been declared for the quarter ended June 30.

The Round Table.

By "kVA."

An Irish electrical contractor whose business was in liquidation was questioned by the liquidator if he had any assets. "Sorr," was his reply, "I'm as innocent of assets as a frog is of feathers!"

* * * *

There has been many suggestions made for "strafing" enemy aircraft, and here is another to add to the list. "Ice," says the inventor of this ingenious method, "is lighter than water and therefore floats. My suggestion is that you should freeze the clouds and place dummy wild animals on these aerial icebergs to scare away enemy airmen. If this does not have the desired effect, place live wild animals on the icebergs!"

* * * *

BON MOT OF THE MOMENT.—"A quantity of gas or a quantity of electric energy, each equivalent to the same quantity of heat units would cost the consumer the same amount of money. On this basis, if electricity were charged at 1d. per unit, the price of gas would have to be 12s. 6d. per 1,000 cubic ft." C. Orme Bastian on Lord Moulton's remarks at the Institution of Gas Engineers. But gas and electricity will never be sold on this basis except in Utopia, and then, as an Irishman would say, gas won't be sold there at all.

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, June 18, 1881.]

ELECTRIC LIGHT AT THE POST OFFICE.—We understand that the Brush Light continues to give satisfaction in the circulation department; in the telegraph instrument room the Brockie Light is said not to have been successful.

ELECTRICITY IN SHIPS' SIDES.—In the "Comptes Rendus," No. 23, for June 6, 1881, is a note by M. A. Ledieu, in which he studies the question of the currents of electricity generated in the sides of ships, in which the covering of iron is separated from the copper sheathing by a layer of wood, the latter being rendered conductive by reason of its humidity. M. Ledieu thinks that one application of this discovery might take the shape of an automatic fire alarm for vessels.

A DIRECTORY OF TELEPHONE EXCHANGE SUBSCRIBERS.—We have received a very well got up and neatly printed directory to the subscribers of the Bell Telephone Exchange in Philadelphia. The names are arranged alphabetically, followed by the address of the subscriber; opposite the name is the subscriber's number. The "Directory" also contains a few brief rules of procedure in using the telephone. We think that this list is worthy the imitation of telephone exchanges in this country.

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CONTENTS.

NOTES 159
Arrangements for the Week 161
Problems of Coal Handling. By W. B. Woodhouse. Illustrated. 162
Trade Parliaments and Their Work. By E. J. P. Benn 165
Possible Economies by the Use of High-Pressure Steam. By Frederick Samuelson, M.I.M.E., M.I.E.E. Illustrated 166
The Maintenance of Economy in the Boiler House. By D. Wilson, A.M.I.E.E. 169
The Problem of Condensing in Large Power Stations. By J. H. Rider, M.Inst.C.E. 172
Considerations Governing the Design of Small Tractors. By A. E. L. Chorlton, C.B.E. 174
Some Considerations Relating to Large Power Station Switchgear. By H. W. Clothier. Illustrated 175
A Contribution to the Study of the Magnetic Properties of Manganese and of Some Special Manganese Steel. By Sir Robert Hadfield, F.R.S., C. Chéneveau and Ch. Géneau 179
THE LARGE POWER STATION 180
The Transmission of Power. By B. Welbourn, M.I.E.E. Illus. .. 181
British Science Guild 185
The Convention of the Incorporated Municipal Electrical Association 186
Report of the Council of the I.M.E.A. 191
The National Kitchen in New Bridge Street, London 192
CORRESPONDENCE 193
Patent Record 193
Volunteer Notices 193
LEGAL INTELLIGENCE 194
PARLIAMENTARY INTELLIGENCE 194
Commercial Topics 195
Electricity Supply 195
Tenders Invited and Accepted 197
Companies' Meetings and Reports 197

Notes.

The Convention of the I.M.E.A.

LAST week the Annual Convention of the Incorporated Municipal Electrical Association was held at Manchester. In many respects Manchester is an ideal centre for such a purpose, but owing to the restrictions which present-day conditions impose, the meeting lacked many of the features to which one is accustomed. There seemed a difficulty in coming across the engineers one wanted to see, and one could not help feeling that the building of the Institution of Electrical Engineers or that of the Civil Engineers provides a better meeting place than the Manchester Town Hall, whose rather forbidding corridors did not lend themselves to much sociability. Moreover, there seemed to be no general headquarters where visitors would naturally foregather, though the Engineers' Club did its best to remedy this defect; and the persistent drizzle last Thursday did not tend to improve matters in this respect. As was inevitable, social functions played no part, and even the technical programme, after the excellent and broad-minded address of the President, Mr. S. J. WATSON, was restricted to a discussion on power supply, relieved by visits to various stations and works.

Electric Power Supply.

SEEING that the Report of the Board of Trade Committee on Electric Power Supply has just been published, this subject was uppermost in the minds of all visitors, and it was opportune that a discussion on the whole subject should be held. An account of the proceedings will be found elsewhere. The Report of the Coal Conservation Sub-Committee still seemed to find a place in the minds of some of the speakers, though we think it must be admitted that this Report may now be considered to be superseded. Generally speaking, the tenor of the discussion may, we feel, be taken as evidence that the Report of the Board of Trade Committee is sound. We cannot expect any report to be quite proof against attack, but the criticisms that were made were chiefly in regard to minor details and were liable to be destructive on account of what we are inclined to think is a feeling in favour of the parochial point of view and the *status quo*, which will no doubt survive for some little time to come. Apart from the question of the large power station and the economics of power transmission, with which we deal in our leading article, the discussion was rather of a political nature than of a technical character. Some speakers seemed to think that the cost of fuel was the main consideration, and that the Committee ought to have dealt with this aspect more particularly. This appears to us to be a mistaken point of view. Assuming that generation on a large scale is more economical than generation in small stations, it follows that there must be a saving of fuel by the use of larger stations, and the actual cost of fuel does not arise. Whether this is high or low the relative saving will be the same.

The Cheapening of Supply.

OTHER speakers expressed the view that electrical energy would not be cheapened by the use of large power stations, and that there was in any case very little point in having it cheaper than it is. Many engineers are realising that the cost of power in industrial construction is a tithe of the cost of material and labour, and it would be ridiculous to suggest that manufacturers are looking to cheap electrical energy to help them to offset the higher wages and increased cost of materials, which are now paid and likely to be paid for some time in the future. Many manufacturers, under the stimulus of steam and gas power engineers, have "bluffed" the central station man into believing that electrical energy can be generated with isolated plants very much more cheaply than it can be purchased from the supply authorities. This process of scientific leg-pulling, which it has virtually amounted to, has resulted in prices for electrical energy being fixed in certain industries at figures disproportionately low. We believe that the discussion at Manchester will help to bring about the correct perspective in these matters. The manufacturer knows by this time that there is no industrial power agent that can serve his interests so well as can the ubiquitous electric motor. Its complete adaptability to the driving of industrial machinery is an asset which has an immense value quite apart from the cost of the electrical energy with which it is served. At the same time it must be remembered that if the output per worker is to be increased a larger quantity of machinery must be employed. In other words, the proportion of cost on account of power will become greater, and it is desirable that the rate at which power can be sold should be reasonably low. Apart, however, from ordinary manufacturing, there are such undertakings as electric railways and electrolytic processes, in which cheapness is a first consideration, and we may add in regard to the domestic heating and cooking load, cheapness again is equally desirable.

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Some Constructive Points.

WHEN we come to constructive points of criticism, these had reference more particularly to the supply of large consumers from the extra-high-tension transmission lines, with the possibility of the control of Electricity Boards by large consumers, and with the treatment of depreciation in the purchase of undertakings. With regard to these points, the removal of large consumers from any undertaking might prove a serious handicap to an undertaking, and shows the necessity for dealing with the supply of a district as a whole and not in sections. The possibility that large manufacturers might obtain control, if this depended upon the amount of electricity purchased per annum, certainly seems to be a source of danger; though we think this might be largely met by the stipulation that such consumers should not have a vote upon any contracts in which they were financially interested, directly or indirectly. The question of depreciation is undoubtedly a difficult one. If depreciation and reserve funds are to be deducted from the purchase price, then those undertakings which have been careful to provide for the future will come off badly compared with those which have aided the rates, or which have distributed profits as far as possible in dividends. On the other hand, if depreciation and reserve funds are neglected it will be felt that the public is paying more for an undertaking than it is really worth. This is a subject which probably requires further careful consideration, and is one of those points which might well be taken up by the Committee suggested by Mr. WORDINGHAM. Generally speaking, we hope that criticisms and suggestions that are made by any authoritative body as representing the electrical industry, will not be destructive, but will be constructive in character with a view to helping forward the conclusions reached by the Board of Trade Committee. We have had too many efforts in the past to put back the clock; at the present day there should be a serious attempt to go forward, irrespective of parochial feelings.

Education and Leadership.

THE chief idea expressed in the addresses at the Annual Meeting of the British Science Guild on Wednesday last was the importance of education, in its influence on the next generation, and especially on the future leaders of the country, both in politics and in industry. Much will depend on the attitude of Labour in the critical years following the war. In reconstruction proposals, as Lord SYDENHAM remarked, there has been a tendency to dwell chiefly on problems of a technical character. It is less generally realised that such proposals can only be carried into effect with the good-will of the masses. For example, the introduction of labour-saving appliances and more efficient methods involves the consent and co-operation of the workers. And when the unrest following the war is passing away and reconstruction in a permanent sense becomes possible, it will be those who are now children who will shape the destinies of the country. If it be true, as Sir HENRY NEWBOLT expressed it, that the world is moving towards a perfect democracy, how important that this democracy should consist of educated units with enlightened leaders! Lord SYDENHAM contrasted the number of universities per million of population in the British Isles with those in America, and mentioned that only one in a thousand of the 600,000 children leaving elementary schools reaches a university. An address by Sir ALGERNON FIRTH had reference chiefly to research and technical education, but he, too, remarked that men in America prepare for their life-work by a much longer period at college. Sir ALGERNON quoted encouraging evidence that employers in this country now recognise more fully the value of technically educated men, and the number of employers who have themselves received such an education, though small, is increasing. But in the future the inducement to young men to undertake courses, or undergo a college education and make research their life-work, must be provided largely by employers. Young men must be able to feel that such training carries with it a corresponding improvement in their prospects.

Institute of Metals.—The annual autumn meeting of the Institute of Metals will be held in London on Sept. 11, when several important Papers will be presented for discussion. A ballot for the election of members will be held on July 17. It is hoped that as a result the membership will pass well beyond the 1,000-mark, and that within the first decade of the Institute's existence.

Review of the Foreign Technical Press.—Some of our readers may be aware that a Review of the Foreign Technical Press has recently been issued by the War Office for private circulation. From the issue of May 28 and onwards this review is now to be obtainable by the public through any bookseller or from the Stationery Office, at the cost of 6d. per issue. The following addresses apply to the Stationery Office: Imperial House, Kingsway, London, W.C. 2; 28, Abingdon-street, London, S.W.1; 37, Peter-street, Manchester; 1, St. Andrew's-crescent, Cardiff; 23, Forth-street, Edinburgh; and E. Ponsonby, Ltd., 116, Grafton-street, Dublin.

An Allied Research Information Committee.—We observe that arrangements have been made, through the National Research Council in the United States, for the establishment of a Research Information Committee in Washington with branches in Paris and London, which will work in close relation with the officers of Military and Naval Intelligence. The functions of the Committee will include the classification and dissemination of information relating to war problems and the interchange of such information between the Allies. This seems a judicious step and may go some distance towards the very desirable course of pooling the scientific resources of the Allied nations.

Industrial Lighting Fittings in the United States.—We notice that the development of fittings for industrial lighting in the United States seems to be proceeding in the direction of eliminating glare, especially when half-watt lamps are used. A form of unit recently introduced under the name "Industrolite" makes use of a conical screen, open at top and bottom, which surrounds the filament and cuts off the direct light within the angles over which it is likely to strike the eyes of operators. This screen is supported under a wide reflector which reflects a considerable proportion of the lamp's rays over the region through which the screen operates. Both screen and reflector are of white enamelled steel and the unit is thus mechanically strong and easy to clean.

Power from the Earth's Heat.—We have several times referred to the interesting scheme for the application of the high temperatures located in volcanic fissures in Italy for power generation, extensions to which are said to be now in progress. According to the "Journal" of the Royal Society of Arts, Mr. N. B. Wales, an American engineer, now proposes to reproduce similar conditions artificially. According to the projected scheme two tubes would be sunk concentrically in the earth until a temperature of 350°–450°F. is attained, water being pumped down the central tube to the heated region, whence it will rise as steam in the space between the two tubes. There are said to be many regions in the United States where the requisite temperature could be found at depths of less than 5,000 ft.

New German Lubricants.—Among other incidental manufacturing difficulties, Germany appears to be experiencing considerable difficulty in finding adequate supplies of lubricating material, owing to the shortage of grease and fats. Among the devices tried one of the most common appears to be the use of tallow, mixed with heavy mineral oil, in varying proportions, though it is said that this does not answer well for fine rubbing surfaces. Graphite, when obtainable, is largely

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used, and it is reported that beds of this material, covering a considerable area, have recently been located in the Roumanian Carpathians. Artificial graphite, obtained by the treatment of carbonaceous material in the electric furnace is also largely used, and it is said that a good variety has recently been prepared by chemical means.

The Electrical Detection of Ores.—A recent United States patent taken out by Prof. R. A. Fessenden refers to a method of locating deposits of ore by electrical means. Bore holes are made in the area under investigation at a distance apart of several miles. For example, in a typical case four such holes would be bored five miles apart and the apparatus used would consist in a Fessenden sound oscillator and three Einthoven recording oscillographs. The holes are filled with water, in which the sending oscillator and the receiving microphones are immersed. By studying the records on the oscillographs, and particularly the relation between sound received direct and through echoes, it is possible to form conclusions as to the nature of the intervening rock and the distances of ore-deposits in the vicinity. It is stated that beds of ore have been detected at a distance of 2½ miles.

The Industrial Reconstruction Council.—The work of this Council is expanding so rapidly that it has been found necessary to secure more adequate office accommodation, and the address of the organisation will in future be 2 & 4, Tudor-street, E.C. 4. The work has been re-organised and divided into sections superintended by sub-committees. Mr. Ernest J. P. Benn remains Chairman and administrative chief, Sir Alexander Roger is in charge of the membership section, Dr. William Garnett and Mr. Emil Davies control meetings, and Sir Herbert Nield, K.C., M.P., is Parliamentary representative. The Council is also extending the work of propaganda through other organisations and is now prepared to send speakers to any societies to lecture or initiate discussions upon the various aspects of the Whitley Report. Applications should be made to the Secretary, who would also be glad to supply literature for distribution.

The I.E.E and Research.—The Council of the Institution of Electrical Engineers are prepared to receive Papers on the subject of "The Co-ordination of Research in Works and Laboratories," with a view to the Paper being read and discussed at one of the Ordinary Meetings of the Institution in London, and also before one or more of the Local Sections. Papers should not exceed 15,000 to 20,000 words in length, and the Council are prepared to award a special premium of £25 to the authorof the Paper which in their judgment best fulfills the objects of the discussion, provided such Paper reaches the standard aimed at by the Council. Papers should be sent to the Secretary of the Institution not later than Nov. 4, 1918. It is the intention of the Council to publish the selected Paper (which will become the property of the Institution) in the "Journal," together with the discussion. Competitors intending to submit Papers are invited to communicate with the Secretary.

Institution of Gas Engineers.—The Presidential Address, recently delivered by Lord Moulton before the Institution of Gas Engineers, referred to the new conditions which might be expected to arise as a result of the schemes for the centralisation of electricity supply now being considered. These conditions, he suggested might furnish reasons for an adjustment of some of the statutory obligations of gas companies. The time was also ripe for the complete abolition of illuminating standards and the substitution of a calorific test. In alluding to the development of by-products, he dwelt especially on the production of fuel-oil, which had been of great value to the Navy, and the possible utilisation of pitch residues for fuel. In the concluding portion of his address Lord Moulton emphasised the importance of research. Those who complained most bitterly of foreign competition were often those who had taken least trouble to apply the methods of research necessary to develop the full capabilities of their industry.

Light Railways.—The Report by the Light Railway Commissioners of their proceedings up to Dec. 31, 1917, and the Report of the Board of Trade under the Light Railways Acts have been issued.

On Dec. 31, 1916, four orders were before the Board of Trade awaiting confirmation; two of these (Kent and East Sussex and Asholme Joint Railway) were confirmed in the following year and two are still under consideration. During 1917, two fresh orders (Darlington and Newport, Mon.) were submitted to the Board by the Light Railway Commissioners for confirmation. Both orders were confirmed during 1917.

The 21st annual report of the Light Railway Commissioners states that a total of 683 applications for orders to authorise light railways (including 124 applications for amending orders) have been made since the commencement of the 1896 Act. In respect of 447 applications (two in 1917 and 445 in previous years) orders have been submitted to the Board of Trade for confirmation; 10 other applications, in respect of which orders are under settlement, have been approved by the Commissioners; and 214 have been rejected or withdrawn. The inquiries with respect to seven applications have been deferred at the request of the promoters and under existing circumstances, and in one case the Commissioners decided to take no action for the present, while four new applications made in November last remain to be considered.

A High-Voltage Oil-Immersed Strain Insulator.—In the "Electrical Review & Western Electrician" we note a description of some special insulators used in connection with the four 3-phase, 60,000-volt circuits and three grounded overhead conductors, installed at Maumee River. The span of 1,300 ft. is supported by 190 ft. steel towers on either bank. The voltage on the insulators will, eventually, be 66,000 volts and the load carried by each insulator will approximate 6,000 lb. The insulator is made up of two heavy wooden members which are connected together by an end casting of special design, and so arranged that the stresses between the wooden members are at all times equalised whilst the grip of the end castings increases with increasing tension. A porcelain jacket or sleeve, equipped with two integral flanges, surrounds these wooden members. This porcelain sleeve is never under tension, however, and acts as a container for the oil or compound with which the insulator is filled and is designed to keep the flash-over on the outside. A reservoir is provided to take care of the expansion and contraction of the oil or compound under varying temperatures. The joint between the porcelain sleeve and the end casting is flexible so as to allow for unequal expansion and contraction and yet is so designed that leakage of oil or compound cannot occur under the most extreme variations of position. The insulator described measures more than 4 ft. overall, the larger insulator petticoat having a diameter of 15 in. This type of insulator is how being built for 120,000-volt service and to carry continuously loads of approximately 35,000 lb.

Obituary.

JOHN BOTTOMLEY.—The death occurred on the 16th inst. in New York of Mr. John Bottomley, vice-president, secretary and treasurer of the Marconi Wireless Telegraph Co. of America.

E. C. GEALE.—We regret to announce the death on the 13th inst at Crouch End of Mr. Edward C. Geale, of the India Rubber, Gutta Percha & Telegraph Works Co. He joined the head office staff at the end of 1883, and after serving in various capacities, was appointed accountant of the company in 1903. He was interred at the St. Pancras Cemetery (Finchley) on the 17th inst.

DEATHS ON ACTIVE SERVICE.—The following death is reported:

Private Patrick Toole, K.O.R.L. Regt. (formerly employed at Blackburn electricity works), and Private Edwin Loder, King's Shropshire Light Infantry (formerly tramcar conductor at Burnley), have succumbed to wounds received in action.

Personal.

We regret to learn that Mr. Thomas Roles, city electrical engineer of Bradford, has had a breakdown due to overwork, and will not be able to return to business for some time. Our readers will no doubt join us in wishing Mr. Roles a rapid and complete recovery.

Arrangements for the Week.

FRIDAY, June 28th (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Papers to be read on "A New Method of Measuring Alternating Currents and Electric Oscillations," by Mr. I. Williams, M.Sc.; and "A Demonstration of Coupled Vibrations," by Prof. E. H. Barton, F.R.S., and Miss H. M. Browning, B.Sc.

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Problems of Coal Handling.

By W. B. WOODHOUSE.

Summary.—The coal pile at a power station may be regarded in the nature of an insurance. In order to arrive at the quantity that is desirable the variations in the supply and demand must be considered. Curves are given showing these variations; also data in regard to the quantities necessary for a station with a load of 100,000 kw. and the ground that would be required for sidings. In conclusion, the various types of plant available for handling coal and ashes are indicated.

The problem of handling coal and ashes in power stations becomes increasingly important as the size of station grows, because of the greater dependence which must be placed on mechanical means of handling, and of the increased bearing which the cost of the coal delivered to the boilers has on the cost of the electrical energy produced.

A general consideration may be of value in emphasising the conditions which determine the type of coal and ash-handling plant to be adopted in any particular case and in indicating the requirements of a site suitable for a large power station.

The particular methods adopted for the handling of the materials will, however, be determined finally by local considerations, as the choice of a station site must be made in the light of other requirements; consequently the coal handling arrangements must be adapted to the site, and no one method or arrangement can be laid down as being of universal application.

The subject may be divided conveniently into the following parts:—

1. The nature of the materials to be handled.
2. The method of transport to and from the site.
3. The variations of supply and demand to be provided for.
4. The methods of handling and storing suitable in any particular case.

Nature of Materials to be Handled.

Both coal and ashes have marked characteristics which govern the methods of handling adopted.

So long as power stations continue to burn raw coal for steam raising, the engineer's business is to deliver to the boilers at a minimum cost the maximum of available heat energy in the form of coal. This involves a consideration, not only of the cost of transport and handling, but of the market prices of various coals, and an estimation of the future trend of prices.

Small coal, on which the business of power supply at present depends, has in recent years increased in price more rapidly than any other class, and, in the case of coking coals particularly, this relative increase seems likely to become more marked in the future, so that power stations will in some areas, if not in all, have to consider the purchase of large coal to meet their needs. In such case crushing plant must be provided, and the possibility of extra handling considered.

An equally important consideration is that of coal washing; the presence of incombustible material in coal is doubly detrimental, as not only is the available fuel constituent reduced by the presence of dirt, but, in addition, some of the heat value of the coal is wasted in the fusion and heating of the ash. If washed coal be purchased there is a saving in the weight of fuel transported, an improvement in combustion and a reduction of the amount of ashes.

All collieries may not be able to supply washed coal, and in some cases, therefore, the power station may have to consider the provision of a washery.

Of even greater importance to the future is the question of economical coal distillation for power production and the recovery of by-products.

The adoption of such processes will modify the coal-handling requirements in certain respects, will undoubtedly require a larger amount of coal to be dealt with, and may call for rehandling of the carbonised residue for use elsewhere than at the station.

In selecting a station site these points should be borne in mind and sufficient area reserved for carrying out the ancillary processes when required.

Apart from the possible necessity to treat coal in any of the ways above mentioned, provision must be made for storage of a considerable quantity, primarily for security of supply in the event of failure of deliveries from any cause; secondly, to equalise the incidence of supply and demand in normal working, and possibly also to take advantage of market conditions by purchasing and stocking coal at times of low prices.

The exposure of freshly-mined coal to air results in oxidation of its combustible elements and a consequent loss of calorific value. There is a great difference in the liability of coal to "weather," dependent on the kind of coal (lignite, bituminous or anthracite), on the presence of moisture and of sulphur compounds, and on its size; weathering is also affected by the time of exposure, the initial temperature of storage and the size and shape of the coal pile. Much research work has been carried out on this subject from which certain practical conclusions may be drawn.

Coal depreciates on its removal from the mine in two ways, by (1) loss of calorific value due to oxidation, and (2) disintegration caused by handling or arising from the oxidation of carbonaceous matter or of the bands or layers of mineral matter.

In bituminous, semi-bituminous and anthracitic coal the loss by oxidation is not great, varying with steam coal from 1 to 2 per cent. per annum for the first few years, but the loss by disintegration may, in course of time, become serious.

Both oxidation and disintegration depend on the size of the coal; the smaller coal, having a greater ratio of surface to volume, depreciates the more rapidly, so that as an ultimate reserve of fuel which may remain in stock for a number of years, large coal is to be preferred.

The possibility of spontaneous combustion or firing depends on the method of storage; coal stored in stacks not exceeding 10 ft. in height and freely exposed to the air, sun and rain, is not likely to fire spontaneously. If the coal be stored under water the oxidation is also checked, but the method is a costly one, and does not merit consideration where sufficient land at a reasonable cost is available for storage.

When coal is stored in bunkers with no access of air, a greater depth may be maintained with safety, but bunker coal is usually handled quickly, and the extra expense of closed bunkers is generally unnecessary. Coal in deep bunkers or heaps will steadily rise in temperature until firing starts, and therefore such heaps must not be allowed to remain unchanged for any length of time. It is not possible to set an exact limit to the time coal may be stored safely in deep bunkers, as this is dependent on the nature of the coal, but as a working figure it may be taken that small coal stored to a depth of 20 ft. will in places rise in temperature about 2°F. per day. Above 212°F. this action accelerates rapidly until firing takes place.

Generally the effect of weathering is to reduce the proportion of carbon and hydrogen in the coal and therefore the calorific value, to increase the proportion of combined water, and to diminish the power of consuming oxygen from the air, so that incidentally coal stored for a lengthy period will require to be burnt under conditions of greater draught than that required for freshly mined coal.

In short, coal will lose some of its heat value every time it is moved, and some more each day it is in stock; consequently, the transport or handling apparatus should be designed to minimise fracture or disintegration of the coal arising from its movement; the number of movements between mine and boiler should be as few as possible, and storage arrangements should be designed to minimise disintegration and oxidation so far as is consistent with the cost of storage and the expense of re-handling.

Ashes, having unfortunately a negative value, do not depreciate, but their characteristics involve careful consideration when large quantities are to be dealt with. In many existing stations the handling and disposal of ashes has been an afterthought, so that as their production grew they became a bugbear and a source of considerable cost.

Except as ballast or earthworks the commercial use of ashes is very limited, and disposal usually resolves itself into dumping the ashes on land chosen for convenience and cheapness as near to the station as possible.

The nature of boiler ashes is indicated by the following analysis of a clean burnt ash:—

SiO_2	43·25 p.c.	K_2O	0·70 p.c.
Fe_2O_3	20·50 „	Na_2O	2·12 „
Al_2O_3	28·32 „	SO_3	1·82 „
CaO	2·50 „		
MgO	0·29 „		99·50 p.c.

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The characteristics of ashes affecting handling plant are grittiness and the possible presence of unburnt carbon, requiring them to be handled when hot and subsequently burnt clean; they may be also corrosive when wet, though more damage to the coal-handling plant is likely to arise from the dust and grit than from this action.

Experience has shown that it is advantageous to consider the handling of coal and ashes as separate matters.

TRANSPORT TO AND FROM THE STATION SITE.

The method of transport between the mines and the station site next requires a general consideration.

As the large station will most probably be on an important waterway and maybe on the coast, delivery of coal can be made by railway, by canal, or may be in some cases seaborne to the station wharf. A consideration of our coalfields shows that the railway is in the majority of cases, the most probable means of transport, but, in any event, supplies will be received in separate lots, which should, for economical haulage or transport, be as large as possible.

The important part that terminal charges play in the cost of rail transport is well known; a study of the railway companies' rate books will show how much the total cost of transporting material is dependent on the full employment of wagon capacity, and on terminal loading and unloading facilities.

The actual rates charged for coal haulage per ton mile are low; the other charges can be reduced to a minimum by regular deliveries of full-train loads, hence the number of deliveries per day should be as few as possible. To permit of this practice sidings are required of ample capacity to relieve the railway company of any delay or extra work.

Having fixed the number of daily deliveries the extent of the sidings can be decided, but here it is not possible to lay down a general rule; the position of the station relative to the railway, the nature of the coal-handling machinery and the design of the coal stores and boiler houses all affect the total siding length required.

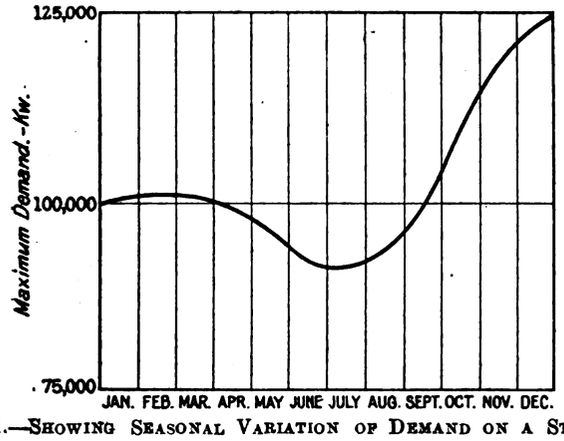

FIG. 1.—SHOWING SEASONAL VARIATION OF DEMAND ON A STATION FROM WHICH OUTPUT IS GROWING.

There are other important considerations which must not be overlooked; the present-day 10-ton wagon will, it is hoped, be superseded by larger ones, which should reduce the need for siding accommodation as well as the inefficiency of transport.

Generally speaking, however, there must be considerable uncertainty as to future needs, and although the minimum siding accommodation required can be fixed without difficulty, yet the growth of the station load and the prospect of using more coal for the reasons mentioned above, make it advisable to take a liberal view of future requirements.

The delivery of coal by canal or ship involves similar considerations as to dock, wharf or basin accommodation sufficient to permit coal handling for the station needs without disturbance to the other traffic on the water.

The vessels bringing the coal to the station may to some extent be used to remove the ashes, and in the case of canal boats there is an interesting field for the designer in adapting the vessel to the varied requirements, involving ease of loading and unloading, in turn, both the coal and the ashes. The lifting of the vessel bodily from the water by a hoist, or the addition of wheels to enable it to be run on to rails as a wagon are examples of special arrangements which may be fully justifiable in certain cases.

VARIATIONS OF SUPPLY AND DEMAND.

The conditions of supply of, and demand for, coal which have to be met in a large power station are, though to some extent variable, not difficult ones; the problem is to supply by intermittent deliveries a continuous demand whose variations can be predicted with fair accuracy, to provide a reserve or storage to equalise the supply and demand at all times, and to do both at a minimum of cost.

The first consideration is that of the quantity of coal and ashes to be handled, figures easily arrived at when the output of the station is known.

The next is the variation of the rate of consumption over yearly periods, such as have to be considered in providing the coal supplies. This variation may include that due to a growing output as well as the characteristic seasonal variation in the summer months due to sunshine, warmth and human nature. Fig. 1 may be taken as an example of this.

If the load-factor is approximately constant the coal consumption throughout the year will vary as the load curve, and provision must be made for the equivalent supplies. The deliveries of coal should follow this variation closely if storage and handling are to be minimised, but market conditions may make it advisable to take regular monthly quantities, or even to increase the purchases at times of low prices. These considerations amongst others, will affect the total amount of coal required to be held in stock.

The stock of coal required may be considered conveniently as made up of two parts: the main reserve stock, which must be provided for security of supply of electricity in the event of an interruption or disturbance of supplies of coal from any external cause, and the working stock, which is necessary to adjust the incidence of supply and demand from hour to hour in normal operations.

The coal held in the reserve stock is in the nature of insurance, and the proportion which it should bear to the annual consumption is necessarily a matter of opinion. A cessation of a public supply of electric power might, by stopping the machinery of the factories and workshops using the supply, throw out of employment a large number of workpeople, and cause consequential losses in two or three days larger in amount than the cost of power for a month, so that on these grounds the provision made for security of supply should be substantial. On the other hand, the annual cost of the reserve stock goes to increase the cost of electricity, involving, as it does, interest on the cost of coal in stock, an allowance for its depreciation and a fraction of the cost of handling dependent on the average time the coal is held in stock. It is unlikely that the bulk of the reserve stock will, once deposited, be handled frequently, and the cost of handling is therefore of relatively less importance than the other charges.

Delivery of coal may normally be depended on for 300 days a year, but fog, snow or accident may reduce this; colliery difficulties may prevent regular or full supplies, and other disturbances are possible which may cause a total cessation.

Taking everything into account, from two to three months' supplies may be considered a sufficient reserve, which, allowing an average of several years for turning it over, may involve an increase of from 1 to 2 per cent. in the total cost of the energy sold.

The working stock is determined from a consideration of the variation between consumption and deliveries from hour to hour during the week, which may be estimated from a study of the load curve and from the known hours of delivery of coal. It is unlikely that coal will be delivered on more than six days in the week, it is usual to confine the period of delivery to daylight hours, and a certain minimum working stock is desirable under normal conditions so as to allow time for supplies to be drawn from the reserve when abnormal conditions arise. These points are illustrated by an example which follows, but one other may be emphasised here—that at any point in the transport of coal where a change of carriage takes place, provision must be made for storage of an amount sufficient to equalise deliveries and withdrawals at that point for a time sufficient to ensure continuity of supply.

Every change of carriage therefore involves cost in three ways—(1) depreciation of the coal, (2) cost of handling, and (3) cost of storing.

METHODS OF HANDLING.

A detailed consideration of the types of plant suitable for handling coal and ashes is beyond the scope of this article, but as the decision as to the most suitable type depends so much on special circumstances, it may be of interest to consider a typical case which will indicate the points to be decided and their effect on the choice of the station site.

The following data are assumed:—

Maximum load at end of year		125,000 kw.
Average weekly maximum load		100,000 kw.
Output, units per annum		438,000,000
Coal consumption, per annum	tons	391,000
Weekly consumption, average	tons	7,520
Weekly consumption, maximum	tons	9,400
Ashes, per annum	tons	58,650
Ashes, per week, maximum	tons	1,410

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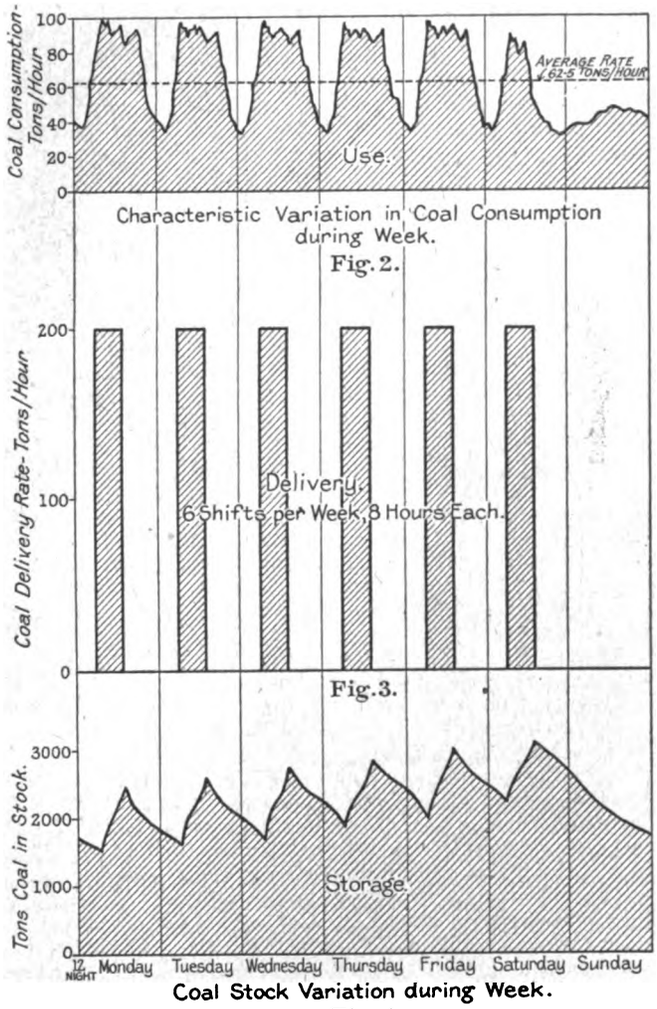
Assuming that delivery is to be made by rail the first consideration is the extent of sidings required. It would seem advisable for several reasons to assume that the deliveries under normal conditions will be confined to eight hours a day and six days a week. In each case the maximum weekly consumption of 9,400 tons must be met at the rate of 1,570 tons a working day, a total of, say, 160 10-ton wagons a day. Dependent on the number of collieries from which supplies are drawn and on their relative situation, delivery will be made in five or more trains a day and, for ease of handling, from six to eight siding tracks must be provided each of sufficient length for, say, 40 wagons. Add to this requirement the length of track required for connecting lines and junctions, and the total area required for sidings may be estimated. Obviously, the area will depend largely on the station lay-out, and it is impossible to give any general figure, but, as an indication of the magnitude, it may be noted that eight parallel tracks as mentioned above would occupy approximately 1½ acres, and the total area of sidings considerably more.



Coal Stock Variation during Week.

Fig. 4.

The unloading of the wagons will usually be restricted to eight hours a day, requiring only one shift of men and ensuring that the work is carried out in daylight. On the above assumption unloading facilities must be provided to permit delivery to the boiler house or reserve stack as required, at the rate of 200 tons per hour. If this practice be adopted there will be, under normal conditions of delivery, unloading and removal of wagons approximately one-half of the daily deliveries in reserve in wagons on the site. In the case considered this would amount to approximately 800 tons.

The maximum rate of consumption of coal being approximately 100 tons an hour, these delivery facilities may seem excessive, and they may, of course, be reduced by extending the hours, but experience in handling large quantities of coal at collieries shows that a large margin is necessary, as weather conditions often seriously affect railway working.

The discharge of the coal from the railway wagons brings us to the point where the special design commences for each station.

From the first unloading the coal may take two paths, either to proceed forward as directly as possible to the boilers, or, alternatively to the reserve stock for future use.

The minimum working stock is required when there is but one change of carriage between the railway and the boilers.

In the typical case considered this amount may be deduced from Figs. 2 and 3, in which the continuous curve shows the characteristic variation of coal consumption during the week, and the columns show by their area the daily deliveries. Fig. 4 represents the difference at any time between deliveries and consumption or the minimum storage required.

The simplest possible case is that in which the railway wagons discharge direct into the boiler house bunkers. Allowing a reserve in the working stock equal to a normal day's deliveries, the storage required is approximately 3,250 tons.

Before considering any alternative arrangement the reserve stock may be considered. Eight weeks' supply at the average rate will amount to 60,160 tons; this quantity, if stacked in a heap 10 ft. high, will occupy approximately 240,000 sq. ft. Allowing 20 per cent. for access roads and irregularities, the total area required is 6·6 acres.

One important point must not be overlooked in this connection, which is that, although the reserve will naturally be deposited gradually, it must be provided with facilities for rapid removal at a rate sufficient to meet the whole station consumption in the event of a complete failure of supplies.

With an elevated railway such as would permit direct unloading into the boiler house bunkers the re-loading arrangements from the reserve stack may be costly, and in view of their infrequent use, it may be found economical to provide special arrangements for a portion of the reserve stock, depending, in case of continued failure of supplies, on working 24 hours a day in the conveyance of the bulk of the reserve to the boilers.

Again, the relative level of railway and station site may be such as to preclude direct unloading into the boiler house, so that, in the general case, it appears probable that an intermediate means of conveyance must be introduced; if this be done the size of the boiler house bunkers may be much reduced, it being sufficient to provide storage for the reduced consumption at night time; and to deposit the main part of the working stock outside the boiler house.

Much may be said for the provision of a deep stack of coal outside, but adjacent to, the boiler house; the short time that the coal is left in the stack makes the fire risk negligible, and the advantages of having a large quantity of coal which can be delivered to the boiler house by one operation is considerable, both as to capital expenditure on conveyors and convenience in station operation.

The station bunkers in such a case would be reduced in size to hold eight hours' supply at maximum rate of consumption.

Ashes.

In a station such as is considered some 60,000 tons of ashes a year must be disposed of.

It would be wise to make provision for at least 30 years' disposal, possibly for a longer period. Assuming that the ashes are deposited on land, one must provide therefore space for 1,800,000 tons; if spread in an even layer 10 ft. thick, this would cover 165 acres.

Ash handling involves, therefore, the most careful consideration, otherwise the cost may grow after a few years at an alarming rate.

The simplest method of removing ashes from the boilers is to provide under each boiler an ash hopper of sufficient storage capacity to enable all ashes to be removed in the day time, and to deposit them therefrom into wagons for removal to the tipping ground.

Two objections occur to this practice; the ashes are not always thoroughly burnt out and the removal and transport is a dusty and dirty operation.

The method may be developed, therefore, by providing means of quenching and slacking the ashes on or before removal, and if the basement of the boiler house is made high enough to permit the use of large tipping wagons, say, of 5 to 10 tons' capacity, this method can be adopted at reasonable cost.

Alternatively, the hot ashes may be removed from the boiler house by a conveyor, but the heavy cost of maintenance tells against the use of the type adopted for coal handling; so, therefore, the present tendency is for removal through pipes as in the suction ash conveyor, in which the ashes, after being crushed, are drawn into pipes and exhausted by fans or steam jets.

Removal of ashes by a flow of water in pipes or troughs may also be considered, but the possibility of corrosion and the necessity for draining the ashes must not be overlooked.

From the point of view of cleanliness and comfort of workmen, the closed system of transport is admirable, and seems likely to predominate.

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CHOICE OF METHOD.

As to the methods of transporting and elevating coal, there is a wide choice, each type of apparatus having its merits and its limitations. It must not be overlooked that in the large station considerable distances have to be traversed, and that, for example, a method of transport found to be the best for a distance of 100 ft., is not necessarily so for a distance of, say, 600 ft.; also, that simplicity and low maintenance cost are worth striving for.

As an example of the choice open to the engineer, delivery by rail, unloading and depositing on a working stack, and elevating and transporting to the boiler house, may be carried out in the following ways :—

Coal.

Operation.	Type of plant.
Delivery	Railway wagon.
Unloading	Bottom doors.
	Tilting hoist and end doors.
	Tippler.
Transporting and elevating to working stack	Bucket conveyor.
	Belt conveyor.
	Plate conveyor.
	Overhead transporter and grab.
	Pipe conveyor.
	Jib crane
Transport and delivery to reserve stack	Tip wagons.
	Belt conveyor.
	Overhead transporter and grab.
	Crane and grab.
	Ropeways.
Reloading from reserve.	Crane and grab.
	Transporter and grab.
	Portable elevator and wagons.
Transport and elevating to boiler house	Bucket conveyor and elevator
	Belt conveyor inclined.
	Plate conveyor inclined.
	Overhead transporter and grab.

Ashes.

Removal to rail	Suction plant, air or steam.
	Pressure, air or water.
	Tip wagons.
	Hoists, cranes.
	Ropeways.

Having decided as to the quantities of coal and ashes, the rates of delivery, the number of changes in the method of handling and the quantities to be held in stock at the various places, the type of plant should not be difficult to decide, but whatever types are adopted they should, above all, be reliable.

Trade Parliaments and Their Work.

By E. J. P. BENN.

X.—THE BIG IDEA IN BUSINESS.

There will be no lack of material to put upon the agenda paper of the Trade Parliament when once it gets going. Difficulty is more likely to arise owing to the number of questions that the delegates of the various associations and unions will desire to bring up for discussion. When once it is admitted that there is a common interest in a trade which all parties may combine to promote, the possibilities of action widen so rapidly that Trade Parliaments will have to exercise care and discretion in the subjects to which they will devote the limited time at their disposal. It is comparatively easy, as I have done in these chapters, to take a subject at a time and state the various problems that arise in connection with it. In such matters as rationing, demobilisation, the disposal of Government stores, or science or education, the scope of the Trade Parliament is well defined and obvious, but the work of these bodies will extend far beyond the limits of these special branches of work. Their greatest interest is to be found in the fact that they are the embodiment of the new spirit in industry which is the definite outcome of the present war. When the economic history of the last four years comes to be written, it will be pointed out that a revolution, far more important than the industrial revolution a century ago, was quietly wrought in the minds of the people while the guns of the nations were roaring on the battlefields of Europe. Whether it is the result of the comradeship of the trenches or of the general awakening to realities that has taken place since 1914, it is undoubtedly the fact that we are beginning to look upon trade and industry from an entirely new point of view. Instead of the sordid ideas of the past, the sentiments of the future will insist upon the raising of our vocational activities to a much higher place in the social order. Trade as a national service; industry as a social obligation; production as the source of all prosperity; waste in materials or methods in goods or in effect as a crime against the community. These are the sentiments which are generally spreading through the ranks of both employers and employed, and which are having the effect of changing the traditional point of view of both parties.

It must not be assumed from all this that the workers will in future cease to take an interest in the rate of wages paid, or that employers will no longer be concerned with the percentage that can be obtained upon their capital. The reverse is, of course, the case. Labour will never go back to the wages of 1914, while unless the rate of interest upon capital is higher than it was the shortage of that commodity will be sorely felt by industry. Trade of the future must produce more to all parties engaged in it than in the past. In asking, therefore, both employers and employed to shoulder national and social obligations which they have not recognised as theirs in the past, there is no suggestion that they should sacrifice any of that reward which they are entitled to look for as a result of their efforts. Just as by subscribing to War Loan one renders a service to the country and makes a good personal investment, so by taking a national point of view in regard to one's business one may promote the interests of the community and at the same time strengthen one's personal position. The solid fact is that our trades, as trades, have never been given a real chance in the past. They have been torn to pieces between contending parties To begin with, the various firms or companies engaged in a trade have wasted a very large proportion of their energies in senselessly fighting one another, while Labour and Capital have entrenched themselves in two opposing camps, and, at the expense of trade, have devoted a great deal of time, money and effort to squabbling. A simple illustration will make this point clear The American Government recently conducted an inquiry into the condition of the pottery trade in Great Britain, Germany, and America, and produced a volume of statistics and information which is worth the study of every business man. It is shown in this volume that Labour and Capital between them take 58 per cent. of the product of the trade in America and 44 per cent. here. In Great Britain Capital gets 5 per cent. and Labour 39 per cent, and in America Capital takes 10 per cent. and Labour 48 per cent. If the English trade unions were to succeed in securing the whole of the product of the industry as at present carried on they could only get 44 per cent., wherease their American cousins are to-day taking 48 per cent., and there is still a handsome margin left for Capital. The present suggestion is simply that Labour and Capital should put their heads together, as, indeed, they have done in the National Pottery Council, in order to see how they can contrive to get the superior return from their trade that is secured in America. By combined effort and by scientific study of all the circumstances they can actually secure between them a bigger gross figure than that over which they were inclined to squabble in the past.

There is a more serious aspect even than this. With the American trade organised as it is, and with the statistics and information and science which it has at its disposal, it is able not only to take 58 per cent. of the product for itself, but to threaten very seriously every market of the world. These are some of the considerations that have brought Labour and Capital together in the pottery business and that led to the establishment of the National Pottery Council, and I do not doubt that, as a result of that movement, the English pottery trade will not only very much improve the personal position of all those who depend upon it, but will be able to re-establish the paramount position of English pottery in the markets of the world. Thus, we are gradually beginning to get a new conception of industry, and we are beginning to realise the truth that the whole is greater than the part. We are beginning to understand that if we would promote our individual interests, the best way to achieve that object is to join hands with others similarly situated and work together for the common good. Patriotism and self-interest run hand in hand in this matter, because while Labour desires to improve its standard of living and Capital is actuated by the same sort of motives, the nation which contains both is in urgent need of a great increase in the rate of production of wealth. If industry, instead of consisting of a lot of factions of individuals striving for their own ends, were transformed into solid masses of citizens working for the national good, the cost of the war—gigantic as it is—would not present those difficulties which economists, who base their theories upon past experience. are so constantly putting before us.

(To be concluded.)

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Possible Economies by the Use of High-Pressure Steam.

By FREDERICK SAMUELSON, M.I.M.E., M.I.E.E.

Summary.—After a reference to the proposal by Mr. W. L. R. Emmett to use a mercury turbine, the author considers the improved efficiency that is obtainable by increasing both the temperature and pressure of the steam. Emphasis is then laid on the economy obtainable by using steam from the turbines for heating feed water. In conclusion, particulars are given of the high-pressure steam plant at the Rugby works of the British Thomson-Houston Co., Ltd.

The near future will see enormous demands for power generation throughout the world. All countries will have to make the best possible use of their natural power producing resources in the interest of conserving the supply and providing power at a cheap rate.

The great bulk of the power at present generated in the United Kingdom is from coal, the heat energy in the coal being converted into electrical energy by means of boiler, steam turbine and electrical generator. This process unfortunately is very inefficient, but as no better means are available for producing power on a large scale, engineers are incessantly at work upon improvements on the old methods, aiming at higher all-round efficiencies. At the same time individuals and committees are investigating the attractive problem of recovering and using the valuable by-products obtained from the combustion of coal at present lost in the ordinary power-producing steam plants. There is no question but that this field of investigation will yield most gratifying results, but it will take a long time to commercially establish such a combination of by-products recovery and power generation on a national scale.

It is well known that the efficiency of a steam or other heat utilising plant depends upon the two limiting temperatures between which the plant works. Most steam engineering students have spent fruitless hours in trying to create a system whereby the exhaust steam coming from a turbine or engine can be efficienty returned to the boiler without going through the condenser, anld thus save the latent heat in the steam. Our knowledge of thermo-

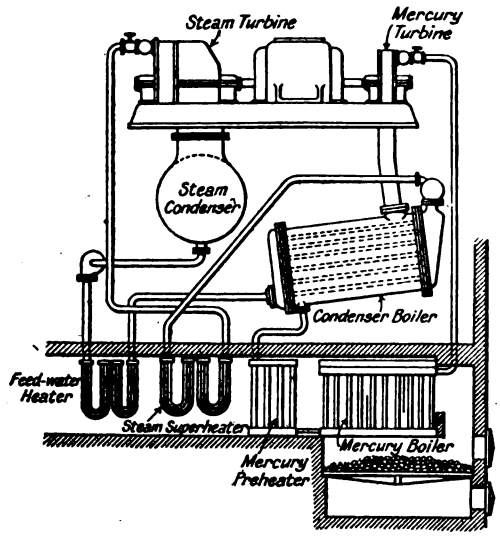

FIG. 1.—DIAGRAMMATIC ARRANGEMENT OF PLANT TO UTILISE MERCURY VAPOUR IN THE GENERATION OF POWER.

dynamics holds out no hope of this being realised in practice, and we have to face the fact that in a steam plant the greater part of the heat in the coal burnt is wasted in the condensing water, which latter also determines the lower limit of the working temperature scale. To obtain a higher efficiency it therefore becomes necessary to raise the upper temperature limit, either by superheating the steam or raising its pressure, or both.

A very interesting proposal to work between greater temperature limits is due to Mr. W. L. R. Emmett.* Emmett superimposes on the steam temperature a high temperature obtained from a second medium, in this case mercury vapour. Mercury boils under atmospheric pressure at 677°F., and condenses in a 28 in. vacuum at 457°F. At a gauge pressure of about 30 lb. the corresponding temperature of mercury vapour is about 800°F. Mercury is vaporised in a boiler heated by a fire in the ordinary way. From this boiler at a pressure not much above the atmosphere the mercury vapour passes through pipes and nozzles to a turbine wheel driving an electrical generator. Attached to the same generator another turbine element is furnished, operating with steam in the usual way. After the mercury vapour has done work in the turbine it passes to a condenser, which is in reality a boiler, where the vapour is condensed on the outer surface of tubes which contain water, and this water is evaporated by the heat given to it by the mercury vapour, the steam generated going to the steam turbine. The condensing boiler is placed at a level above the mercury boiler, so that the condensed liquid will run back into the mercury boiler by gravity without the aid of a pump. Since the mercury vapour is much hotter than steam, the furnace gases will normally leave the mercury boiler at higher temperatures than they would have in leaving a steam boiler. To utilise the excess heat in the gases they are led after leaving the mercury boiler through a heater which raises the returned mercury near to the boiling point; secondly, through a superheater which superheats the steam delivered by the condensing boiler, and, thirdly, through an economiser which heats the feed water for the condensing boiler. A diagram illustrating this heat cycle is shown in Fig. 1. Emmett estimates that a saving of some 40 per cent. in the fuel will be obtainable by the addition of the mercury plant to an ordinary steam plant. Obvious difficulties have to be overcome in such a very original combination to secure satisfactory operation, but the expected efficiency is so high as to warrant patient research and liberal expenditure.

Returning to the consideration of a simple steam system, Fig. 2 illustrates the efficiency ratio obtained from various initial pressures and temperatures. The curves are based on feed water entering the boiler at 80°F., and that adiabatic expansion is carried down to a pressure equal to 28½ in. vacuum (bar. 30 in.). The efficiency ratio shown on the curves is derived from the relationship of :—

$$\frac{\text{Heat available in steam.}}{\text{Total heat in steam}}$$

From the curves it is seen that the efficiency increases with increased pressure or temperature and that the improvement in

Table I.—15,000 *kw. Turbine.*

Full-load steam consumptions and overall efficiencies (without feed heating).

Pressure (lb. gauge)	Vacuum (in.)	Superheat. 100 °F. lbs.kw.hr	100 °F. Eff. %	200°F. lbs.kw.hr	200°F. Eff. %	300°F. lbs.kw.hr	300°F. Eff. %
150	29·0	12·55	22·35	11·53	23·30	10·73	24·07
	28·5	13·03	21·77	11·94	22·74	11·10	23·49
	28·0	13·42	21·29	12·30	22·24	11·42	23·00
	27·5	13·81	20·82	12·65	21·76	11·72	22·55
200	29·0	12·04	23·17	11·06	24·16	10·31	24·90
	28·5	12·46	22·63	11·43	23·60	10·64	24·37
	28·0	12·80	22·20	11·74	23·15	10·92	23·91
	27·5	13·15	21·73	12·04	22·72	11·18	23·48
250	29·0	11·68	23·78	10·73	24·77	10·01	25·51
	28·5	12·06	23·28	11·06	24·27	10·30	25·03
	28·0	12·38	22·86	11·35	23·83	10·56	24·60
	27·5	12·70	22·42	11·62	23·42	10·82	24·15
300	29·0	11·43	24·23	10·48	25·25	9·78	25·99
	28·5	11·77	23·76	10·80	24·77	10·06	25·52
	28·0	12·07	23·35	11·05	24·37	10·29	25·13
	27·5	12·36	22·95	11·30	23·98	10·51	24·75
350	29·0	11·22	24·61	10·30	25·63	9·60	26·38
	28·5	11·55	24·14	10·59	25·17	9·86	25·94
	28·0	11·82	23·78	10·83	24·80	10·08	25·56
	27·5	12·09	23·39	11·06	24·41	10·29	25·18
400	29·0	11·06	24·89	10·17	25·87	9·45	26·70
	28·5	11·36	24·47	10·42	25·50	9·70	26·27
	28·0	11·62	24·11	10·65	25·13	9·90	25·92
	27·5	11·87	23·76	10·87	24·77	10·11	25·53

* A.I.E.E., Vol. XXXIII., *see* THE ELECTRICIAN, Vol. LXXIII., July 17, 1914, p. 601.

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efficiency is greater the higher the temperature. For instance, at 175 lb. absolute pressure, an increase in temperature from 700°F. to 800°F. increases the thermal efficiency twice as much as does the rise in temperature of from 400°F. to 500°F. The relationship of pressure and efficiency will also be readily observed. For instance, the same efficiency is obtained with steam at 300 lb. pressure and 500°F. temperature as at 175 lb. pressure and 800°F. temperature. As the highest permissible safe working temperature of steam is about 800°F. as applied to ordinary boiler, pipe and turbine material now in use, higher economy can only be obtained by increasing the pressure. The curves give the theoretical values, and for simplicity have been drawn only for 28½ in. vacuum.

To further illustrate what influence the operating conditions have on steam consumption and efficiency, the following Table I. has been prepared, which is applicable to a turbo-generator set of about 15,000/20,000 kw. rating. The figures given in the table are based on a feed-water temperature 5°F. below the temperature corresponding to the vacuum in each case—boiler efficiency of 100 per cent. and no power for auxiliaries. The relative value of the efficiencies in the table will hold good for all sizes of turbo-generators, but will vary in absolute value in accordance with the size of unit under consideration.

It is hoped that the table will be useful to engineers contemplating extension to their existing plant, or erecting new stations. It has taken some 50 years to increase the boiler pressure from 50 lb. to 200 lb., and further increases in pressure will take time, but are sure to come, and come to stay.

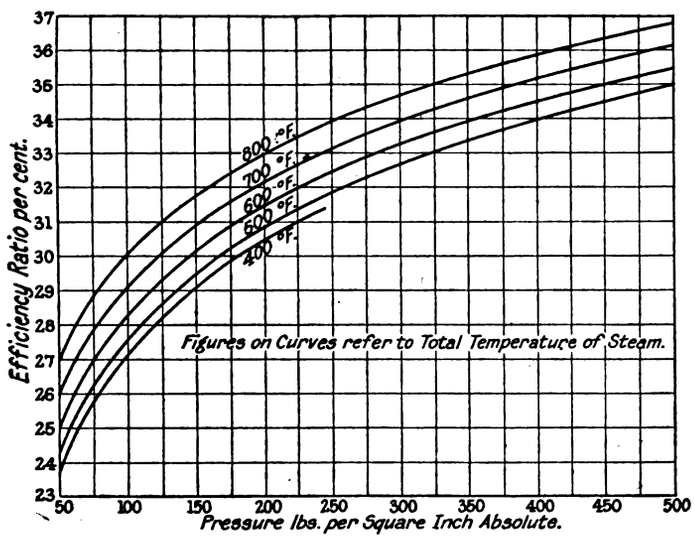

FIG. 2.—RELATIVE EFFICIENCY OF ADIABATIC EXPANSION. Feed-water temperature, 80°F. 28½ in. vacuum.

Feed water heating by means of steam tapped from the turbine has of late received deserving consideration, as considerable economies can be effected by this means. The higher the feed water is raised in temperature the greater is the saving effected, which is only natural as less heat is taken away by the circulating water. Fig. 3 illustrates diagrammatically a feed heating arrangement.

The saving that can be effected from feed water heating by tapping the turbine is shown in the Table II. below. Here, as in the previous table, boiler efficiency is assumed to be 100 per cent., and temperature of condensate 5°F. below the temperature corresponding to the vacuum in each case. Looking at Table I. above under 350 lb. pressure, 300°F. superheat, 29 in. vacuum, the steam consumption is found to be 9·60 lb. and the efficiency 26·38 per cent., the feed water temperature being 74°F. From the Table II. below it will be seen that with a feed water temperature of 300°F., other conditions being the same, the steam consumption has gone up from 9·60 lb. to 10·72 lb., but the overall efficiency has increased from 26·38 to 28·44 per cent., representing a very marked saving of over 7·5 per cent. in fuel. This example at the same time provides an excellent illustration of the erroneous conclusions apt to be formed by considering only the steam consumption per kilowatt as the sole criterion of real efficiency.

Table II.

Steam pressure and temp. of feed water.	Vacuum (in.)	Superheat. 100°F. lbs.kw.hr	Eff. %	200°F. lbs.kw.hr	Eff. %	300°F. lbs. kw.hr.	Eff.%
350 lb.	29·0	11·81	26·02	10·81	27·05	10·05	27·81
	28·5	12·10	25·40	11·05	26·46	10·26	27·24
200°F.	28·0	12·30	24·99	11·25	25·99	10·43	26·79
	27·5	12·53	24·53	11·45	25·54	10·63	26·29
350 lb.	29·0	12·70	26·64	11·58	27·66	10·72	28·44
	28·5	12·98	26·07	11·83	27·07	10·94	27·87
300°F.	28·0	13·22	25·59	12·05	26·58	11·14	27·40
	27·5	13·47	25·12	12·25	26·15	11·33	26·91

With a high-pressure plant working with, say, 350 lb. steam pressure and a temperature of 750°F., steam can conveniently be taken out for warming the feed water up to 300°F. Before tapping, the steam would have done work in the turbine equal to about 47 per cent. of the steam going to the condenser. As the remainder of the heat in the tapped steam, including the latent heat, is going into the feed water, the efficiency of this portion of the steam is practically 100 per cent., against about 26 per cent. for the steam passing all the stages of the turbine and the condenser. To secure the highest efficiency it is clear that the steam should do as much work as possible in the turbine before being tapped for heating purposes, and when the feed water is heated to such a high temperature as 300°F. it will be desirable to tap the turbine at two or more places, putting the heaters in series and pumping the condensate through same in contra flow. Such a system can be made comparatively simple, and the condensate pumped direct from the condenser to the boilers without being exposed to the atmosphere, thereby minimising the amount of air getting into the boilers with resultant better vacuum and less liability to corrosion.

Many manufacturing processes—such as paper mills, soap, oil and cellulose works, &c.—require large amounts of low-grade heat. As the steam turbine, especially when working with extra high-pressure and temperature, is particularly well suited for tapping for heat extraction, it should be used for this purpose to the fullest possible extent. In selecting a site for a new power station this valuable feature of the turbine should be kept in mind with the view of grouping such factories around it with mutual benefits arising out of the sale and purchase of heating steam for manufacturing purposes.

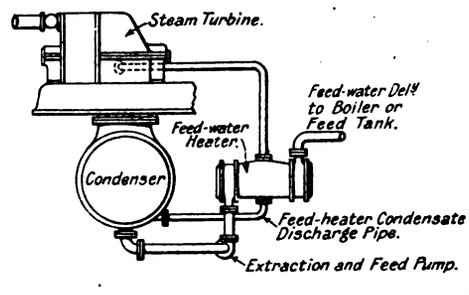

FIG. 3.—DIAGRAMMATIC ARRANGEMENT OF FEED-WATER HEATER.

With high-pressure boilers the quality of the make-up water must be carefully studied. A small amount of lime in the water is beneficial, as it protects the steel from corrosion to which it is liable if the boiler is too clean and pure distilled water used, the corrosion being due to presence in the feed water of carbonic acid which is neutralised by the addition of lime. On the other hand, if too hard water is used, blow-down will have to be resorted to frequently, which does not aid efficiency. When the make-up water is of a nunsuitable character, evaporators will be found very useful. These would take the required heat from a suitable tapping on the turbine, the evaporated water will be condensed in the feed heater, and practically all the heat required for evaporation be recovered. Fig. 4 illustrates diagrammatically a feed water heating arrangement combined with evaporator.

If the feed water enters the boiler at such a high temperature as 300°F. the gases going to the chimney will be considerably hotter than is the case where the feed water enters at about 140°F., which is the usual feed water temperature in most stations. Valuable heat would thus escape, and steps must be taken to prevent this loss.

At present most power station boilers are fitted with a heater section, commonly termed "economiser." The feed water passes through the tubes of this section, being heated by the combustion gases leaving the boiler. Where high temperature feed is used a convenient arrangement would be to retain this economiser in a modified form, and pass air instead of water through the tubes, the heated air being delivered to the combustion chamber of the boiler. Such a heater would be inexpensive and its maintenance costs low. As the temperature of the entering air is low, the gases going to the chimney could be reduced to a lower temperature than is possible

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in the case of a water-type economiser, where the feed water is pumped in at a temperature exceeding 100°F. The ventilating air coming from the electric generator should also be led to the boiler furnace, as for each kilowatt generated the ventilating air carries away with it about 100 B.Th U.'s, which can be conveniently recovered in this way instead of escaping to the atmosphere.

Reheating the steam between the stages of a turbine was proposed by Ferranti many years ago, but has not found any general favour, due no doubt to the difficulties of its practical application entailing an unrecoverable loss in steam pressure and additional radiating losses, the resulting net gain in efficiency hardly warranting the extra complication.

The data given above clearly prove on purely theoretical grounds that higher steam pressures and temperatures should be used in order to ensure the maximum efficiency in power generation. The extent to which advantage has been taken of these possibilities of increasing the efficiency in practice has been very limited, engineers having possibly been too much inclined to adopt the more comfortable policy of "wait and see" before committing themselves. General interest in the question is, however, increasing rapidly, and a wider application may be looked for in the near future. Some of the more progressive consulting engineers have plants on order on the lines advocated here, and even at higher pressures than shown in Tables I. and II. A valuable and welcome contribution to this subject by Mr. J. H. Shaw, of Bradford, was recently presented before the I.E.E., and will no doubt stimulate discussion and promote further interest amongst engineers.

A 350 lb. pressure plant was designed by the writer in 1913, and put into service late in 1914 at the works of the British Thomson-Houston Co. (Ltd.), Rugby, and it may be of interest to give a brief description of same.

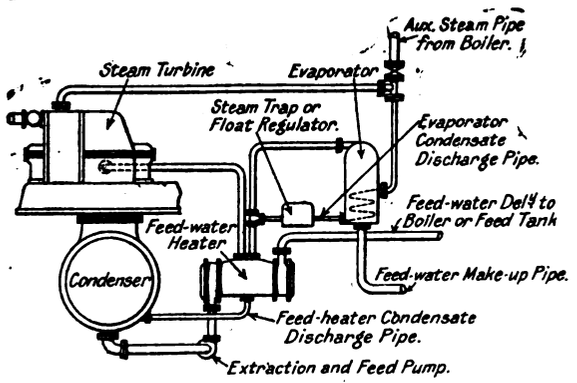

FIG. 4.—DIAGRAMMATIC ARRANGEMENT OF EVAPORATOR AND FEED WATER.

It was decided to make the capacity of the plant 1,500 kw. normal rating, and it was hoped that 500 lb. steam pressure could be used. After consultation with Messrs. Babcock & Wilcox, who supplied the boiler, a compromise pressure of 350 lb. was decided upon, the steam to be superheated to a total temperature of 700°F. The capacity of the boiler is 18,000 lb. of steam per hour, and the type selected was the maker's well-known self-contained marine type, with boiler, superheater and economiser sections inside one casing, and fitted with chain-grate stoker and induced draught. The turbine, which is of the Curtis impulse type, was built to standard design, slightly modified to suit the higher steam conditions. The alternator is totally enclosed, and the air used for cooling is delivered to the boiler grate. The plant was put into service at the end of 1914, and has run continuously since that time except for the usual shut downs for overhaul and inspection. The steam consumption taken on the turbine shows a consumption of 11·2 lb. per kilowatt-hour at full-load with 350 lb. pressure, 700°F. total temperature, and 28½ in. vacuum. It should be pointed out that the turbine was not specially designed throughout for the higher steam conditions, as standard parts available in 1913 were made use of. If the turbine had been specially built for the higher pressure, the steam consumption would be reduced about 3½ per cent. Tests on the boiler show an efficiency varying from 80 to 83 per cent. During a 10 hours' test at full-load the actual fuel consumption was 1·83 lb. of coal per unit generated, the vacuum obtainable during this test being only 27·7 in. The average heat value of the coal as fired was just under 11,000 B.Th.U.s per lb., or the equivalent to 20,000 B.Th.U.s per unit generated. The steam and fuel consumptions referred to above do not include for power taken for the auxiliaries which could not be properly estimated, as the circulating pump was also supplying other condensers. Originally it was intended to erect the plant for experimental purposes only, and if found satisfactory to dispose of it afterwards. The plant proved so successful and economical, however, that it was decided to retain it as a permanent addition to the works generating plant. A saving in coal of 15 to 18 per cent. was expected as compared with the results obtained on the other plant hitherto available, working under similar steam conditions to those prevalent in the majority of power stations in this country. It was gratifying to note, that notwithstanding the constantly varying load and power conditions experienced in a large works, the expectations were more than realised. Only minor troubles have been met with either in the turbine or in the boiler. Some of the parts in the turbine were found unsuitable for the high temperature and had to be renewed, but these have been of minor character, and have not interfered with the operation of the plant. Apprehension was expressed by many engineers as to the possibility of finding a blading material to satisfactorily stand up to the high temperature of the steam, but no difficulty has been experienced. The temperature of the steam changes with the load on the plant, and the half-hourly records show a variation of between 625°F. and 760°F. measured at the turbine stop valve. With regard to the boiler, a certain amount of corrosion or rusting has been set up inside some of the economiser tubes, believed to be due to the presence of carbonic acid entering the boiler with the feed water. The water trough in the main steam drum is likewise corroded, presumably due to the same cause. This rusting was first noticed last summer, and on the boiler being opened up during the last Easter holidays it was found that the rusting is still continuing. In order to free the feed water from entrained air as much as possible before entering the boiler the temperature of the feed water will be raised from 120°F. to 180°F., and some lime will be added to neutralise any carbonic acid which may be liberated in the boiler, and it is expected that this treatment will stop the rusting. The main tubes and other parts of the boiler, including the superheater section, are in good condition, and show no signs of attack either inside or outside. All valves and fittings on the boiler and turbine are in good condition, none having required renewal. The turbine is located close to the boiler, and no difficulties have been experienced from leaky joints or pipe expansion, a point not to be overlooked where any considerable length of piping is used.

From the practical experience gained, and from the technical data given above, the writer would unhesitatingly recommend the adoption of higher steam pressures and temperatures, especially where new stations have to be built. Although experience has only been had with a plant of comparatively small size, there is no fundamental difference to contend with in a station of very large capacity having generating units of 25,000 kw. rating. The latter probably represents the largest single unit that can be conveniently installed in the near future in view of the necessity of efficiently utilising the highest possible vacuum obtainable, the difficulties of electrically controlling larger units and the limitation of railway transport.

Lightning Arrester Spark-Gaps.—Some interesting problems in the design of lightning arrester spark-gaps were dealt with by Mr. C. T. Alcutt in a recent Paper before the American Institute of Electrical Engineers. The author discussed in some detail the results of previous investigations on the subject of impulse voltages, and especially the provision of adequate protection against transient voltages on steep wave fronts. A case of special interest is that which occurs when a high frequency impulse is super-imposed over a low frequency wave. With a view to protection against the effect of steep wave fronts in this case selective action on the part of spark-gaps is very desirable, and the author described a form of "impulse protective gap" which is considered specially effective in providing against these disturbances. Among other points emphasised in the design may be mentioned the use of an impulse ratio (*i.e.*, the ratio of the impulsive breakdown voltage of the gap to the continuously applied breakdown voltage) of less than unity, and in fact as low as possible. The impulse ratio was found to depend very materially upon the shape of the electrodes, the length of the gap, and the nature of the wave. Needle gaps, for example, often have a ratio exceeding two, while for sphere-gaps the ratio is consistently near to unity. The form of impulse gap preferred by the author utilises two gaps in series, each shunted by a comparatively high impedance but designed to exercise selective effect at two different frequencies, and is stated to have given very favourable results.

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The Maintenance of Economy in the Boiler House.

By D. WILSON, A.M.I.E.E.

Summary.—The author lays stress on the importance of keeping regular and detailed records of the performance of a power station. This is particularly important in the boiler house. After dealing with the question of transmission of heat, the author describes the sampling and testing of coal with a view to accuracy, and lays down the routine that is desirable in regard to the control of flue gases and combustible in ashes.

The average thermal efficiency of electric generating stations in Great Britain does not exceed 10 per cent., whilst the highest figure we have on record is that for Detroit, U.S.A., of 17 per cent; and when discussing concentration schemes and super-power stations, and comparing the relative value of such, estimates should be based not upon the average results, but upon what the average should be if each station was operated at the maximum efficiency possible.

Whilst there are many well-known factors which account for the low average efficiency, the present figure could, no doubt, be raised considerably by much closer supervision in the boiler house, and in this respect it is now generally accepted that, so far as electric power stations are concerned, the boiler house must in the future receive much more scientific consideration than in the past.

This fact has already been recognised fully in America, and the late Mr. A. Stott, chief engineer of the Rapid Transit Railway, New York, was seriously considering the appointment of college graduates to act as actual firemen.

The writer believes that the very low thermal efficiency of many electric stations is largely due to the fact that scientific data are not regularly collected and tabulated for each section of the works. It is a serious reflection on our methods that in a great many stations such data are not forthcoming, whereas detailed information of this sort should be before the engineer responsible at least once a week—details such as the Victoria Falls & Transvaal Power Co. embody in their excellent weekly returns for each power house, and which the writer again reproduces below:—

ELECTRICAL STATIONS REPORT.

Output.

1. Units sent out to network .....
2. Station consumption, per cent. .....
3. Machine load factor, per cent.....
4. Boiler load factor, per cent.....
4*a*. Station load factor .....

Coal.

5. Pounds per unit sent out .....
6. Energy value, kilowatt-hours per lb. .....
7. Uptake temperature, degrees centigrade .....
8. Percentage of CO_2.....
9. Ash, per cent. of coal burnt .....

Water.

10. Condensed water per unit sent out, lb. .....
11. Water evaporated per unit sent out, lb. .....
12. Water evaporated per lb. of coal, lbs.....
13. Feed water temperature .....

Vacuum Temperatures.

14. Inlet channel T_1, degrees centigrade .....
15. Outlet channel T_2, degrees centigrade.....
16. Condensate T_e, degrees centigrade .....
17. Vacuum T_c, degrees centigrade .....
18. K=Kilowatts per square foot per 1°C. .....

Steam.

19. Gauge pressure at boilers, lbs./square inch .....
20. Temperature at boilers, degrees centigrade .....
21. Gauge pressure at machines, lbs./square inch .....
22. Temperature at machine, degrees centigrade.....

Efficiencies.

23. Turbine house, including auxiliaries .....
24. Steam .....
25. Boiler house, including steam range .....
25. Overall .....

REMARKS:—

Economy in the boiler house involves the close consideration of many scientific details, the more important being:—

1. Heat Transmission.
2. Coal analysis.
3. Flue gas analysis.
4. Combustible in ashes.

TRANSMISSION OF HEAT.

The question of heat transmission involves a study of radiation, convection and conduction, and each of these distinct modes is governed by a definite law not applicable to the others. Before the heat reaches the body of the boiler water it changes its mode of travel at least twice. It is first imparted to the dry heating surface (*a*) by radiation from the hot fuel bed, the furnace walls and the luminous flames, and (*b*) by convection from the hot moving gaseous products of combustion. When the heat reaches the dry surface it changes its mode of travel, and passes through the soot, metal and scale to the water side purely by conduction; from the water side of the heating surface the heat is carried into the boiler water itself mainly by convection.

The quantity of heat a boiler will absorb per unit of time depends almost entirely upon the quantity of "available heat" given (that is, the heat which is above the temperature of the boiler water) delivered to it. Unfortunately, the boilers in common use can only absorb a part of the available heat, and this part expressed as a percentage of the total heat available is the true boiler efficiency (not the usual commercial efficiency), and is thus represented by the equation:—

$$\text{True boiler efficiency} = \frac{\text{Heat absorbed by boiler}}{\text{Heat available for boiler}}$$

From the above remarks it will be seen that the efficiency of the boiler is affected by the percentage of heating surface so exposed to radiation from the fuel bed, furnace walls and flames as to receive heat both by radiation and convection; but by far the greater proportion of the surface receives heat only by convection from the moving gaseous products of combustion.

The greatest resistance to the flow of heat is experienced before the hot gases reach the dry heating surface. If a boiler is moderately clean, the resistance of the plate to the flow of heat is very small, and the resistance to the passage of heat from the plate into the boiler water is also very small; in fact, a clean heating surface can transmit to the boiler water practicallly all the heat that is imparted to its dry surface. The problem, therefore, is to increase the rate at which heat can be imparted to the dry surface of the heating plate, because thereby the rate of steam production will be increased in the same proportion, and as most boilers derive the principal part of their total heat from convection we may, by increasing the rate of this process, cause a nearly proportionate increase in the rate of steam production. Thus, with the initial temperature of the moving gases remaining constant, and the velocity with which the latter pass over the heating surface increased, we shall increase—in an almost direct ratio—the rate at which heat is imparted to the dry heating surface, and therefore also almost directly the rate at which steam is made.

The rate at which heat is imparted to a unit of surface depends upon the number of gas molecules coming in contact with it; in other words, the rate of heat impartation is directly proportional to the rate at which molecules of gas pass forward and backward from the stream to the metal surface. This brings us back to the question of the velocity of the flow of gases. Given small passage-ways for the heated gases, the gas particles would be likely to make more contacts in a unit of time than if the passage-ways were larger.

In a test on a water-tube boiler it was found that the rate of heat absorption increased almost in direct proportion to the increase in weight of the gases passing through the boiler, and that the boiler developed a boiler horse-power on less than 3 sq. ft. of heating surface, thus indicating that the heating plates of the boiler were able to absorb all the heat the gases were able to deliver. In the case of a locomotive boiler it was found that the rate of heat absorption increased almost directly as the rate of heat delivery, so that when the delivery was doubled the heat absorbed was also nearly doubled.

In connection with the efficiency of heat transmission, greater attention should be given to maintaining the boiler heating surface in a clean condition, internally and externally. On the Continent the purification of "make-up" water and the operation of the

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water-softening plant receive as much scientific attention as other sections of the plant, and probably as a result of this higher rates of evaporation per square foot of heating surface are more common than in this country. In several cases only distilled water is used for the "make-up," and this is a point which should receive most serious consideration by the designers of large new super-power stations in this country.

It is very difficult to determine the loss in efficiency due to scales as, with a given thickness of scale, so much depends upon the nature of the deposit, and its degree of porosity. If the scale be dense and hard, so as to be practically waterproof, a thin coating of it may be an effective non-conductor, and it may be a source of great danger as well as loss of economy. If, however, a scale be porous, as many are, it will allow water to pass through it to the metal surfaces of the boiler, and the decreased transmission of heat will be comparatively slight.

Again, the loss due to scale in the front part of the boiler may be compensated for, to a certain extent, by increased recuperation in the remaining portion of the boiler.

Mr. Stromeyer, in the introductory portion of his Paper, entitled "An Enquiry into the Working of Various Water Softeners," read before the Institution of Mechanical Engineers in 1903, put the matter pretty clearly, and gave the following table, showing the temperature distribution as follows:—

Sq. ft. of heating surface per lb. fuel per hour ...	0	¼	½	1	2	4	28
Boiler with plates free from scale.							
Flame and flue temp., °F.	3,000	2,421	1,961	1,335	728	426	381
Max. plate temp., °F. ...	400	396	392	387	383	381	380
Total heat transmitted, %	0	19·8	35·6	57·0	77·8	89·2	89·7
Boiler with scale ⅛" thick.							
Flame and flue temp., °F.	3,000	2,484	2,070	1,471	835	459	384
Max. plate temp., °F. ...	691	630	581	510	434	389	382
Total heat transmitted, %	0	17·5	31·8	52·4	74·2	87·0	89·5

The deposition of soot and dust on the fireside of a boiler affects the efficiency more rapidly than does the formation of scale, and attention in this direction, with every class of boiler, is most desirable.

Coal Analysis.

It is quite impossible to control intelligently the thermal efficiency of power stations unless means are taken to establish week by week the calorific value of the coal used, and no station can be considered complete unless equipped with a small laboratory and coal testing plant. The expenditure on such plant is relatively small, and is fully justified by the results which can be obtained. The methods to be adopted for collecting average samples will vary according to the arrangements of coal-handling plant, and by proper mixing and quartering the quantity required for the laboratory analysis can be reduced to reasonable proportions.

It is far better to make a small number of analyses in a careful manner than a larger number in a haphazard way; an inaccurate analysis is worse than useless, inasmuch as the information given is misleading, and may be the cause of waste of time and money.

Before making an analysis of a fuel by far the most important item to have in mind is to get a truly representative sample to work upon. When one considers that with a laboratory sample of, say, 20 lb., the heat value is determined on about one-thousandth part of this sample, it will be appreciated how easily an error of 1,000 to 2,000 B.Th.U.s can be obtained if the sampling is not carefully attended to. On the other hand, when the coal is carefully sampled, although such a small quantity is used for the determination of the heat value, result after result will and should agree to within 20 B.Th.U.s.

The most difficult coal to sample for analysis is a damp Midland slack containing a fair amount of small—about 40 per cent. passing through a ⅛-in. meash sieve—and also having a few pieces of shale amongst the large.

It is essential that the surface moisture should be taken from the sample before attempting to re-sample. This can best be done by keeping a record of the weight before and after the whole sample has been left on a large tray in a very thin layer for, say, 48 hours. This air drying is necessary for two reasons—firstly, the total moisture cannot otherwise be correctly ascertained, as the coal will be losing moisture during sampling, and secondly, it is otherwise impossible to get a good mixture, as the small damp coal and soft shale will cling together and not mix with the freshly ground drier coal.

It is wrong to rob the laboratory sample of a part for separate moisture determination, as is frequently done, inasmuch as this would have to be done with little or no crushing of the larger coal, and would not only be unrepresentative of the remaining moisture content, but may also be robbing the remainder of an undue proportion of either clean coal or shale.

After being exposed, as suggested above, for 48 hours in the rooms in which the further sampling is to be carried out, the coal will be at equilibrium with the atmosphere, and in this condition can be safely ground and mixed without either losing or gaining moisture.

It is difficult even after grinding to properly mix a sample of 20 lb. and select from it a smaller representative sample. The following will be found a very satisfactory method of overcoming this difficulty:—

Separate the 20 lb. sample by means of sieves, as for example:—

(*a*) Over ½ in. and under 2 in. in size	5 lb. =	25%
(*b*) Over ¼ in. and under ½ in. in size.....	3 lb. =	15%
(*c*) Over ⅛ in. and under ¼ in. in size	4 lb. =	20%
(*d*) Under ⅛ in. in size	8 lb. =	40%
	20 lb. =	100%

It will be evident that one should not expect to find the heat value of all these grades similar; this will particularly apply when comparing samples (*a*) and (*d*); in some cases the fine coal contains more heat units than the larger coal, but in the majority of cases the fine contains a large amount of dirt, and consequently, is of lower value. The separate grades, as referred to above, can now be reduced in equal proportion to, say, 25 per cent. of the present quantity.

Dealing firstly with grade (*d*), in view of the small size of this, after mixing we can, by the quartering method, take a 2-lb. sample, which is representative of the 8-lb. Placing this 2 lb. on one side in a labelled covered tin and disposing of the remaining 6 lb. we proceed to reduce the three grades (*a*), (*b*) and (*c*) to 20 oz., 12 oz. and 1 lb. respectively. After each grade has been ground and passed through the ⅛-in. mesh sieve, it can be dealt with similarly to grade (*d*) and put in a separate tin. We now have four tins containing a total weight of 5 lb. of coal, and are sure of having so far a proportionate amount of the better and inferior (large and small) coal. This we could not have been so sure of, had we ground the whole 20 lb., mixed it, and then taken out 5 lb.

The next step is a still further reduction of the sample for analysis. Taking the first tin (*d*) containing 2 lb., this should all be ground to pass through a sieve having 30 meshes to the inch, thoroughly mixed and 25 per cent., namely 8 oz., taken and placed in a covered tin, which will also be used for the further samples. The other tins, (*a*), (*b*) and (*c*) should then be treated in a similar manner separately, the same percentage—5 oz., 3 oz. and 4 oz., making the total weight of sample 20 oz. We are now certain of having one-sixteenth of the various grades of coal which were delivered to the laboratory in the 20-lb. sample.

The next step is to grind the 20-oz. sample and pass it through a sieve having 60 meshes to the inch; too much importance cannot be attached to seeing that the whole of the sample passes through the sieve, for the more friable particles—which usually consist of clean coal—will more readily break up and pass through the fine meshes, leaving the harder particles (generally shale) behind, and if these are not broken to the same fineness and mixed with the remainder the sample will be spoiled.

After thoroughly mixing this fine coal on a sheet of glazed paper we can take our samples for the calorimeter test and analysis from any part of the heap, and if the difference obtained from such samples exceeds 0·2 per cent. for the former, or 0·1 per cent. for the latter, something must be wrong with the operation of determining the heat value or analysis, and the error should be looked for in this direction.

Although this operation of sampling may suggest loss of moisture the whole time, on actual tests this loss has not exceeded 0·5 per cent. even on a coal containing as much as 12 per cent. of hygroscopic moisture, and the smaller the quantity of hygroscopic moisture contained in a coal the less chance there is of losing any moisture by this method. By adopting the suggestion made above to air dry the coal, the only moisture that can be lost is, of course, the hygroscopic moisture.

The maximum loss of 0·5 per cent. on a coal of 12,000 B.Th.U.s amounts to 60 B.Th.U.s, which is negligible when compared with the much greater error which can be introduced by incorrect sampling, and in the average case this loss of moisture will be found to be a great deal less than 0·5 per cent. Further, one has to remember that there will frequently be a loss of moisture during the original sampling, and before the coal reaches the laboratory.

The acknowledged standard calorimeter is the oxygen bomb of the "Mahler" type. This instrument, however, is rather intricate (that is to say, so far as its use is concerned), and in order to obtain

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consistent and accurate results, it is necessary that the operator should be frequently using it. For general works use the sodium peroxide electrically fired bomb calorimeter will be found a very convenient and satisfactory instrument.

With a little experience, values can be determined on this instrument which will agree closely with those obtained on the Mahler bomb. As with all apparatus used in the laboratory it is necessary to keep the calorimeter quite clean in order to obtain accurate results. The type of instrument suggested is easily cleaned, and one useful hint might be given for cleaning the combustion chamber after use; if this is placed in the sink and filled with some of the water from the calorimeter—which will be rather warm after making the calorific test—the hard deposit will quickly dissolve. The whole instrument should be thoroughly cleaned and dried immediately after use, to prevent corrosion.

It is strongly recommended that before sending coal away for independent check analysis it should be carefully sampled in the manner described above. If this is done, after a little experience results obtained in the sodium peroxide instrument will be found to agree very closely with the determinations made by an expert on the Mahler bomb. The differences so frequently obtained—often on the same instrument or type of instrument—are almost entirely due to insufficient care being taken to ensure that the final samples worked on are in each case identical.

FLUE GAS DATA.

Whilst the importance of reducing flue gas losses to a minimum is well understood by all engineers, the fact remains that the average loss in this direction is very much higher than it need be; and this, again, is no doubt very largely due to the failure to collect and establish reliable data at regular intervals—in other words, the loss is apt to be overlooked, whereas if the necessary data is placed before the responsible engineer each day there is naturally an incentive for increased effort in the direction of economy.

Reliable apparatus is now available for recording temperatures and analysing gases, and whilst the application of same on extensive lines may have been difficult in the small stations, owing to the "lay-out" of the plant, it should be possible to arrange most efficient control in large new super-power stations—in fact, it is now done in America and on the Continent, modern power stations being equipped with long-distance temperature control boards, where the switchman can control all the instruments recording the temperatures at various points throughout the works, and enter the readings in a log book every half-hour if necessary.

Such a system, of course, involves the fixing of reliable electrical pyrometers at the boiler dampers and at various points in the main flue, care being taken to ensure that the thermo-couple is placed in the direct flow of the gases. CO_2 recorders are essential, but they require scientific attention at least once a day, and it has no doubt been the absence of such attention which has caused several engineers to discard these recording instruments. Again, in order to be of real value, a separate recorder should be fixed to each individual boiler unit, and in a super power station this should not present any great difficulty.

Whilst the writer considers CO_2 recorders essential, it is not desirable to rely entirely upon such instruments, as in the effort to maintain a high percentage of CO_2 some unburnt hydrocarbon gases may be carried over. No modern station can be considered complete without a fully equipped laboratory, and such laboratory should include an Orsat apparatus fitted with a combustion burette, so that samples of gas collected throughout the day can be tested for complete analysis.

COMBUSTIBLE IN ASHES.

The lowering of the quality of coal which has to be burned at most power stations and works for steam raising adds importance to the checking of the loss of combustible matter which is carried away in the ash and clinker. In the past, when burning good class coals, a certain percentage of combustible matter in the residue did not represent anything like the proportion of heat units purchased that a similar percentage of combustible would represent in the case of the lower grade coals.

Two examples will demonstrate the increased loss referred to. When using coal having a calorific value of 12,500 B.Th.U.s as fired, from which the ash and clinker amounts to 6 per cent. of the coal fired and contains 20 per cent. of combustible matter, it will be seen that this latter represents 0·012 lb. per lb. of coal burned, and assuming this combustible to be all carbon, and therefore having a value of 14,500 B.Th.U.s per lb., the loss amounts to 174 B.Th.U.s, or 1·4 per cent. of the coal value.

With a coal of 9,500 B.Th.U.s, and resulting ash and clinker representing 24 per cent. of the coal fired, the same percentage of combustible matter (20 per cent.) will present 0·048 lb. per lb. of coal; and, on the same basis as the above, this represents a loss of 696 B.Th.U.s per lb. of coal, or 7·4 per cent. of the coal value.

At first sight it may appear that the figure used in the above example of 20 per cent. of combustible matter in the ash is on the high side, but careful tests have shown that the ash and clinker discharged from boiler furnaces which would frequently be passed as satisfactory, contains this quantity of combustible matter, and shows how very difficult it is to estimate with anything approaching accuracy the quantity of combustible matter contained in the residue from different coals. The ash and clinker taken away from many boiler houses will be found to exceed the figure given above of 20 per cent.

The examples given indicate the necessity of keeping a careful check on this point. It will, however, be appreciated that this is not very easily done owing to the difficulty of obtaining a good sample of the residue. One has to deal with small ash and also large clinkers, and usually the combustible matter is principally contained in the former. It is therefore necessary in taking the sample to obtain a correct proportion of small ash. To do this with anything approaching accuracy means that a large proportion of the whole should be crushed. On a complete boiler test, where this point is taken into consideration, the only really satisfactory way to obtain a sample is to have the whole of the ash and clinker ground to a powder. This can conveniently be done in an ordinary mortar mill. A sample taken by the usual quartering method from this crushed clinker should contain approximately the correct proportion of combustible matter, the amount of which can readily be determined in the laboratory.

In ordinary works practice it is not, of course, practicable to grind the whole of the clinker, but a convenient and satisfactory method of checking the amount of combustible loss will consist of taking the ash produced, say, on one boiler during a shift and grinding the whole of this for a sample. This will be found far more satisfactory than endeavouring to obtain a sample from the whole of the clinker produced by taking a shovelful from different parts of the heap and then mixing it.

The minimum percentage of combustible obtainable will necessarily vary with the class of coal. With a free burning coal not containing a very heavy percentage of dust it should be possible to get down to, say, 7 to 10 per cent. of combustible matter in the clinker and ash; but with some coals the minimum will be somewhat higher than this.

Draught and Damper Control.—In America, automatic damper regulation is becoming somewhat popular, and, whilst a perfect automatic control would approach the ideal, there are obvious disadvantages with such a system, varying according to the class of fuel used. It will require serious consideration before being generally adopted.

In a modern power house, however, the system of control can be made much more perfect than exists in many of the present stations. All fans might be operated from a central control office in the boiler house, equipped with a sensitive steam gauge and load indicator, from which instruments the attendant would gauge the draught regulation necessary, the duty of the fireman being confined to adjusting the fires to suit the draught.

To assist the fireman, an open dial draught gauge should be fixed on the front of each boiler, and connected to a point at the boiler side of the damper.

By closely watching the draught gauge and the CO_2 recorder it should be possible to maintain the fire in a condition of maximum efficiency.

In a modern boiler house fitted with superheaters and economisers it should be quite possible to maintain a daily working efficiency of 76 it not 80 per cent.

The temperature of the flue gases entering the chimney need not exceed 300°F., and the CO_2 at this point should certainly not be less than 10 per cent., representing a flue gas loss of approximately 9 per cent., whereas the present average figure is probably not less than 20 per cent.

There are many other matters connected with boiler-house economy which require consideration when designing large new power stations, and the present article is simply to emphasise again the importance of bringing the highest possible degree of scientific supervision to bear upon boiler control, and to urge the necessity of tabulating complete records covering each section of the plant.

In many stations which the writer has visited it would only be possible to fill in a table such as that given above after erecting all sorts of temporary testing tackle under conditions of dirt and discomfort which would certainly not offer any inducement to repeat the tests at frequent intervals, whereas in designing a large new station it is quite a simple matter to arrange the plant so that all the necessary data are obtainable with ease and comfort.

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The Problem of Condensing in Large Power Stations.

By J. H. RIDER, M.Inst.C.E.

Summary.—Emphasis is laid on the very large quantities of condensing water which are necessary in a power station of 200,000 kw. Methods are considered which may be used when the flow of water on a river site is insufficient for the purpose, and figures are given showing the reduction in vacuum that may result. Attention is drawn to the limitations of cooling towers for large power stations.

Large power stations of an ultimate working capacity of 200,000 kw. and over are very much in the air just now. Whether they will ever materialise and appear in solid form in this country will depend upon several things.

To justify their existence "super" stations must fulfil one or both of two conditions, the one being a cheaper supply to the consumer and the other a saving of one of the nation's assets, that can never be replaced, viz., coal.

To fulfil the first condition the saving in the cost of generation must be greater than the increased cost of transmission over the larger area of supply, and this, in itself, will necessarily fulfil the second condition. But, if the only available site for such a station in any district be such that the increased transmission charges equal, or even exceed the saving in the generation costs, the station might still be warranted, from a national standpoint, if a material saving of coal were the result.

The costs of generation in a super-power station should be considerably less than in a number of smaller local stations of equal aggregate capacity, for the following reasons, viz. :—

(*a*) Much larger generating units would be employed, with a consequent saving in steam and coal.

(*b*) A smaller operating staff would be required.

(*c*) The station load factor would be increased, owing to the greater diversity of load in the larger area of supply.

(*d*) The capital costs per kilowatt, and therefore the annual capital charges would be reduced.

It is not the purpose of this short article to discuss the question as to whether power could be generated at and delivered to the consumer from super-power stations, over an area having a radius of, say, 50 miles, at a cheaper rate than the same amount of power could be generated at and distributed over the same area from a number of smaller local stations, but rather to consider one of the most important problems in connection with super-stations, on which the cheaper production almost entirely depends, viz., the problem of condensing.

Let the case be assumed of a station with a maximum working load of 200,000 kw., and an annual station load factor of 60 per cent. Such a load factor is quite likely in the future, when electrical energy is employed generally for such diversified loads as factories, railways, tramways, collieries, electric furnaces, cooking, lighting, &c. Let it be further assumed that the maximum load is given either by eight turbo-generators, each of 25,000 kw. capacity, or by six machines, each of 33,000 kw. capacity, working at one time.

On the basis of a steam pressure of 225 lb. per square inch, superheated to 650° F., and with a back pressure not exceeding 1 in. mercury (*i.e.*, 29 in. vacuum with a 30 in. barometer), the steam consumption should not be greater than 10·5 lb. per kilowatt hour on the total units generated. This figure would doubtless be reduced somewhat if higher steam pressure and superheat were used, but it is a question whether we should be justified in going much higher with our present limited experience

Under the conditions stated above it should be possible to obtain the output with an expenditure of not greater than 18,500 B.Th.U. per kilowatt hour. With coal having an average calorific value of 11,500 B.Th.U. per lb., this would mean an annual consumption of :—

200,000 kw. at 60 per cent. load factor = 1,051,200,000 units per annum.

1,051,200,000 kw. hours × 18,500 B.Th.U.
= 19,447,200,000,000 B.Th.U. per annum

$$\frac{19,447,200,000,000 \text{ B.Th.U.}}{11,500 \text{ B.Th.U. per lb.}} = 1,691,060,869 \text{ lb., or } 754,937 \text{ (say } 756,000) \text{ tons of coal per annum.}$$

The maintenance of a high vacuum is essential for steam and fuel economy. A reduction from 29 in. to 28·5 in. would mean an increase in steam (and coal) consumption of at least 3·7 per cent., or about 28,000 tons of coal per annun.

For a vacuum of 29 in. it would be necessary to use a quantity of condensing water at least 70 times that of the steam, at a temperature not exceeding 55° F. At the full load of 200,000 kw. this would mean :—

200,000 kw. × 10·5 lb. × 70 = 147,000,000 lb., or 14,700,000 gallons per hour.

On a load factor of 60 per cent. this would mean an *average* of 8,820,000 gallons per hour, or 211,680,000 gallons per day, throughout the year.

A better idea of the volume of water required at full load will be obtained by a consideration of the following figures. A flow of 14,700,000 gallons per hour = 245,000 gallons per minute = 4,082 gallons or 654 cub. ft. per second. Put into the form of a table, we have :—

Velocity.		Cross sectional area of stream in sq. ft.	Dimensions of stream.	
Feet per second.	Miles per hour.		Feet deep.	Feet wide.
1	0·682	654	10	65·4
2	1·364	327	10	32·7
3	2·046	218	10	21·8
4	2·728	163	9	18·1
5	3·41	131	8	16·4

Ratio of water to steam.		Inlet temperatures.								
		50 deg.	55 deg.	60 deg.	65 deg.	70 deg.	75 deg.	80 deg.	85 deg.	90 deg.
60	Exit temp.	68·4	73·3	78·2	83·1	88·1	93·0	97·9	102·8	107·7
	Vac. temp.	78·4	83·3	88·2	93·1	98·1	103·0	107·9	112·8	117·7
	Vac. ins.	29·04	28·86	28·67	28·44	28·18	27·9	27·58	27·2	26·8
65	Exit temp.	67·0	71·9	76·8	81·8	86·7	91·6	96·5	101·5	106·4
	Vac. temp.	77·0	81·9	86·8	91·8	96·7	101·6	106·5	111·5	116·4
	Vac. ins.	29·09	28·92	28·72	28·5	28·26	27·99	27·67	27·32	26·92
70	Exit temp.	65·8	70·7	75·7	80·6	85·5	90·4	95·4	100·3	105·2
	Vac. temp.	75·8	80·7	85·7	90·6	95·5	100·4	105·4	110·3	115·2
	Vac. ins.	29·13	28·96	28·77	28·56	28·32	28·05	27·75	27·4	27·02
80	Exit temp.	63·8	68·8	73·7	78·7	83·6	88·5	93·5	98·4	103·4
	Vac. temp.	73·8	78·8	83·7	88·7	93·6	98·5	103·5	108·4	113·4
	Vac. ins.	29·18	29·03	28·85	28·65	28·42	28·17	27·87	27·54	27·16
100	Exit temp.	61·1	66·1	71·0	75·9	80·9	85·8	90·8	95·7	100·7
	Vac. temp.	71·1	76·1	81·0	85·9	90·9	95·8	100·8	105·7	110·7
	Vac. ins.	29·26	29·11	28·95	28·76	28·54	28·3	28·03	27·73	27·37

N.B.—This Table is based on a difference of 10° F. between the temperatures of the vacuum and of the condensing water exit in each case.

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The vacuum obtained with any given condenser will depend primarily on the inlet temperature and only to a very small extent on a variation in the quantity of the condensing water. The following table will show the vacua which may be expected under different conditions, with a good average condenser, and with the barometer at 30 in.

The quantity of water and the size of the condenser may be increased indefinitely beyond a certain point, without any material gain in the vacuum, unless the temperature of the water be lowered. There is a greater gain in vacuum by reducing the temperature of the inlet water by 5°F., when using a ratio of 60 times, than by increasing the ratio to 80 times and keeping the temperature constant. The reason is obvious. Each point in the vacuum curve corresponds to a certain fixed vacuum temperature, which must (in a surface condenser) always be higher than the *exit* temperature of the condensing water. This difference can sometimes be brought as low as 8°F., but in the above table it has been taken as 10°F. as being a more general commercial figure.

The exit temperature must always be higher than the inlet temperature, by an amount which depends upon the quantity of water and the number of heat units abstracted from the steam. The latter will depend upon the vacuun obtained, as the higher the vacuum the lower will be the vacuum temperature, and therefore the greater will be the number of heat units abstracted.

A continuous supply of cold water at the rate of 14·7 million gallons per hour cannot be obtained unless the super-power station is situated on the banks of a large river, an estuary or a large inland lake.

Most rivers of any size are tidal for a considerable distance inland, and, where non-tidal, are frequently dammed back for navigation purposes, thus giving a fair depth of water for some distance, with a flow which depends upon the rainfall and the area drained.

If the station be built on the banks of a tidal river there must be sufficient depth of water at low (spring) tides to cover the mouths of the suction pipes, whether these be laid out into the stream or a branch channel be carried from the river into the station. A large proportion of the total flow of the river could be used at low tides, as it is not likely that there would be any navigation at such times. A minimum depth of not less than 8 ft. will be found essential.

If, for reasons connected either with the coal supply or with the transmission area, the station have to be built farther inland on a part of the river which is non-tidal, either (*a*) there must be a *minimum* dry weather flow at not less than the full rate required, (*b*) a certain proportion of the water must be used over and over again at times of minimum flow by a local circulation of the river between the mouths of the inlet and outlet channels, or (*c*) a quantity equal to the maximum natural flow of the river at any time may be used directly, and the balance required may be circulated through cooling towers.

Condition (*a*) will be difficult to meet on most British non-tidal rivers, and, in the majority of, if not in all, the cases where a non-tidal river has to be used, either (*b*) or (*c*) would be the only solution. We are at once faced with an unavoidable increase in the temperature of the condensing water, and, in the case of (*c*), with additional disadvantages which will be mentioned later.

Condition (*b*) means that, since water is being pumped at a rate exceeding the natural flow of the river, a certain amount of the discharged water must flow back into the suction channel. The resultant temperature of the inlet water will depend upon the proportion of the colder natural flow to the total quantity pumped, and upon the amount of cooling which can take place between the mouths of the outlet and inlet channels. This will depend upon the distance between them and upon the width of the river, *i.e.*, upon the amount of water surface exposed to the air. The direction of the flow of the river will obviously be reversed between the two points.

Let it be assumed that the river has a minimum dry weather flow of only one-half of the total quantity of condensing water required, and that its average temperature at such times is 60°F. Being non-tidal it is not likely to be any lower at times of minimum flow. Let it also be assumed that the mouth of the discharge channel is sufficiently far away from the mouth of the suction channel to lower the temperature of the proportion of discharge water (one-half) which has to flow back, by, say, 1·5°F.

At starting, with the whole of the inlet water at 60°F. and with a ratio of 70 times the steam, a vacuum of 28·77 in. should be obtained with the discharge water at 75·7°F. But in a short time the temperature of the inlet water would gradually rise, due to the intermixing of a proportion of warmer discharge water. This would lower the vacuum and still further increase the temperature of the discharge water, which, in turn, would increase the temperature of the inlet water, and so on, until a thermal balance was obtained. This would be when the loss of heat units by evaporation, in the section of the river between the outlet and inlet channels, was equal to the heat units added to one-half of the condensing water during equal periods of the condensing process. In the case in question, a balance would be obtained when the combined inlet water was at a mean temperature of 74°F., as the following conditions would have been reached:—

Inlet temperature	=74° F.
Outlet „	=89·5° F.
Vacuum	=28·12 in.
Half discharge water returning to inlet at 88·0°F. / Half water from river flow at 60°F.	Mean=74°F.

The result, therefore, would be to reduce the vacuum by 0·65 in. below that which would have been obtained if the flow of the river had been sufficient for the full requirements of the station, and to increase the coal consumption by about 4·8 per cent. while the above conditions lasted. The effect of this method of working upon the annual coal consumption would, of course, depend upon the extent of the period during the year over which the water requirements of the station exceeded the natural flow of the river, and would vary in each case.

If the minimum dry weather flow of the non-tidal river be so small that cooling towers have to be employed at such times, we have to expend the same amount of capital on the towers, whether they be used continuously or not. The only differences would be in the amount by which the vacuum would be reduced during the time the towers were employed, in the cost of the extra pumping due to the use of towers, and in the amount of make-up water required to compensate for the evaporative losses of the towers. We will consider the latter point first.

Cooling towers can only cool the water by evaporation, and, in so doing, lose about 2 per cent. of the total quantity circulating, which has to be made up from some outside source.

A 200,000 kw. station, working on a 60 per cent. load factor, would require, as already pointed out, a maximum of 14·7 million gallons per hour, and an average of 8·82 million gallons per hour continuously. At periods of full load, therefore, there would be an evaporative loss of about 294,000 gallons per hour, with an average loss of about 176,000 gallons per hour. This would be absolutely wasted and could not be recovered or returned to the source.

At times of flood there would probably be no difficulty in obtaining the make-up water from the river, but these would be the times during which the towers would probably not be required. At times of minimum flow, when the towers were in full use, and the full quantity of make-up water was needed, it would be very questionable whether the river authorities would permit the permanent abstraction of so large a quantity, which might seriously injure riparian owners and others lower down the river.

From what source could the make-up water be obtained at such times? It could not be taken from the water mains of any town or city in the neighbourhood, not only because of the prohibitive cost, but because no town's water supply could furnish it. An average rate of 176,000 gallons per hour equals 4,224,000 gallons per day, an amount which, at 20 gallons per head per day, is sufficient for the domestic needs of a town of over 200,000 inhabitants.

It is not necessary that water for condensing purposes should be potable. Any kind of water which was free from deleterious acids or chemicals would suffice, if its temperature were low enough. Purified sewage effluent has been used in some cases, and, if sufficient in quantity, could be used for the make-up service, provided that there was no objection from the sanitary authorities to its continual evaporation.

Or mine water could be used, if the mine owners would guarantee the supply and would deliver it to the station at a very low cost. But it certainly would not pay to equip and work any deep level mine pumping scheme solely with a view of obtaining the water.

The make-up water problem is the prime controlling factor in any cooling tower station of the size under discussion. Cooling towers have served and are serving a very useful purpose in the case of comparatively small power stations, which were built, and have had to be extended on sites in or adjacent to towns, with only a small natural water supply. But they are out of the question for power stations having a maximum working load of about 50,000 kw. and over, if the station load factor be high and if they have to be relied upon to cool the whole of the condensing water for long periods. They are out of the question because of their prime cost and maintenance charges, because of the very real difficulty of providing the make-up water, because of the nuisance caused by the large clouds of vapour given off in damp weather, because of

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the lower vacuum and higher coal consumption, and because of the very large amount of land necessary for their erection.

Cooling towers have probably already reached their practical limits of size, and any increase in capacity must be obtained by increasing the number at a proportionately increased cost. The towers for a working load of 200,000 kw. would probably require an area of about 16 acres, and, including the land, foundations, water channels, &c., would cost about £1·5 per kilowatt. For a working load of 200,000 kw. a plant of at least 250,000 kw. total capacity would be necessary, and the capacity of the towers should correspond, so as to make provision for overhauling, repairs, &c. This would add about £375,000 to the capital cost of the station, while the annual capital and maintenance charges, and the additional cost of pumping, would add about £56,000 to the working expenses.

It is not likely that the average temperature of the inlet water to the condensers could be brought down lower than 80 F. with cooling towers, if the station be working on a 60 per cent. load factor. The vacuum would therefore be about 27·75 in., or a reduction of 1·25 in. below that which could be obtained if the station were situated on the banks of a tidal river, with an average temperature of 55°F., while the increase in coal consumption would be about 9·25 per cent., or at the rate of about 80,000 tons of coal per annum.

The actual increase would depend upon whether the towers had to be used during the whole or only part of the time. It it be assumed that for six months of the year the river could supply half the water necessary, while the other half was re-circulated in the river in the manner already discussed, and that, for the remainder of the year, the cooling towers had to be used continuously, the average increase in the coal consumption would be about 7 per cent., or about 53,000 tons per annum. With coal at, say, 15s. per ton, this would add about £40,000 per annum to the fuel bill, and the inclusion of the capital and maintenance charges would bring the total additional expenses to about £96,000 per annum.

This figure is equal to about 0·022d. per unit, which may not appear large to those engineers whose station costs are already high. But it means an increase of about 10 per cent. on the total costs of the super-power station, and is sufficient to pay interest at 5 per cent. per annum on a capital outlay of nearly £2,000,000.

Before a solution can be found of the problem of condensing in large power stations the quantities involved must first be appreciated. When this has been done the limitations or advantages of any particular site will become apparent at once. The ideal sites in this country are very few, but this does not mean that super-power stations could not be built and worked economically elsewhere, or that their use would not be justified. The working costs would doubtless be increased somewhat over those on the more favoured sites, but they could still be low enough, and the saving in coal be great enough, to warrant their existence.

The first essential for any site is water, as everything except water can be brought to the site, and without water no economies of any kind can be made. The second essential is coal. There is an idea in some quarters that the proper site is at the pit's mouth, but a little consideration will show the fallacy in that argument.

As already mentioned, a 200,000 kw. load, at a 60 per cent. load factor requires some 750,000 tons of coal per annum, or over 2,000 tons per day. How many pits in this country produce such a quantity? It is about 3 per cent. of the whole annual output of either of our largest coal producing counties, and could only be obtained in practice at the power station by a combination of supplies from a number of collieries. Even if one or two of the largest pits were so favourably situated that they could provide the coal, and that an adjacent site with an adequate water supply could be obtained, it would not be wise to make no arrangements for procuring coal from other sources. Consider the effect of strikes, mine flooding, breakdowns of winding and other plant, a failure of the coal measures, and other possible local troubles, and their effect upon a power station which had to depend upon purely local supplies.

As a matter of fact, the coal would have to be brought to the station from a great many sources, and this involves either rail, canal, river or sea transport, or possibly a combination of them. The cost of delivering the coal from the pit's mouth into the station bunkers is made up of two principal items, the one being the cost of the carriage pure and simple, and the other being the terminal costs of loading and unloading the trucks, barges or ships. It is not suggested that distance of transport does not add to the total cost of delivery, but there is very little difference between the total cost of the coal when brought for 5 miles and when brought for 20 miles.

Bearing in mind the essential qualifications for the sites of super-power stations, there are two methods of considering the question. The one is to take existing areas of supply, as defined by local municipal or county boundaries, and, having decided upon a grouping of the areas, to select the best site or sites for the stations to supply the particular combined area. The other is to decide first upon the suitable sites in the country for the erection of super-stations and to bring into their areas of supply all those districts which could be economically served therefrom.

The whole question of electricity supply in Great Britain is in the melting pot at the present time, but in order to produce a good sound product the matter must be dealt with on broad national lines and on those lines only.

Considerations Governing the Design of Small Tractors.*

By A. E. L. CHORLTON, C.B.E.

The problem of providing mechanical power to replace that of the horse, &c., for agriculture is one of considerable difficulty, the guiding factors being such variables as the size of the farm, class of land, nature of crop, road transportation, first cost and annual charges. On such points little precise information exists. The views held by farmers may be divided into two groups—those who favour a special implement for each purpose and those who think a general machine should be provided to deal with all. Expense is an important item, especially in view of the small size of the average farm in this country. The three main principles governing the design of tractors are:—

(*a*) Road work—transport.
(*b*) Land work—ploughing.
(*c*) Farmstead—threshing, &c.

The author discusses how these requirements may best be met in a single machine. Little information is available regarding the tractive adhesion in road work, and the author presents a table summarising the tractive resistance of various materials, ranging from concrete to gravel. For steel tyres the maximum value is about 0·56—*i.e.*, rather more than half the load on the driving axles can be used in drawbar pull. On country roads 0·45 is suggested as a safe value for steel tyres, 0·5–0·55 for rubber tyres. As an average value for macadamised roads a traction resistance of 60 lb. per ton is taken, while gradients up to 1 in 10 may be allowed for, the above data leading to a desirable total load of 4,400 lb. on the driving axle. From the mechanical point of view the limit of pressure is set by the necessity to avoid sinking into the ground. Driving wheels are apt to rotate and act as milling cutters, scraping out the soil from underneath. On very soft land the wheeled tractor is unsuitable and the caterpillar type essential; but this is rare in English agricultural operations.

Some experiments are described on a tractor to the following specification:—

Weight of tractor, 3¼ tons.
Weight on driving wheels, 5,000 lb.
Brake-horse-power of engine, 18·75.
Driving wheels, 4½ ft. diameter, 15 in. wide.
Plough, Ransome three-share cutting, 6 in. deep, 9 in. wide.

Diagrams are presented showing the fluctuations in load in ploughing 1·57 miles per hour in stubble on still clay land, and 2 miles per hour in stubble on medium soil. In the first case the mean drawbar pull is 2,300 lb., or 3·21 lb. per share; in the second, 1,500 lb., or 2·66 lb. per share. The fundamental values for the multi-purpose tractor may be taken as:—

—	Power required.	Driving axle loading.
Road work	18–20 H.P.	4,400 lb.
Land work	23–25 H.P.	4,400 lb.
Farmstead	20–25 H.P.	Stationary

The results from engines running on paraffin or crude oil are discussed. The consumption in practice is about 3 gallons per acre; but, in theory, better results—even less than 1 pint per acre per brake-horse-power—should be possible.

In the remainder of the Paper mechanical engine details are dealt with. The above results are of interest in view of the possibilities of electrical agricultural machinery.

* Abstract of a Paper read before the Institution of Automobile Engineers.

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Some Considerations Relating to Large Power Station Switchgear.

By H. W. CLOTHIER.

Summary.—The author deals particularly with oil switches for large powers. There are a number of controlling factors in design, such as length and velocity of break, head and volume of oil, strength of container, lag and ventilation. These are considered, and diagrams are given illustrating the conditions found in practice. Drawings are reproduced showing a form of switchgear in successful operation and suitable for use in a power station of 60,000 kw., and the possibilities for larger power station gear on armoured lines are implied. In conclusion, emphasis is laid upon the desirability of research on the conditions to which switchgear is subject.

In general construction there are two forms of switchgear which may be considered as typical of large power station practice :—

1. Cellular.
2. Armoured.

In the cellular construction standard parts are employed and, with a view to eliminating the risks of trouble in one part spreading to another, each part is contained in a separate cell of concrete or brickwork, and the several parts are connected together with bare conductors or cables passing through insulators which are cemented into the partitions. In the case of large power station gear where there are a number of parts, the cells become numerous and occupy several floors of the building.

The Armoured construction consists of an assembly of standard units or panels, each unit being complete in itself and embodying its several members into one homogeneous design. In this case the risk of arcing from one part to another is eliminated by the complete enclosure of *all* conductors within a metallic covering, the space between the covering and the conductors being filled with insulating compound or oil.

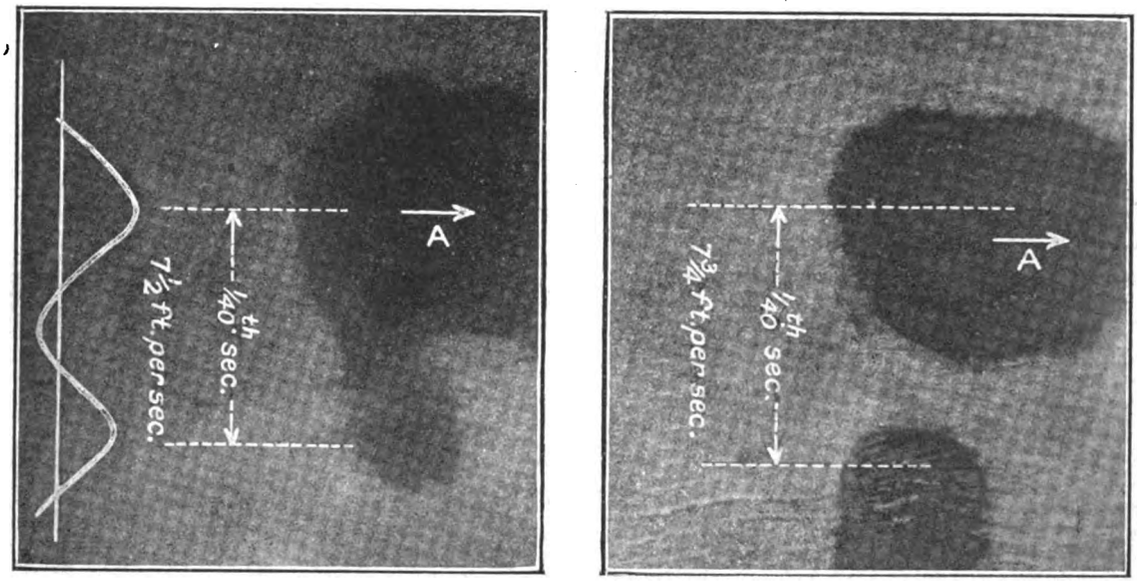
It is not proposed in this short article to discuss the relative advantages and disadvantages of these two systems as there has already been ample discussion thereon.*

Considerations which affect the working of the switch proper are common to both forms of switchgear construction, and as its performance under ordinary and extraordinary conditions is of primary importance, it is proposed to deal principally with the switch, but at the same time to illustrate the switch as applied to the armoured construction.

TYPES OF SWITCHES.

Apart from the method of enclosing conductors there are under a very broad classification three types of switches on which experience has been gained on large power systems. For the convenience of this article these three types will be referred to as :—

1. *Heavy Tank Type.*—Switches with a large volume of oil contained in tanks of boiler plate construction with attachments to withstand heavy internal pressures.



Assumed Wave Formation (unsymmetrical). A—Direction of Magnetic Blow-out.

FIG. 1.—PHOTOGRAPH OF PERTINAX PLATES PLACED ADJACENT TO THE SPARKING CONTACTS OF A 20,000-VOLT SWITCH. THE BURNT PATCHES INDICATE THE INTENSITY OF THE ARC AT THE FIRST AND SECOND PERIOD RESPECTIVELY.

2. *Pot Type.*—Switches with a comparatively small volume of oil contained in cylinders designed to withstand heavy internal pressures.

3. *Flexible Tank Type.*—Switches with a large volume of oil in tanks with flexible sides which would yield to heavy internal stresses, but with strong cylindrical extinguishers mounted inside the tank and enclosing the sparking contacts.

The first is of British origin established some years ago by the large power systems of the North-East Coast, and extensively applied elsewhere.

The second is manufactured and used in large quantities in America, and has been successfully used on large power systems in this country.

The third—the large tanks with yielding sides—is typical of German practice, the extinguishing chambers having been added to overcome troubles due to the bursting of these tanks as experienced on the Victoria Falls & Transvaal Power Co.'s system. Mr. Bernard Price, who matured this improvement in South Africa, calls these extinguishers "Explosion Pots," and describes them as insulated metal cylinders which surround the actual contacts. Their main function is to force the gases downwards into the oil so that they may cool before bubbling up to join the air above the oil. Incidentally they also take the pressure impulse and relieve the tank of strain.

Selection of Switches.—In the existing state of knowledge of the

* "Switchgear and the Isolation of Faults on Power Supply Systems," THE ELECTRICIAN, Vol. LXVI., pp. 420 and 468, 1910.

* Paper by J. H. Rider, "The Electrical System of the London County Council Tramways." "Journal" I.E.E., Vol. XLIII., page 235, 1909, and the present author's discussion thereon.

* P. V. Hunter, "Static Sub-station Design," "Journal" I.E.E., Vol. XLVI., page 462, 1911.

* J. R. Beard, "The Design of High-pressure Distribution Systems." "Journal" I.E.E., Vol. LIV., page 125, 1916.

* Dr. C. C. Garrard, "Switchgear Standardisation." "Journal" I.E.E., 1918, and the Newcastle discussion thereon.

* E. B. Wedmore, "The Control of Large Amounts of Power." "Journal" I.E.E., 1918, and Newcastle discussion thereon.

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phenomena present when breaking heavy short-circuit currents in switches, it is not possible to state any accepted formula for the purpose of determining by calculations the exact type of switch required for the several conditions of practice. Much useful work, however, at present unpublished, has already been done in this direction by Dr. W. M. Thornton, but much more remains to be done. One of the leading difficulties in this country is to obtain the necessary check by practical tests upon the theories and formulæ which have been advanced

SOME CONTROLLING FACTORS.

Among the known controlling factors are the following :—

1. Length of break.
2. Effect of magnetic blow-out.
3. Velocity of break.
4. Head of oil above point of break.
5. Volume of oil.
6. Strength of top plate, tank and attachments.
7. Inherent lag in operation of the switch.
8. Artificial lag in operation of the switch.
9. Ventilation.

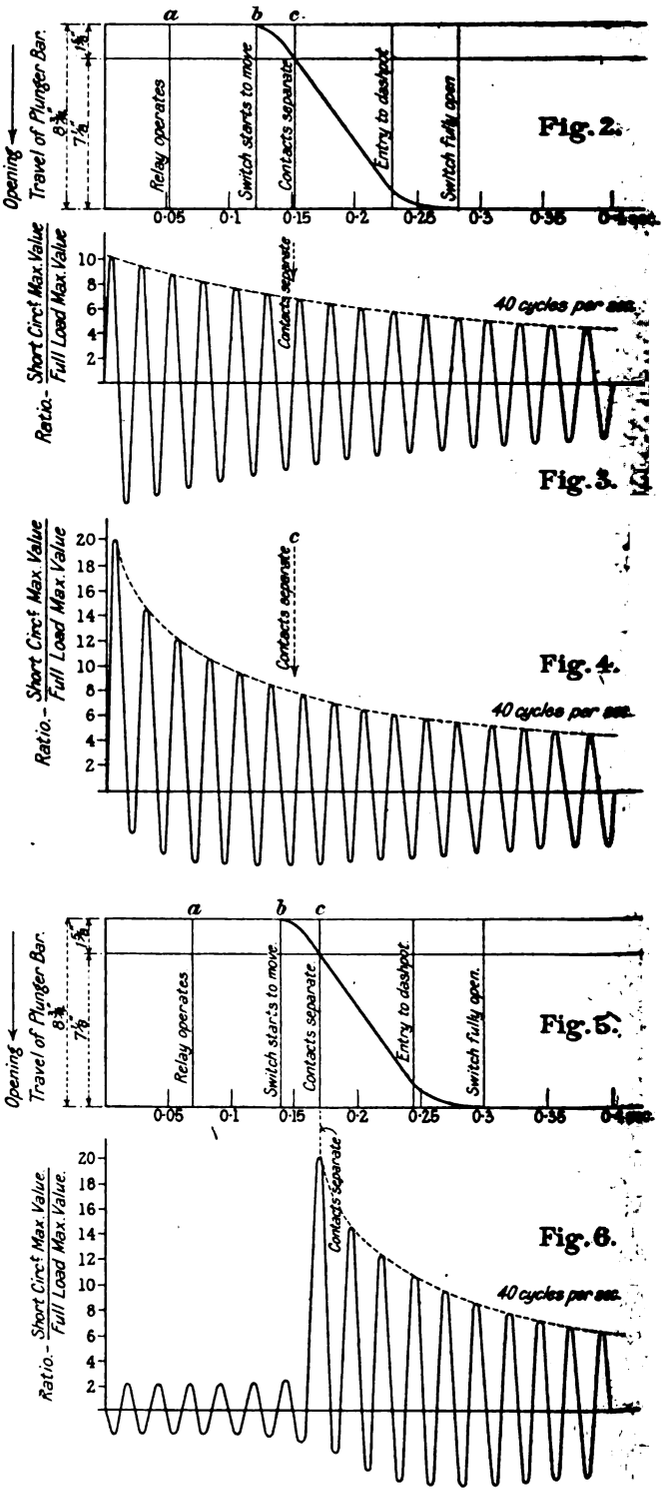
Length of Break.—A long length of break is no criterion of the breaking capacity of the switch, although, considered with other factors, it is of some importance. Some excellent results are obtained with switches having a small volume of oil and long breaks (12 in. or so), but, on the other hand, switches having a larger volume of oil have given very satisfactory results with short breaks (2 in. or so). The risk of a short break is that the arc may be maintained, although the switch has reached the end of its stroke.

Effect of Magnetic Blow-out.—Possibly the reason why the very short breaks answer satisfactorily is that they are used on both the heavy and flexible tank types with two breaks in one tank on each phase, the position of the breaks being arranged in such a manner that there is magnetic repulsion of the arc and so, notwithstanding the shortness of the break, the arcs are magnetically blown longer before their final extinction. In the Pot type this magnetic blow-out is not so evident. It is usual in that case to have two breaks in series, but each break is in a separate pot with wider centres, and the desired length of the arc is obtained by the longer travel of the moving parts.

Velocity of Break.—The higher the velocity of the sparking contacts the greater the distance separating them at the zero points on the current wave, and the less the chance of re-establishment of the arc at the next wave. The speed is usually obtained by a spring kick-off action, which need only be limited by the resistance it offers to the closing of the switch by manual or solenoid control. Fig. 1 is taken from photographs of two plates attached to the side of a sparking contact on switches having a velocity at point of break of 7½ ft. per second. Both these switches operated on short-circuits of 250,000 k.v.a. It will be seen that there are two burnt patches. The centres between these are found by measurement to correspond approximately with the periodicity, and they serve to illustrate how the arc may be extinguished at zero and re-established in the next period on an unsymmetrical wave-form. It is interesting also to note that the top burnt patches which, in a way, are a measure of the intensity of the arc at the first wave, are much greater than the following patches, thus supporting the theory that the greatest strain occurs on the switch at the first wave or "biff." Provided the switch ultimately clears the arc its hardest work is done when the first wave is passed. High velocity at the point of break has the effect of drawing out the arc during this, the most critical portion of the switch travel.

Head of Oil above Point of Break.—At the point of break, *i.e.*, the instant of separation of the sparking contacts, a bubble of conducting vapour or gas is formed, and it seems to be one of the desirable functions of a switch to clear this bubble away from the sparking contacts and to allow its place to be taken by a flow of clean oil. Were this the only consideration, a small head of oil would seem to be advantageous, but this is not so, as, if the head of oil is too short, there is a risk of persistent arcing across the insulators between the conductors and the top plates of the switches, and so it is better to have a good head of oil. Owing to the inertia of the oil above the bubble the strain on the sides and bottom of the tank may increase with the head of oil, and this is a factor to be taken into account in determining the particular head which will give the best results.

Volume of Oil.—Notwithstanding the low modulus of compression of oil the volume of oil contained in the tank ,or perhaps the surface of oil in contact with the arc, is an appreciable factor in determining the breaking capacity. For instance, it was found on tests that the pressure developed in a Pot Switch with a cylinder of 10 in. diameter was only from one third to one fifth of that developed in a cylinder 8 in. diameter.* This implies approximately that the pressure varies inversely with the square of the area. This is a subject which requires further careful investigation under short circuit test conditions. In the absence of reliable formulæ establishing the relation of the arc on breaking a short circuit to the pressure resulting upon the walls, sides, tops and bottoms of switch tanks, the



DIAGRAMS ILLUSTRATING CONDITIONS OF WORKING.

safest guide is the actual experiences and observation of switches which have operated under severe conditions, and from these it has been found that the main determining factors are the mechanical strength of the enclosure and the volume of oil enclosed. For example, a switch which was capable of withstanding a steady internal pressure of 100 lb. per square inch failed to clear a short circuit not exceeding 150,000 k.v.a.; the tank was bulged, burst and severed from the top plate, whereas a switch calculated to with-

* E. B. Merriam, "Some Recent Tests on Oil Circuit-breakers," A.I.E.E., Chicago, June, 1911.

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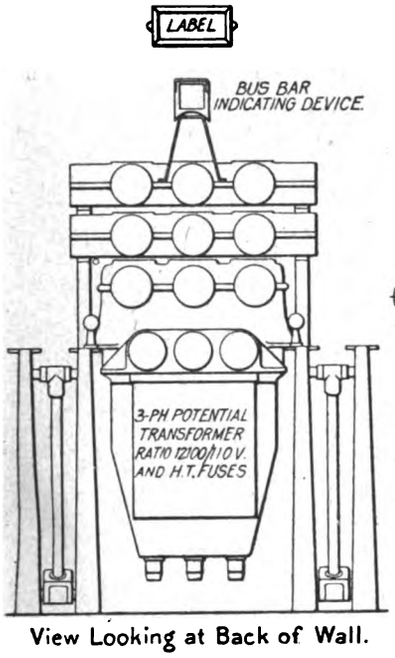
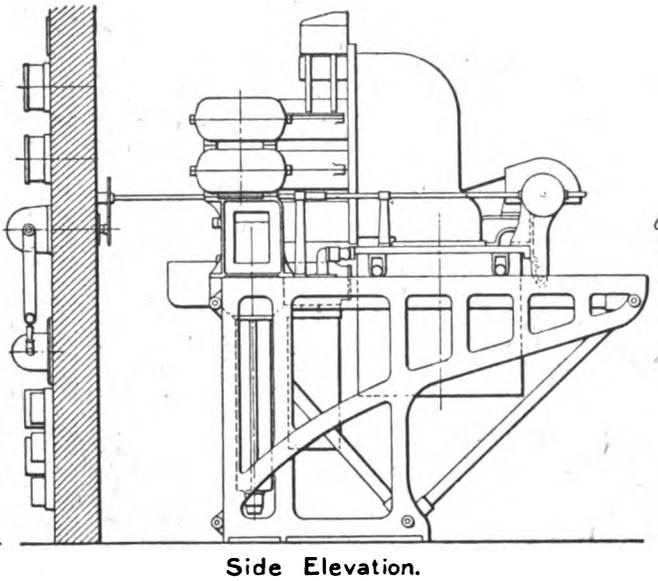
stand 50 lb. per square inch pressure, but of three times the volume of oil, satisfactorily cleared a short circuit of 200,000 k.v.a.

Strength of Top Plate, Tank and Attachments.—It does not follow that the breaking capacity of all switches can be improved by increasing the strength of the tank and top plate. A limit must always be reached where the tank is not the weakest link, *i.e.*, for instance, no increase in the strength of the tank will avail if the arc can be maintained across the break, but such defects are uncommon. The strength of the tank, top plate, and the attachment between these two parts are the main guarantee of satisfactory operation under heavy short circuit conditions.



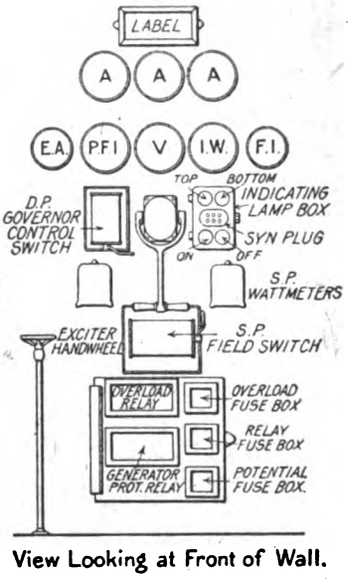
View Looking at Back of Wall.

FIG. 7.



Side Elevation.

FIG. 8.



View Looking at Front of Wall.

FIG. 9.

ARRANGEMENT OF ARMOURED PANEL, REMOTE CONTROLLED THROUGH A WALL. MECHANICAL OPERATION.

LAG IN SWITCHES.

Inherent Lag in Operation of the Switch.—The term "lag in operation of the switch" is here intended to cover the total time interval between the occurrence of a fault and the automatic separation of the sparking contacts. This time may be divided into three distinct sections, as shown in Fig. 2, which is an operation diagram for a quick acting switch. The three sections are :—

(*a*) Magnetic and mechanical lag inherent in the relay.

(*b*) Magnetic lag in the trip coil and mechanical delay during which the plunger of the trip coil is moving from rest and striking the tripping mechanism.

(*c*) Lag in transmitting motion from the tripping mechanism to the other mechanical parts of the switch down to the actual separation of the sparking contacts.

The interval (*a*) on the diagram does not include any artificial lag or definite time limit, but the interval varies with the nature and intensity of the fault.

The time intervals (*b*) and (*c*) are practically constant ; (*b*) may vary slightly with the tripping voltage and (*c*) with the mechanical condition of bearings and springs. The diagram shows the operation of a switch on a dead short circuit as represented by Fig. 3, which shows the decrement of the short circuit current on an average modern generating plant with 10 per cent. short circuit reactance ; the short circuit having been assumed to occur at an instant favourable to a symmetrical wave formation.

A comparison of Figs. 2 and 3 shows in this case that the short circuit current at the separation of the sparking contacts will be about 6½ times the normal aggregate full load of the generating plant.

Fig. 4 is a similar fault except that it assumes that the occurrence of the fault is favourable to an asymmetrical wave formation. In this case the short circuit current at the separation of the sparking contacts is about eight times the normal.

Fig. 5 shows an operation curve of a switch with a high resistance fault. This assumes that the fault current is just sufficient to trip the relay and, therefore, the inherent lag in the relay is longer than Fig. 2.

Fig. 6 is a corresponding short circuit characteristic of the worst kind for the switch, viz., an incipient fault or one which in the first instance has a high resistance and which, in the course of a few cycles, develops into a fault of maximum short circuit current. In the curve it is assumed that this development has happened to coincide with the instant of separation of the sparking contacts. In such a case the maximum pressure will occur in the switch tank and the short circuit current at the separation of the sparking contacts on the same plant as the preceding illustrations, may be as much as 20 times the normal. This will be referred to later.

Artificial Lag in Operation of the Switch.—The introduction by the relay of a definite time lag of 1½–2 seconds or more, occurring before the tripping circuit is complete on the contacts of the relay, will reduce the strain on the switch under ordinary operating conditions, as the instant of sparking contact separation will generally occur when the short circuit current has declined to the level of the sustained short circuit current, which may be only about three times the normal.

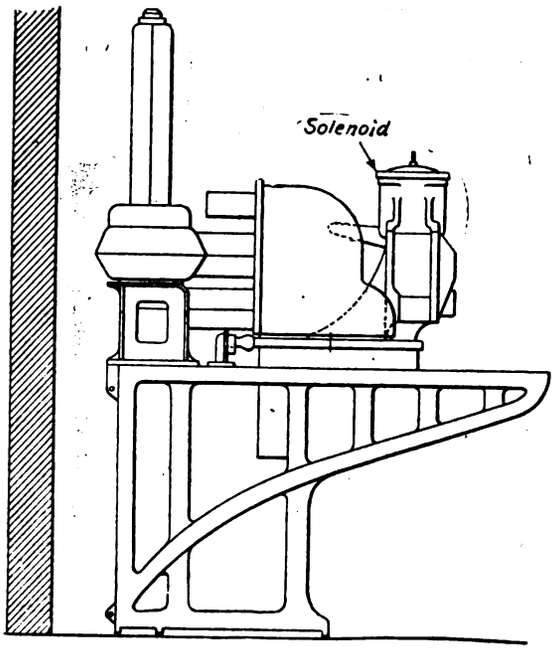


FIG. 10.—SIDE ELEVATION OF ELECTRICALLY OPERATED ARMOURED PANEL.

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Ventilation.—One of the troubles experienced in the past has been explosions of the mixture of the gases which are the product of the arc under oil and the air on the surface of the oil. Another has been the ejection of these conducting vapours from the tank into the 'bus bar connections setting up arcs across conductors outside the switch. Yet another, perhaps rarer, trouble, has been the explosion of these gases outside the switch, in some cases really raising the roof of the switch room. These troubles are removed by a strong tank enclosure, preferably with a cooling flange at the joint. There is no difficulty in making a tank to withstand the maximum pressure of an explosion of gas, and so it is possible that ventilation of switches is in some cases superfluous. A vent pipe, however, tends to relieve the pressure and at the same time carries away the conducting vapours, but it is when the conductors are not completely enclosed and immersed that it is most needed as a means of avoiding risks of arcing across 'bus bar connections.

PRACTICAL APPLICATIONS.

This article will not be complete without showing by illustration how the above factors have been applied in large power stations, and so Figs. 7 to 11 are given to illustrate one form of switchgear in successful practice. Considered from the aspect of the above factors, the description of the switch is as follows :—

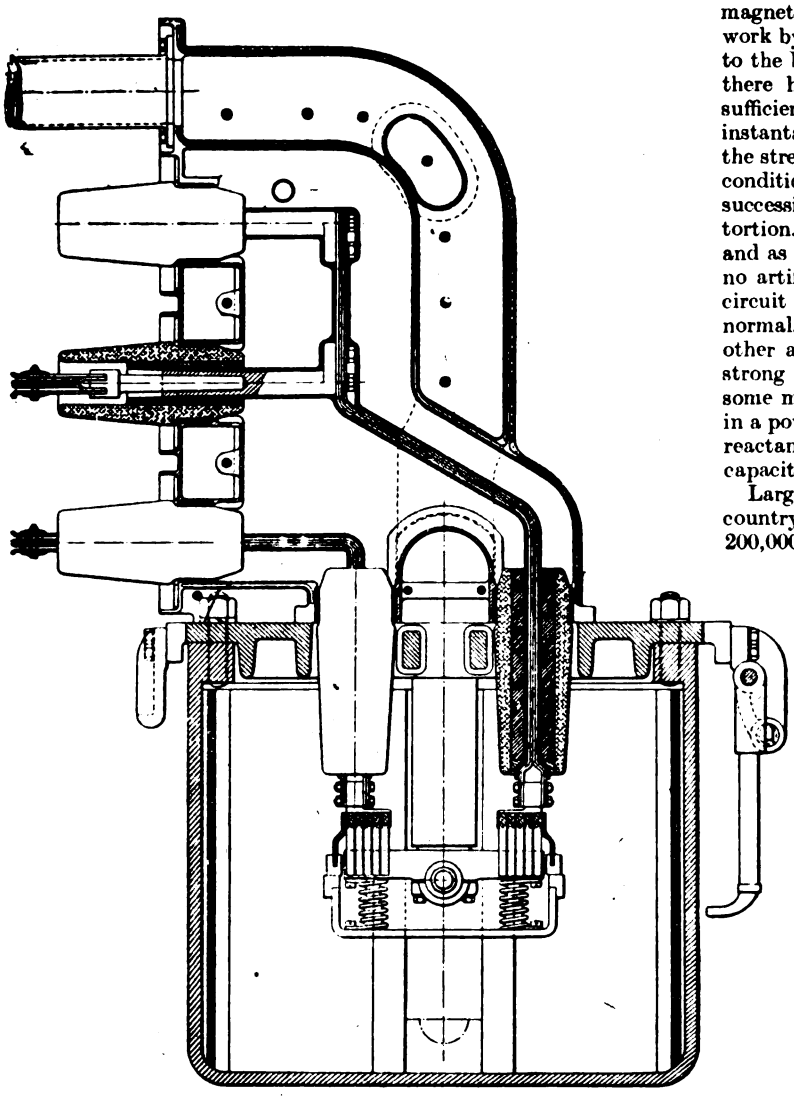

FIG. 11.—DETAILS OF OIL SWITCH.

The length of break between each pair of sparking contacts is 6½ in., making a total break of 13 in. The two sets of sparking contacts are arranged at 13 in. centres, at which, under short-circuit conditions, there is a strong magnetic repulsion between the two arcs, tending to lengthen them. The velocity of break is 6¼ ft. per second, which may be accelerated by magnetic repulsion. The parts are constructed so that the moving elements have reached their maximum velocity at the instant of separation of the sparking contacts. This is illustrated by the straight line portion of the operation diagrams, Figs 2 and 5. The head of oil above the break is 10 in. The volume of oil in the switch tank is 15 cubic ft., and the volume of air cushion above the surface of the oil is 1¼ cubic ft. The tank and the attachment thereof to the top plate are designed to withstand without permanent distortion a steady internal pressure of 400 lb. per square inch. The joint between the top plate and the tank is a machined flange 3 in. wide. It is estimated that, thanks to the air cushion between the surface of the oil and the top plate, the stresses on the top plate will not be so great as those on the sides and bottom of the tank; but, nevertheless, the top plate is of a heavy section of cast steel, having an ultimate tensile strength of 30 tons per square inch. The natural lag in operation of the switch, including the relay and trip coil, is shown on the above operation diagrams, Figs. 2 and 5. Ventilation is afforded by means of a duct passing through the centre of the hood on each phase. This duct exhausts into the atmosphere, or into a channel if required above and well clear of the 'bus bars. The aggregate area of the exhaust thus provided is 36 sq. in. at the outlet. Every conductor, including the connections to the 'bus bars, is enclosed within a metal covering, suitable arrangements being provided in some places by the choice of metals and in others by the addition of copper rings, which produce a neutralising magnetic flux in order to avoid excessive heating in the metal framework by induced eddy currents. It must be admitted that the limit to the breaking capacity of this switch is unknown, mainly because there has been no opportunity of making a practical test with sufficient generating plant capacity. But similar switches with instantaneous setting of relays and fitted with tanks of only a quarter the strength have operated several times under heavy short circuit conditions close to power station 'bus bars. For example, on three successive occasions separate switches cleared without any distortion. The generating plant running at the time was 45,000 kw., and as the alternators were not all of modern design, and there was no artificial reactance in circuit, it will be allowed that the short-circuit possible at the instant of break would be at least 10 times the normal. In any case, it is a reasonable deduction from this and other available data, that the switch having a tank four times as strong will clear a short circuit of 1,000,000 k.v.a. and still have some margin in hand for safety. Such a switch is suitable for use in a power station of 60,000 kw. generating plant with a short circuit reactance of 10 per cent. The maker's present listed breaking capacity rating for it is 350,000 k.v.a.

Larger switches are at the present time under construction in this country for use with super power stations of 150,000 kw. to 200,000kw. It is early yet to describe these, but it may be here stated that in one make all conductors are enclosed in metal armouring, and all insulators, as well as the conductors, are immersed either in compound or oil, so that there is no surface of insulator in air or air gap separating any live parts between phases or between any phase and earth. Sufficient strength in the containing parts immediately surrounding the switch proper is provided with the object of clearing short circuits of 1,500,000 k.v.a. to 2,000,000 k.v.a. There is no limit to the practical possibilities in the design of power station switchgear for even heavier short-circuits if required; but there are other reasons, such as damage to windings of plant, which will make it necessary to limit the shocks to the system.

FACTOR OF SAFETY OF SWITCHES.

A certain amount of repair must in all cases be expected on a switch after breaking a very heavy short circuit current. This, in ordinary cases, should be confined to cleaning up the sparking contacts; but as will be seen from the above, even with short circuits of similar characteristics, there may be very different current amplitudes actually broken by the switch. Figs. 3 and 6 are an extreme but nevertheless possible combination. Anything between these extremes may occur, and this fact probably accounts for the experience of switches suffering differently when acting on faults which are otherwise similar.

The question, therefore, arises whether or no the switches must be selected for the extreme. Obviously, the initial costs are multiplied considerably, there being a difference of 6½ to 20 between the ordinary and the extreme. The author suggests that switches be rated in catalogues with breaking capacities at the ordinary short circuit operating conditions; but that all switches should have a factor of safety enabling them to at least break circuit at the extreme conditions. If a switch *breaks circuit* under conditions more severe than the "ordinary," even although in doing so some parts are distorted or burnt, it should be still accepted that it has performed its function.

When such serious faults as are under consideration occur a certain expense in repairs is inevitable. Faults close to the switch-

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gear are, or should be, rare, and the "extreme" cases will be rarer still, and so to repair a switch on the "extreme" occasions should not be looked upon as a very serious matter. In any case, it may be cheaper to repair a switch occasionally than to bear the capital expense of making all the switches capable of dealing with the "extreme" without effort. The most essential thing is for switches to *break circuit* under *every* contingency, and in order to comply with this the factor of safety should not be less than four times the listed breaking capacity rating: allowing at this stage for constructional irregularities, an additional factor of safety of not less than 2½ on the materials employed.

The Scope for Research.—The theory of breaking capacities and the influence of such factors as are briefly mentioned in this article are fitting subjects for full and careful research when the times are happier and when men and plant are available for the work. In addition to the items already stated, the following will require attention:—

The effect upon the switch stresses of inductance or capacity in circuit with the fault.

The time lag permissible without the risk of synchronous plant running out of step.

The stresses occurring on breaking single phase fault currents—(*i.e.*, faults between phases) as compared with three phase faults.

The voltage phenomena occurring on the sudden extinction of the arc when breaking circuits with capacity and inductance, and the possibility of the velocity of break being made too fast or the extinction too sudden.

The actual incidents at the instant of break and immediately after under oil and their effect upon the switch breaking stresses.

The relation of the velocity of break to the number of breaks in series and its effect upon the strains on the switch parts.

It is to be hoped that these and other items which arise in connection with breaking heavy short circuit currents will receive the earliest attention of the Institution of Electrical Engineers' research organisation, and that the results will guide all British manufacturers to maintain the highest standard of safety and reliability, our national and imperial inheritance.

A Contribution to the Study of the Magnetic Properties of Manganese and of Some Special Manganese Steels.*

By Sir ROBERT HADFIELD, F.R.S., C. CHÉNEVEAU and CH. GÉNEAU.

The object of this research has been to find a connection between the magnetic susceptibility per unit mass (called the mass susceptibility), of different manganese steels and their chemical constitution. All measurements were made with the help of the magnetic balance of P. Curie and C. Chéneveau.† In this instrument the body to be tested is attached to one arm of a torsion balance. A horseshoe magnet can be moved horizontally, so that the direction of motion is at right angles to the line joining the poles, and the body is gradually brought into a stronger and stronger field. The observed deflection of the torsion balance increases at first, then diminishes, and becomes zero when the body lies between the poles of the magnet. If the magnet be moved still further, a deflection in the opposite direction is observed, which again passes through a maximum at the point where the variation of the field of force is greatest. The difference between the readings of the torsion balance when the deflections are greatest on either side is proportional to the mass susceptibility, so that this quantity may be determined by comparison with a specimen whose susceptibility is known.

Throughout the Paper the mass susceptibility is denoted by the symbol χ.

Glass Envelopes.—Unless otherwise indicated, all specimens were included in glass tubes of very different shapes, and generally with very thin walls, which gave an appreciable deflection in the most intense magnetic fields, even when the balance was at its greatest sensibility, *i.e.*, when the platinum wire was the thinnest procurable.

Standard of Comparison.—P. Weiss and Foex ‡ have devoted great attention to the determination of the mass susceptibility of salts in solution and in the solid state. We have adopted, as standard of comparison, anhydrous cobalt sulphate, to which these workers assign the value

$$\chi = +58 \times 10^{-6} \text{ at } 20^\circ \text{ C.}$$

The values of the field strengths which are only approximate, were calculated from the general formula of the apparatus by the aid of the known value of χ for cobalt sulphate and from the constants of the torsion balance. An excellent verification of the validity of this procedure was readily obtained by the aid of a Grassot fluxmeter. This gave 25,500 maxwells. Taking an approximate value of 12 for the permeability of steel, and 1·235 sq. cm. for section of polar space, a field of 1,750 gauss was calculated.

To obtain more feeble fields the magnets were shunted, but the results of such tests were very irregular.

Varying sensibilities were obtained not only by interchanging the magnets, but also by altering the diameters of the platinum suspending wires. The effect of the susceptibility of the air was found to be negligible in all cases.

Experiments made on steel placed in a glass tube showed that in these experiments a variation of 26°C. had but little effect on the result. In all cases, on account of experimental difficulties, and the many sources of error which had to be overcome, the steel results can only be trusted to within 5 per cent. The manganese results are a little more accurate.

In the original Paper the authors next proceed to give a detailed account of the experiments made on the various materials studied. Their chief conclusions are as follows:—

1. *Manganese.*—Manganese was studied under two forms, powdered and fused, in an atmosphere of hydrogen.

Whatever its condition, so long as there is no occluded gas, manganese is paramagnetic; its mass susceptibility at 18°C. is $11{\cdot}0 \times 10^{-6} \pm 2$ per cent. This value is a little higher than that given by H. du Bois and Honda (8·9).

The ferro magnetism of cast manganese is attributed to the presence of hydrogen. This agrees with the observation that this type of manganese, after being heated red, cannot be remagnetised, and with the well known analogous properties of electrolytic manganese and electrolytic iron.

It is of interest in this connection to recall the effect which certain occluded gases have upon the magnetic properties of cast metals and alloys.

2. *Special Manganese Alloys.*—The mass susceptibilities of these alloys, which vary between $+17 \times 10^{-6}$ and $+259 \times 10^{-6}$, were independent of the magnetic field. The strength of the field ranged from 320 gauss to about five times that value. These alloys are therefore paramagnetic.

(1) *Manganese Steels.*—Within the range examined, the mass susceptibilities are only slightly influenced by the amount of manganese present, but depend considerably on the carbon content. Speaking generally, we may say that for these special steels the mass susceptibility increases as the rattio C/Mn diminishes.

(2) *Steels containing Manganese and other Metals.*—If the carbon-manganese ratio is kept constant, the addition of other metals always increases the mass susceptibility.

Manganese-nickel Steels.—An increase of the nickel (from 2·57 to 19 per cent.) raises the mass susceptibility in the ratio of 23 : 67.

Manganese-tungsten Steels.—An increment of 0·74 per cent. of tungsten increased the mass susceptibility in the ratio of 18 : 29.

Manganese-chromium Steels.—Chromium seems also to cause a slight increment. An increase of 3·5 per cent. of chromium seems to correspond to an approximate increase in the mass susceptibility of 10 per cent.

Manganese-nickel-copper Steel.—The comparison of two steels each having the same manganese, nickel and carbon content, one containing no copper, and the other 2·25 per cent., shows that this metal, in spite of its diamagnetism, increases the mass susceptibility by about 19 per cent.

All the preceding steels were quenched in water from 1050° C. They are all of the well known paramagnetic Austenitic type of steel. The addition of a substance like manganese, which is also paramagnetic, will have but little effect in altering the properties of these steels, which remain paramagnetic.

Manganese-silicon Steel.—The addition of 6 per cent. of silicon to a manganese steel, where the C/Mn ratio is about 0·01, makes the steel much more ferromagnetic. A secular change in the magnetic properties of this steel has also been observed, the specific magnetism increasing, in a period of several years, from the order of 4 or 5 per cent. of that of pure iron up to nearly 50 per cent.

* Abstract of a Paper in the "Proceedings" (A) of the Royal Society.

† "Journ. de Phys.," Series 4, Vol. II., p. 796 (1903); "Phil. Mag.," Vol. XX., p. 367 (1910).

‡ "Journ. de Phys.," Series 5, Vol. I., p. 274 (1911).

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The Large Power Station.

This week's issue of THE ELECTRICIAN is mainly concerned with the large power station, or what is often termed in these days, the "super"-power station. We need scarcely remark that this subject is one of the greatest importance, and one that is in the minds of many engineers at the present day. There is no question that the large power station has many advantages. It gives a better utilisation of capital, it secures lower running costs, and the larger the area which it supplies the higher is the diversity factor, which has a most important bearing upon the capital charges. There is no doubt, theoretically speaking, that such a station has marked advantages, however large it may be, and there is equally no doubt that generating stations in the future will be very much larger than they have been in the past. The question at issue, however, is whether there is a limiting size, beyond which there are counterbalancing disadvantages. Some practical difficulties arise when a station is beyond a certain size, and it is with some of these problems that the articles in our present issue deal.

Then there is the great question of the handling and transmission of power. Very large powers introduce certain well-known difficulties in switching, but apart from this, assuming that there are no practical difficulties of any kind, there is the great question whether a station should be erected on an ideal site, some distance from the load, in preference to being near the load, but where the conditions of operation are less economical. At last week's Annual Convention of the Incorporated Municipal Electrical Association the President, Mr. S. J. WATSON, showed very clearly the advantage of a bulk supply station when dealing with such quantities as 4,000,000 up to 17,000,000 kw.-hours per annum. The case which he had in mind was a supply over an area of 400 sq. miles by means of underground cables. Unfortunately, the cost of transmission beyond, say, 20 miles is by no means a negligible quantity, as is shown by some interesting figures which Mr. B. WELBOURN gives in our present issue. It, therefore, becomes necessary to see very distinct financial advantages, if the power station is to be placed at some distance from the load, to counterbalance the cost of transmission.

In this connection Mr. S. E. FEDDEN gave some interesting figures at the I.M.E.A. Convention. Taking the case of a 100,000 kw. station for Sheffield, running at a load factor of 66 per cent. and a power factor of 0·8, he found that such a station with cooling towers could supply energy at 0·275d. per kilowatt-hour to a radius of one mile. If instead of supplying at 11,000 volts, energy were supplied at 30,000 volts, using underground cables, from a distance of 10 miles, the cost was 0·274d.; and at 20 miles this became 0·314d. If overhead cables were used at 30,000 volts, the cost became 0·304d. at 20 miles, and 0·331d. at 30 miles, the pressure in the latter case being 40,000 volts. It will be remembered that Mr. S. L. PEARCE recently came to the conclusion that it would not pay to have a power station more than 20 miles away from Manchester unless there were a gain in the cost of coal. Taking the case of 100,000 kw., 66% load factor, 0·8 power factor and a transmission at 150,000 volts over a distance of 30 miles, he found that the annual cost of the transmission was £100,000. On the other hand, the cost of working with cooling towers at Manchester would be £70,000, so that a saving of 5s. per ton of coal would be necessary at the ideal site to justify the cost of transmission.

Apart from the question of handling large blocks of power, there are two main difficulties in very large power stations, due to fuel and water. As is pointed out by Mr. W. B. WOODHOUSE on another page, the fuel for a station working on an average load of 100,000 kw. would amount to, say, 9,400 tons per week, or a total of 160 10 ton wagons a day. Delivery would be made in five or more trains a day, and ample sidings would be necessary to provide for this handling. Even the ashes provide a problem of some magnitude, since the amount of ashes would be some 60,000 tons per annum. Perhaps the greatest difficulty, however, is in the provision of the necessary condensing water. Such a station would require some 5,000,000 gallons of water, or more, per hour if a high vacuum is to be maintained, and this quantity is by no means easily obtained. In an article in our present issue Mr. J. H. RIDER shows what this means. A good waterside site would be essential, and this might be so far from the load that the financial result of the whole scheme might prove to be unsatisfactory. On the other hand, if reliance is placed on cooling towers the area to be covered by the plant becomes rather serious, the make-up water may not be easily obtainable, and the economy is not so good. The prime cost and maintenance charges of cooling towers are not negligible; some eight acres of land would be necessary; and when the cost of pumping is taken into account the total annual cost becomes considerable.

One advantage of the large power station is that very large units of plant can be employed. Unfortunately, there is very little experience yet available with such turbo-generators as we have in mind, namely, 50,000 kw. There is, however, a good deal to be said in favour of the smaller sizes, such as 25,000 kw., or even smaller. As was recently stated by Mr. S. E. FEDDEN in a communication to us, there is not much advantage or economy when the 15,000 kw. size is exceeded, nor is there much to be gained in price, as it is necessary to run the larger sets at a lower speed. Moreover, if very large units are employed their capital charges become so serious that it is necessary to run them practically continuously at nearly 100 per cent. load factor if the full advantage is to be gained. Moreover, if there is a breakdown it is a much more serious matter than with a smaller size of unit. Further, the handling of these very large machines in erection is by no means an easy matter, and there may be difficulties in transport.

What, then, is the alternative to the large power station? It appears to us to consist in the large unit rather than in the large station, and that development will be on the lines of connecting a number of stations of, say, 50,000 kw. on a ring main so as not to have a great deal of power concentrated at any one place. Advantage would be taken, however, of large units, and each station would contain, say, two 25,000 kw. sets, or three sets of 20,000 kw., all the stations being worked as one combined station so as to avoid any considerable amount of spare plant. Many sites could no doubt be found with condensing water adequate for power of this magnitude, though not for a "super" power station, and such would be used. Where waterside sites are available for large powers these also would be utilised, but it seems unlikely that the bulk of the power in this country can be generated at such sites owing to the cost of transmission.

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The Transmission of Power.

By B. WELBOURN, M.I.E.E.

Summary.—Electric transmission may be carried out by underground cables or by overhead lines, or by both. The author deals with some of the considerations which must affect the choice. If cables are employed, then the armoured type, laid direct in the ground, is to be preferred. In transmitting large powers special care must be taken to provide for the dissipation of the heat. Overhead lines present certain marked disadvantages, but they would inevitably be used if the pressure exceeded a certain value, say 40,000 volts. As to whether power should be transmitted, or the station placed near the centre of the load, depends finally upon the overall cost. Upon this subject not very much of an authoritative character has been published, but, in the present article, the author gives detailed transmission costs of five schemes.

The subject of these notes is one of the utmost importance at this time, when large bulk supply stations and systems are being planned and when various supply authorities are actively discussing the inter-connection and extension of their existing systems. There has been very little public discussion so far, on the all-important financial and other questions which arise out of the problem of transmission and, in fact, not sufficient attention has been given to them.

It will be recognised that the problem of electrical power supply and transmission for our country must be settled after a detailed examination of the local conditions in each area by, or in close co-operation with, the local engineers and officials of the existing supply authorities. There is very little guidance to be obtained from other parts of the world as there is no other country which has such highly industrialised areas, not widely separated, with abundant supplies of coal in times of peace and to some extent of water. Some of these areas which readily occur to the mind are:—

(*a*) The Clyde.
(*b*) North-East Coast.
(*c*) West Riding of Yorkshire.
(*d*) South Yorkshire and North Lincolnshire
(*e*) Lancashire.
(*f*) Black Country.
(*g*) South Wales.
(*h*) London.

The London case is exceptional, because the coal has to be brought to it by rail or by sea, but the possible opening of the Kent coal-field may modify this in a few years.

The question of transmission costs is highly important in the examination of every proposed new scheme, as on them must depend to a very large extent, whether a so-called super-station shall be equipped or whether one or more large economical units shall be erected at or near the load centres of gravity and shall be inter-connected. There is a large and growing body of expert opinion in favour of the latter view*, but first we will consider the transmission of power from a super-station. No one defines exactly what a super-station is, but we will assume that it is equipped so that it is capable of dealing with a maximum demand of 100,000 kw. and has a 66 per cent. load factor. It will also be convenient to assume that the growing tendency to adopt 11,000 volt three-phase 50 cycle generators has been followed and that we have a virgin area to deal with, such as is contemplated in the report of the Coal Conservation Sub-Committee. It is probably fair to reckon that 20,000 kw. will be sold within a radius of two miles to electro-chemical and other works, which may be expected to be established to obtain, among other things, the advantage of cheap power, not loaded with heavy transmission costs. The remaining 80,000 kw. will usually go out by one or more ring mains for transmission to a number of towns or areas and, in rare cases, there may be straight point-to-point transmission. The best way of transmitting these large supplies requires very careful consideration in each case, and the subject may be conveniently treated under the following heads:—

I. Cables.
II. Overhead Transmission Lines.
III. Costs of Transmission.
IV. General Conclusions.

I. Cables.

It is well-known that the Institution of Electrical Engineers gave evidence last year through the president, Mr. C. P. Sparks, to the Board of Trade Electricity Supply Committee and, among other things, recommended the adoption of 66,000 and 33,000 volts between phases as the two main transmission pressures for the United Kingdom, and that there has already been a wide acceptance of the latter pressure for purely cable or mixed cable and overhead line schemes. This has undoubtedly been helped by the readiness of the British cable manufacturers to supply paper insulated cables for this pressure in any quantity, although the actual experience with the manufacture and working of cables above 22,000 volts is not yet extensive in this country. In these days of rapid progress, it would be too rash to say that considerations of the power factor of cables at working temperatures, &c., will limit the development of three-core cables to 33,000 volts; but other matters, such as bulk, weight, transport, number and cost of joints, &c., become increasingly important at higher pressures. Therefore we shall probably not see any higher pressure used on cables on a large scale until more experience has been gained at 33,000 volts, quite apart from the fact that many engineers think that there are "sufficient eggs in one basket" when some 12,000 to 15,000 k.v.a. are transmitted by one 33,000 volt 0·25 sq. in. cable.

The disposal of the 20,000 kw. in the neighbourhood of the power station would almost certainly be done at 11,000 volts for the sake of simplicity and to avoid step-up transformers, extra switchgear, &c. This work would come under the heading of "Distribution," and need only be considered in so far as it affects the number of cables to be brought out of the station. It should be sufficient to allow for 10 such "distributors."

Assuming that the remaining 80,000 kw. will be dealt with by 33,000 volt cables, the number required would depend on the disposition of the load. Assuming that the transformer house is a part of the station, probably another eight cables should be allowed for, making 18 in all. A consideration of the safety of supply and of the heat to be dissipated from the cables will probably result in the laying of the cables in at least four different groups on separate routes through the station premises and yard. The important point is not the actual number of cables but the necessity of laying them so that these considerations will be safeguarded. There should be a minimum of two routes each for the 33,000 volt and 11,000 volt systems, and it would give sufficient separation of one group of 33,000 volt from one group of 11,000 volt cables to lay them on opposite sides of, say, one of the works' roads. It should hardly be necessary to add that the position of all these E.H.P. cables and joints should be very carefully recorded on the Mains Record Maps, and that space for laying them should be definitely allotted when the station lay-out is made.

The choice of the best type of cable to be laid requires full consideration. Experience in America and elsewhere goes to show that it is a mistake to bring several heavily loaded cables through a nest of ducts because of the difficulty of dissipating the heat from the cables, as the air in the ducts is a very poor medium for heat conduction. Attempts have been made in America to improve the heat conduction from a bank of earthenware ducts by arranging for the surrounding soil to be kept moistened. This seems to be an impracticable and expensive scheme on a large scale, and if the greatest efficiency is to be got out of cables which are carrying large amounts of power, then conduit systems must be abandoned as a general rule. Where ducts must be used in special cases for, say, crossing a railway, they should be of cast iron with a minimum free air space round the cable.*

* Strong support is given to this in Clause 31 of the Electric Power Supply Committee's Report (Cd. 9062) since published.

* Since writing the above, a striking confirmation has appeared in the "Electrical Review" of May 17, 1918, as follows: Where cables are laid in ducts artificial cooling is possible, and in an article in the "Electrical World" of April 20th, by W. Keating and C. H. Mueller, particulars are given of experiments with air cooling on a section comprising 10 ducts, about a mile in length, which contain eight three-phase 11,000 volt cables, No. 0000 gauge, each carrying 200 to 220 amperes during peak loads. Above a temperature of 150°F. (65 6°C.), dielectric hysteresis causes very rapid heating, which quickly leads to breakdown, and in the summer of 1916 there were 38 failures in the section referred to. The temperature of the cables approached 130°F. By installing air blowers at alternate manholes, the air escaping at the intermediate manholes, the temperature of the cables was reduced to an average of 96°F. (35·6°C), which is just within the safe limit. Only two breakdowns, both due to station failures at other parts of the system, have occurred on this section since the blowers were installed. In general, the authors say, 35,000 k.v.a. is the maximum load any duct line should be called upon to carry, and it is at points on the Pittsburg system, where this value has been exceeded, that trouble has developed.

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The alternatives are :—

1. *Specially Built Cable Tunnels.*—These suffer from the difficulty of getting rid of the heat quickly, unless special steps are taken for their continuous ventilation and for keeping air in circulation through them. Against this must be set the possibility of adding further cables without re-opening the surface of the ground. The risk of fire in the tunnel may not be serious, but it must not be overlooked as a fire might cause a total interruption of supply.

2. *Cables Laid on the Solid System.*—This system has largely fallen into disuse, and deservedly so, because ample experience has shown that "solidity" is seldom attained. Apart from this, the pitch or bitumen filling and the stoneware or creosoted wood troughing are very objectionable from the point of view of heat dissipation.

3. *Armoured Cables Laid Direct in the Ground.*—When properly made, these cables have all the advantages of the theoretical solid system in that the lead and armour are continuously protected against corrosion by flexible compound and Hessian tapes, under favourable conditions in the manufacturer's works. They are then sent out ready for laying, whatever the weather may be. Extensive experience with armoured cables has shown that they dissipate their heat into the surrounding earth in which they are laid much more rapidly than is possible with other systems.

It is recommended, therefore, that, wherever the local conditions permit, galvanised wire armoured cables suitably protected against corrosion should be used and that they should be laid direct in the earth.

In order to secure the best results, 33,000 volt, 3-core, 0·25 sq. in. armoured cables should be laid 36 in. apart, and one group of four might be laid at the four corners of a "diamond," as indicated in Fig. 1. or in some similar way.

The five 11,000-volt cables might be laid as in Fig. 2

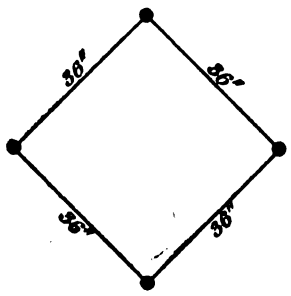

FIG. 1.

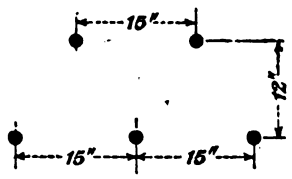

FIG. 2.

Special attention is directed to this question of heat dissipation and spacing as they have not always received sufficient notice in the past. Perhaps it will help to bring it home to mention that the heat to be dissipated continuously by a 33,000-volt, 0·25 sq. in., 3-core cable per yard when worked at 66 per cent. load factor is that due to 22 watts (approximately). It would be of great assistance to the supply industry if the I.E.E. would publish a preliminary report from the committee on "The Heating of Buried Cables," and deal only with E. H. P. cables.

Outside the works, armoured cables will usually be employed, and they will be given further mechanical protection by laying at about 3 in. above them ferro-concrete slabs, creosoted boards, or other suitable covers. This protection may also be advisable in the works' yard.

So far we have only considered the question of transmission by an all-cable scheme with step-up transformers at the power house. Another case may arise similar to that at Niagara, where there is direct generation at 12,000 volts, and the power is carried to the outskirts of the small town on the Canadian side by 12,000-volt cables to step-up transformer stations, and then converted for use on the high voltage long distance transmission lines. A similar procedure would almost certainly be adopted here in those cases in which 66,000-volt lines may be required.

Before leaving the subject of cables a word should be said about their jointing to withstand heavy load conditions. In no case should the joint on the conductors be made with a soldered ferrule, unless suitable provision is made for preventing the drawing out of the core in the event of undue heating. In all cases where overloading of the cable is likely to be met with, or where the cable runs through a subsidence area, Vernier expansion joints should be provided.

It is also advisable to call attention to the electro-static capacity of a cable transmission line and distribution network, as most modern systems are troubled with highly inductive loads which result in power factors as low even as 0·55. It is clear, then, that the capacity current which is required to charge the cables and which is 90 deg. in advance of the load current must, to some extent, help to improve the power factor. The trouble is that there is not nearly sufficient electro-static capacity in the cable system.

A point which requires considerable care in the design of most transmission systems is the provision of a sufficient number of pilot and telephone circuits in one or more separate cables to provide for full telephone communication between the control engineer or "load dispatcher" and all sub-stations, and to provide sufficient wires for connecting up automatic protective apparatus and pressure or other indicating instruments. Unfortunately, on many systems, sufficient attention has not been paid to these points of detail and convenience at an early stage in their development.

In view of the labour situation which is arising out of the war, it will be well worth while to consider the installation of an automatic telephone system as has already been done in one case with great advantage. The telephone cable should be of the multiple twin or twisted twin types and, in special cases, the former may be balanced for electro-static capacity. Where the telephone and pilot circuits are combined in one cable, it is advisable to screen the latter in order to prevent inductive interference between the circuits.

In all cases of 33,000-volt cable transmission the neutral point of the three-phase system will probably be earthed by common consent, but it may be desirable to indicate some of the reasons for advocating that this should be done.

1. The system will not have a free period of its own as would be the case with a Delta system.

2. The cable can be switched into circuit at the correct frequency without any undue pressure rise and without the use of any cable charging apparatus or transformers connected across the far end.

3. A resistance can be inserted in the earth connection to limit the current which can pass through any fault. This limits the possible damage due to mechanical forces and also the pressure rises.

4. High frequency oscillations "trickle away" to earth via the transformer windings.

5. The operation of automatic protective gear is rendered more certain.

6. The star-cable costs less than the delta cable and has less bulk and weight.

7. It is obviously an advantage to have to deal with a pressure to earth which is only that between phases divided by $\sqrt{3}$.

II. OVERHEAD TRANSMISSION LINES.

As there is a possibility of lines for 66,000 volts and higher pressures and the probability of lines for 33,000 volts being used in the near future, the whole question of the uses of *Main* and *Distribution* lines requires the most careful re-consideration from various points of view.

American engineers have demonstrated that 140,000 volt lines can be operated successfully in a clean atmosphere, and the best example is probably that of the Au Sable Co. in East Michigan. The use of such a pressure implies transmission over a considerable distance, and a load which is big enough to justify the economical use of conductors of sufficient cross-section to prevent corona. In our damp climate and especially in our industrial areas where there is much soot, coal dust, &c., it is doubtful whether any pressure above 100,000 volts between phases should be attempted, and it is much more likely that a commencement will be made with 66,000 volts as recommended by the I.E.E.

Before, however, extensive lines become practicable, certain difficulties must be dealt with by legislation and negotiation.

1. *Wayleaves.*—This subject has been frequently discussed before the I.E.E. and elsewhere, and particularly by Mr. Vernier in a Paper devoted wholly to it before the I.E.E. last year. Everyone in the electric supply business agrees that something must be done and much is hoped from the recommendations of the Board of Trade Electricity Supply Committee, which has just completed its report, but, so far, there is no sign of Government action in the matter to meet the universal demand for some expeditious machinery for settling wayleaves disputes.

2. *Local Authorities' Veto.*—Legislation is urgently needed for modifying the powers possessed by these in England, Wales, and Ireland, and by the county councils and police commissioners in Scotland.

3. *Interference with Post Office Circuits.*—The Post Office has a monopoly in the transmission of news in this country; and, naturally, it guards with great care the delicate plant and apparatus which it requires for carrying on its work and with which it has earned a high reputation for accuracy and speed. No bar conductor working at a pressure above 3,300 volts is now allowed to cross

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a telegraph or telephone wire, so that considerable expense may be caused to owners of E.H.P. transmission lines. The usual way, at present, of meeting the wishes of the Post Office is to put the power wires underground by means of insulated cables at the crossings, or, in some cases, to pay for the cabling of the Department's lines. Now there is no experience in this country with three-core cables in series with overhead lines at any higher pressure than 33,000 volts and, while higher pressure three-core or single-core cables may be possible in series with them, it is unlikely that responsible engineers will be ready to risk important supplies until much more experience has been gained. Even at 33,000 volts, the cost of these cabled crossings will be onerous and it is "up to" the supply engineers to find a way out of the difficulty by negotiation with the Post Office engineers. Until this is done it would seem probable that no higher pressure will be used in this country in the industrial areas.

Consumers in the United Kingdom have become so accustomed to receiving a continuous supply of energy, and supply engineers have such a high reputation to maintain for this continuity of supply, that nothing should be done to risk the mutual good feeling which now so commonly exists, nor the loss of revenue. It must therefore always be recognised that overhead lines have certain inherent defects which should be most carefully weighed before deciding to use them for the main transmission lines on which all the distribution lines and cables depend for their supply.

1. In every severe snowstorm, accompanied by high wind, broken wires are reported from some district. As the wires get older they tend to become crystalline at the supports, and there is, therefore, an increasing liability to breakage.

2. While lightning is not so serious in this country as in many others, cases are fairly common of lines being struck, resulting in broken insulators, wrecked terminal boxes, &c., and sometimes damage to transformers and other connected plant. Unfortunately, no method of protection against a direct lightning stroke has been or is likely to be, devised. Two personal experiences are worth recording on this subject. One afternoon, some years ago, the electric tramway service was shut down for two hours in one of the principal cities of Canada during a lightning storm. No one seemed to think much about it, as the inhabitants were not used to the continuous service which we expect in England. Again, in Italy recently, reliable information was obtained that no Continental 33,000 volt paper cable tried in series with an overhead line would withstand the conditions during lightning. *Verb. sap.*

3. The cost of maintenance may be taken at 3 per cent. per annum, or about double what it is on an all-cable system.

4. The life of an overhead line may be expected to be considerably less than that of cables. If steel towers are used, experience with tramway poles in industrial districts may give a useful indication of the expected life. In South Lancashire there are examples of these poles which have been regularly painted, and yet which have required renewal in 20 years, while one important railway company will not use steel posts, &c., where they can be avoided.

If creosoted wood poles are used, we have the following guidance from Sir William Slingo—engineer-in-chief of the British Post Office—"When we take into account such contingencies as premature decay, compulsory removals due to wayleave difficulties, and inadequacy owing to the growth of the system, the effective life is more nearly 20 years. That, at least, is the figure arrived at by the Post Office, and covers several thousand poles, most of them erected on public roads." (*See* "Journal" I.E.E., Vol. 52, No. 226, page 232.)

5. Overhead lines must be shut down periodically for the overhauling of fittings, &c., and for painting where steel poles are used. It follows that continuity of supply can only be maintained on a point-to-point transmission scheme by providing duplicate lines, each of which is capable of dealing with the maximum load. On a ring-main system the lines must be capable of maintaining the full supply at any sub-station whenever a section of the line is out of commission.

6. Assuming that a decision is taken to depend on overhead line transmission in some cases (as apart from distribution lines) and that all wayleave and other difficulties have been overcome, the full benefits of the lower capital costs in normal times cannot be attained in practice, because it is forbidden to run extra high-pressure lines beyond the outskirts of towns and through villages. This results in the addition of considerable quantities of cable and, in the case of 66,000 and higher voltage schemes, the additional cost of a second transformation will be incurred.

7. It is very expensive to suspend the pilot, telephone, &c., cable from catenary wires along a pole line, and there is always the possibility of damage to the circuits (particularly the telephones) when they are most required, say, during storms or when an E.H.P. conductor is broken.

8. *Damage from Stone-throwing, &c.*—That this is no theoretical drawback the following newspaper extract of May, 1918, will show :—

> *Breaking Power Line Insulators.*—A boy named Freeman Field, of Stanley, was charged last week with damaging an insulator belonging to the Yorkshire Electric Power Co. (Ltd.) by throwing stones at it. Owing to the breaking of the insulator the current was interrupted for two hours, and several collieries and a large munition works were seriously affected. The live wire fell into a field: The boy was ordered to pay 15s. 2d. costs and was placed on probation for two years.

An interruption of this kind is serious enough on an overhead *distribution* line, but it is "unthinkable" on a *main* line.

During the past year two particular difficulties in the way of erecting extensive overhead lines have become apparent and they are rapidly getting worse.

1. There is a great and increasing shortage of wood, steel, and other poles, and it seems probable that the exhaustion of stocks will not be made good for some years to come. The shortage of wood poles is the more serious as they are more suitable for use in industrial areas than other types. Naturally, the shortage of supplies has resulted in a big increase in prices.

2. There is difficulty in obtaining sufficient linesmen for anything except short extensions, and maintenance work. A linesman's work is essentially that which can best be done by fairly young and active men of good physique, and as these men come under either Code Nos. 0587, 0588 or 1925 in M.M. 130 (revised), probably all Grade I. men who were under 28 on Jan. 1, 1917, will now be required in the Forces, and they cannot be replaced by women or by men over 50.

In these circumstances it will not be at all surprising if all overhead line extensions, except short ones, automatically cease for a time if the war should last for another year or more and, even now, there is often considerable delay in getting a permit for poles.

The difficulties referred to above have, in some cases which have been looked into, so increased the total cost of overhead lines and made the time for completion so uncertain that the right decision has been to put in cable which can still be manufactured as rapidly as it can be laid.

Before leaving the subject of overhead transmission it is right to point out that a line may be required over difficult country or over ground which is liable to severe subsidence or other abnormal conditions In such circumstances, an overhead line, with its known defects, may be the only practicable way out of the difficulty.

III. Cost of Transmission.

This is one of the burning questions which are exercising the minds of many supply engineers at the present time. Undoubtedly the cost of transmission is one of the most important problems to investigate, whether a point-to-point transmission from a super-station or a ring-main transmission between a number of smaller stations is being considered. The cost of transmission may be the deciding factor in a point-to-point scheme but it is not necessarily so in a ring-main linking-up scheme where the coupling together of load-areas may so improve the conditions of running that the most efficient generating units can be kept continually loaded with a marked improvement in the running costs. It may be recalled that the committee of engineers of Lancashire and Cheshire in their first Inter-connection Report issued in September 1916 stated that, in their opinion, the linking-up only of 28 generating stations at a cost of £281,397 would result in a saving of not less than £82,000 per annum in the coal bill alone, reckoning coal at 17s. 6d. per ton Thus the saving in coal alone would have paid for the whole cost of linking-up in 3½ years, or in 1¼ years if the export value of the coal be taken.

It is generally realised that the best theoretical conditions for cheap generation and transmission cannot now be attained, at an early date, owing to the large amount of money which has been invested in the 600 odd existing generating stations and which must remain as a dead-weight debt unless Parliament decides that the nation should refund the cost of the inefficient plants and so make the way clear for a speedier adoption of the most economical generating plant suitably located with the consequent saving in coal, &c.* *Any drastic action of this*

* In a Paper on "Fuel Economy," before the I.M.E.A., 1917, Mr. J. A. Robertson has shown how the consumption of coal (12,500 B.Th.U.) was found to vary from 2½ lb. to 8 lb. per kelvin sold in 26 electrical undertakings in Lancashire and Cheshire, and that the average was 3·2 lb. He went on to show that it is possible, with a 15,000 kw. turbo-alternator and favourable conditions, to get down to 1·45 lb. per kelvin sold at full load. It is fair to assume, therefore, that we shall get down to less than 2·00 lb. as more efficient plants are brought into use and with improved load factors for them.

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kind must inevitably be accompanied by close supervision of the use of coal in private electrical and other plants, as it is notorious that some of these are extraordinarily wasteful.

There is a good deal of unpublished data on transmission costs, and it is hoped that the following information will stimulate others to make their data public, as this is a very opportune time to discuss the essential financial points in connection with big electricity supply schemes. More discussion is needed on transmission costs than on any other point as the costs of generation at different load factors with given conditions of plant, steam pressure, available condensing water and prices of coal are already well known or can be forecast with considerable accuracy.

It should be noted that all the costs given below are on a war basis, and in Scheme A an indication is given of the amount of the increase over normal times.

SCHEME A.

The problem was to ascertain the total cost per unit for switchgear, transformers and split-conductor cables when transmitting 100,000 kw. at 66 per cent. load factor, 0·80 power factor, and 50 cycles over distances of 3, 10 and 20 miles at various voltages. The estimates were made when the metal prices were as follows :—

Copper	£143	per ton of 2,240 lb.
Lead	32	,, ,,
Armour	33	,, ,,

Labour was considerably lower late in 1916 than it is now, but as copper has declined in price, the following figures will be sufficiently correct. The watts lost in the cables were valued at 0·25d. per kilowatt-hour. The cables were to be taken by three routes working in parallel and no spare cables were allowed, but the maximum temperature rise at full load was to be 60°F., and 20 per cent. overload for short periods was to be allowed.

The units to be delivered per annum were 578,000,000. The nature of the district made overhead lines impracticable.

Length in miles.	Voltage.	Cost per unit transmitted, including all capital and running charges for switchgear and transformers.
3	11,000	0·0359d*.
—	22,000	0·0299d.
—	33,000	0·0286d.
10	11,000	0·1019d*.
—	22,000	0·0596d.
—	33,000	0·0505d.
20	22,000	0·1007d.
—	33,000	0·0808d.

Correcting the first three figures, as a matter of interest only, for copper at £70, lead at £15, and armour ar £10 per ton, we get :—

3	11,000	0·0228d.
—	22,000	0·0189d.
—	33,000	0·0178d.

There were two plain deductions from the above figures :—

1. *Other conditions being equal,* the generating station should be placed as near as possible to the centre of gravity of the load.

2. Even with a 3-mile transmission, it would pay in this case to step-up to 33,000 volts and so be in a good position for taking load which was offered beyond the 3 mile distance.

It is interesting to compare these results with Scheme E.

SCHEME B.

When opening a discussion in Manchester on March 5 on the Coal Conservation Sub-Committee's Interim Report, Mr. S. L. Pearce made the following remarks † :—

> In my evidence before Sir Archibald Williamson's Committee, I considered the question of a Mersey-side site for Manchester, a site at which it would be possible to obtain ample river water for condensing purposes. I assume a super-power station. The load to be transmitted from that station was 100,000 kw., 0·8 power factor, 66 per cent. load factor, transmission voltage 150,000 volts, which is the highest so far used in the States (and possibly not practicable in this country.) But let that pass. Putting the best construction on this problem, it appears that the annual charges on such a transmission line would be of the order of £100,000 to £125,000 per annum. Supposing we were to establish a station in Manchester and use cooling towers, it would result in an increased coal bill, because it is impossible with cooling towers to obtain a vacuum of more than 27 in. or 27½ in. at the outside, as against the figure of 29 in. or 29½ in. with a natural waterway and plenty of cold water. Therefore I have assumed an increased coal consumption of 15 per cent. Then there are all the costs incidental to the towers. I estimate that the extra annual cost for cooling towers, compared with a natural waterway are of the order of £70,000 per annum. So that, on the one hand, we have transmission costs of £100,000 to £125,000, and, on the other hand, the figure of £70,000. Clearly in that case it would not pay Manchester to go to the Mersey-side for current.

Again, take the question of transmission costs in relation to coal transport costs. Assuming the same data—viz., 100,000 kw. transmitted, voltage 150,000 watts, 0·8 power factor, 66 per cent load factor—it would only pay to establish power stations 30 miles away from the area of supply if you can get coal 5s. per ton cheaper. On this basis it would not pay Manchester to have a power station at a distance exceeding 20 miles from the area of supply for the purpose of obviating the use of cooling towers, assuming there is no advantage to be gained in the cost of coal.

The above figure of 20 miles could be increased if cheaper coal and ample water were both available, but such sites do not exist in Lancashire. Again, it is difficult to establish a case in favour of transmitting electrical energy rather than railing coal. The superiority of electrical transmission only becomes apparent with very high-load factors.

Mr. Pearce has kindly placed at the disposal of the writer the data on which his transmission costs were based and it appears that they make the best possible showing as an unbroken 150,000-volt transmission line has been considered, although it may not be practicable in this country.

A single transmission line 33 miles long was allowed for in series with 5 miles of 33,000-volt cables, three sets of transformers, two sets of switchgear and sub-station buildings, while copper was taken at £100 per ton.

The total capital cost comes to £734,950, and the annual charges are £125,859. The total annual cost per unit delivered is 0·052d., of which standing charges =0·0382d., running charges =0·0138d. As the transmission system for such an important scheme should be duplicated in order to ensure reasonable continuity of supply, the above figure becomes 0·067d.

SCHEME C.

It may be objected that it is too optimistic to take a 66 per cent. load factor as in the two previous examples. A 40 per cent. load factor overhead line scheme has, therefore, been examined with no additions for connecting cables. It should be noted that *the figures apply to the lines only,* and that nothing has been included for switchgear or transformers. The other particulars are :—

1. Split-conductor lines at 33,000 volts three-phase.
2. 0·8 power factor.
3. 50 cycles.
4. 10 per cent. for interest and sinking fund and 2 per cent. for maintenance.
5. 0·25d. per unit for line losses.
6. £125 per ton for copper.

K.v.a.	Miles.	No. of 3-phase circuits.	Percentage drop at full load.	Units, *d/d* per annum.	Total cost per unit.
11,000	10	1	6·8	30,900,000	0·0336d.
11,000	20	1	9·5	30,900,000	0·0662d.
11,000	40	2	9·5	30,900,000	0·1780d.
37,500	10	2	8·1	105,000,000	0·0212d.
37,500	20	4	8·1	105,000,000	0·0582d.
37,500	40	8	8·1	105,000,000	0·2060d.

When suitable additions have been made to the above figures for the capital and running costs of connecting cables, transformers and switchgear, it will be evident, *under the conditions,*

1. That a 33,000-volt point-to-point transmission will not pay beyond 15 miles, and that a higher voltage must be considered for a longer distance.

2. That, as a point-to-point scheme, only it would be difficult to compete with a modern plant working at 40 per cent. load factor, installed at or near the load.

SCHEME D.

Another set of figures on a 40 per cent. load factor basis was made recently to get a straight comparison between an all-cable and all-overhead line. The results are theoretical only, as they ignore the fact that, in the case under consideration, it would not be possible to get an all-overhead scheme and that considerable quantities of cable would have to be used in series with the line at villages, etc., to get a complete transmission.

The data on which the comparison was made are :—

1. 30,000 kw. at 0·8 power factor, 25 cycles, 40 per cent. load factor.
2. 30,000 volts three-phase split conductor system.
3. 15 miles point-to-point.
4. 3 armoured cables or 3 overhead circuits so that transformer and switchgear and annual loss charges are equal for either scheme.
5. 10 per cent. per annum for interest and sinking fund, 0·25d. per unit for losses.
6. Maintenance 2 per cent. for cables, 3 per cent. for overhead lines.

* These figures are for cables and switchgear only.

† For full report *see* THE ELECTRICIAN of March 29, 1918.

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7. Wayleaves for overhead line—£50 per mile per annum. The cost of and the time taken in obtaining the wayleaves were not allowed for.

8. Copper at £125 per ton of 2,240 lb.

9. Voltage-drop at full load is 3½ per cent. for cables and 5¾ per cent. for lines.

10. Units d/d per annum would be 105,000,000.

11. Capital costs—Cable scheme £199,500.
Overhead scheme £127,500.

12. Cost per unit d/d cable scheme 0·0618d.
Overhead scheme 0·0467d.

It will be seen that the apparent difference of 0·015d. per unit in favour of an overhead scheme will be eliminated when the necessary additions are made in a practical scheme to the 0·0467d. for cables (as mentioned above) and also for the additional circuits required to ensure the same reliability of supply as with cables.

SCHEME E.

A particularly interesting and closely detailed investigation was made in July, 1917, to determine the correct voltage for transmitting 10,000 kw. at 27 per cent. load factor, 0·9 power factor, 50 cycles for 3 miles by cables only, from an existing 6,000-volt three-phase station. Close prices were supplied for the necessary switchgear and transformers, so that accurate results would be obtained. The C^2R and hysteresis losses were allowed for at 0·35d. and 0·15d. per unit respectively. It will be sufficient to give the results as follows :—

Voltage	6,000	20,000	30,000
Annual cost per unit d/d by cables ...	0·0528d.	0·0263d.	0·0247d.
Do. switchgear & transformers	*0·0049d.	0·0505d.	0·0554d.
Totals	0·0577d.	0·0768d.	0·0801.

It is valuable to compare this with Scheme A. The figures have also been worked out for 40 per cent. and 66 per cent. load factors, and the full comparison is as follows :—

Load factor.	Cost per unit at		
	6,000	20,000	30,000
27	0·0577d.	0·0768d.	0·0801d.
40	0·0415d.	0·0592d.	0·0327d.
66	0·0283d.	0·0449d.	0·0474d.

GENERAL CONCLUSIONS.

1. In point-to-point proposals, the cost per unit transmitted will usually determine the site of the generating station when coal and water are available in reasonable quantities and at fairly equal prices at two or more sites.

2. In linking-up schemes, the cost per unit transmitted will not necessarily be the deciding factor for or against the proposal. The reduced running costs resulting from improved load factors on the most efficient plants, the saving in spare plants, the stand-by considerations, &c., may easily outweigh transmission costs, which will, in any case, usually be incurred over fairly short distances.

3. With our present experience of the reliability of cables it is almost certain that the main transmission of large powers over the short distances required in the industrial areas of this country will be done by means of cables laid underground and that no "spare" cables will be provided.

4. The main cables are likely to be of the armoured three-core three-phase type, laid direct in the ground and to work at 33,000 volts between phases. The experience with 20,000 volt cables has been very satisfactory and it is unlikely that responsible engineers will adopt any higher pressure than 33,000 volts on cables on an extensive scale without considerable further experience at that pressure.

5. Where long main transmission circuits are needed, at pressures exceeding 33,000 volts, overhead lines will be used at 66,000 or at some higher voltage, probably not exceeding 100,000 volts. In these cases, duplicate lines *must* be provided where continuity of the main supply is a *sine qua non*, as it usually is, and the lines must be taken with their known limitations.

6. In this country, the chief use of overhead lines is likely to be in connection with the distribution of power as distinct from its transmission. There appears to be no reason to change the opinion expressed elsewhere ("Journal" I.E.E., Vol. 52, No. 226, page 177, 1914) that "It may be taken for granted that pole lines have come to stay in rural districts where low first cost is of paramount importance in enabling supply authorities to give a cheap supply of energy to industrial works, collieries, houses, &c."

*Switchgear only.

British Science Guild.

TWELFTH ANNUAL MEETING.

The twelfth annual meeting of the British Science Guild took place at the Mansion House on June 19, the Lord Mayor presiding. The adoption of the annual report was moved by Prof. R. A. Gregory, who referred in detail to the work of the various committees of the Guild on education, the metric system and the dye industry. A memorandum recently submitted to the Government Committee on the Teaching of Science, urged the institution of more stimulating and broader courses of instruction in science at schools and universities. The teaching of the metric system in schools was advocated in a memorandum presented to the Ministry of Reconstruction and various suggestions were made to prepare the way for the general use of such measures in trade and commerce. In particular it was suggested that the metric system should be used in Government reports and as a basis for Government tenders. The report on the dye industry emphasised the very powerful support enjoyed by the various firms engaged in this industry in Germany, which amounted to a total sum exceeding £50,000,000. The capital invested in the industry in this country was thus at present moderate in comparison. Few peopole realised the complexity of the many so-called intermediate products and the deficiency of trained chemists to deal with them. One of the chief tasks before the industry was to sub-divide its activities, so that there was no needless duplication of effort, and especially to concentrate on products for which there is a demand, A survey of the whole position by a small committee appointed by the Government was suggested. Prof. Gregory also referred to the British Scientific Products Exhibition organised by the Guild, which is to be held in London during August and September. The exhibition should have a useful educational effect in showing the value of research in industry; and should have the encouraging result of showing that substantial progress in certain directions has already been made.

The adoption of the annual report having been moved by Prof. Gregory, seconded by Sir Edward Brabrook, and carried, an address was given by Lord Sydenham on "Education, Science and Leadership." After referring briefly to several points in the report, Lord Sydenham proceeded to discuss projects of reconstruction, in which he said there had naturally been a tendency to refer to matters affecting industrial and commercial efficiency. Peace, however, would find us faced by new problems in democracy still unsolved. Democracy was on its trial, and its limitations frequently forgotten. Much would depend on the acquired knowledge of the leaders which the enfranchised masses elected to follow, and this choice of leaders in turn would be governed by the moral and intellectual equipment of the masses. Education, therefore, deserved an important place in our present discussions, and in this respect we now knew better where our weakness lay. In the number of our institutions providing higher education, and in the financial support they receive America and Germany stood ahead of us. Only 4,400 students entered at our universities in 1913-14, and of these several hundred were foreigners. The number of students taking full-time courses per 10,000 of population was 16 in Scotland, 13 in Germany, 10 in the United States, 6 in Ireland, 5 in England and 5 in Wales. At present only one child in a thousand of the 600,000 leaving the elementary schools each year reached a university. In future there must be equal chances for natural talent wherever found.

A Paper by Sir Algernon Firth on "Science and Scientific Research in Industry" was read by Sir Donald Ross, the author being unavoidably absent. Sir Algernon contended that the general idea that manufacturers were not sufficiently alive to the benefits of research and technical education was unfounded. Manufacturers in this country had made great advances in this respect. On the other hand, the progress of industry was often checked by lack of scientific knowledge in Government departments, the aniline dye industry being a conspicuous example. Quotations were made from recommendations by a Board of Trade sub-committee appointed to inquire into 12 industries in this country, in which the value of research was strongly emphasised, and suggestions made for its encouragement. In conclusion, it was remarked that there would be no room for waste in industry in the future. Attainment of maximum production in industry would be the great object and scientific handling of materials and processes a vital necessity.

A short address was also given by Sir Henry Newbolt, who referred to the importance of education as a factor in leadership. He dismissed the idea that humanistic and scientific education were antagonistic. A vote of thanks to the Lord Mayor and the speakers terminated the proceedings

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The Convention of the Incorporated Municipal Electrical Association.

Owing to the war the annual convention of the I.M.E.A. has in recent years been held in London. This year, however, the rule has been broken, Manchester being chosen as the place of meeting. The technical programme was somewhat restricted, and there were no social events. The attendance was smaller than usual, and there seemed no recognised gathering ground where members could be readily met, except on the Thursday evening (the 20th. inst.), when a smoking concert was given at the Engineers' Club.

Among the delegates and visitors were the President, Mr. S. J. Watson (Bury), Mr. C. H. Wordingham, C.B.E. (President of the Institution of Electrical Engineers), and Messrs. S. T. Allen, W. J. Bache, A. W. Barham, J. A. Bell, A. S. Black, J. H. Bowden, S. E. Britton, R. A. Chattock, J. Christie, W. H. Cooke, A. C. Cramb, H. Dickinson, H. S. Ellis, S. E. Fedden, J. W. Hame, H. A. Howie, W. T. Kerr, W. W. Lackie, R. B. Leach, H. Tomlinson Lee, F. M. Long, J. F. Magoris. A. Nichols Moore, H. A. Nevill, F. A. Newington, E. G. Okell, S. L. Pearce, H. Faraday Proctor, F. W. Purse, L. L. Robinson, C. Newton Russell, A. H. Shaw, C. Turnbull, P. P. Wheelwright, W. J. H. Wood and C. H. Yeaman.

The LORD MAYOR OF MANCHESTER (Sir Alexander Porter), in welcoming the Association, said this was the third time it had met there, and he hoped the third time would be lucky, and that the conference would be the most satisfactory one that had been held there, and that the weather would continue to be fine. Within a 10 mile radius of that hall there were about 2½ million people, so that there was enormous scope there for the application of electricity both for power and lighting. He believed the Association represented municipal authorities, the capital of whose electrical undertakings was about £55,000,000. Manchester was happy in the possession of Mr. S. L. Pearce, the city electrical engineer, who had been president of the Association and was a very important official both in regard to his scientific abilities and his administrative capacity.

The PRESIDENT thanked the Lord Mayor for coming there to welcome them and for placing that fine hall at their disposal.

The PRESIDENT then announced that in addition to the invitations to members to visit the Westinghouse Works and the Stuart-street Generating Station, members were invited to visit the works of Messrs. Ferranti (Ltd.), Dick, Kerr & Co. (Preston) and Messrs. W. T. Glover & Co.

Mr. WATSON then delivered the following presidential address :—

Presidential Address.

By S. J. WATSON.

After some reference to the affairs of the association, the author passed to broad questions of electricity supply. Progress was well illustrated by what had taken place in Lancashire.

Census returns show that Great Britain, with a population of 45,000,000, employs power to the extent of 10,750,000 H.P., including 2,000,000 H.P. used by public utility undertakings, leaving 8,750,000 H.P. for manufacturing purposes, say, an average of approximately 1 H.P. to five inhabitants. In parts of industrial Lancashire the amount far exceeds this figure ; in some cases it is as high as 5 H.P. to eight inhabitants. In the area of 400 sq. miles with Manchester in the centre and a population of 2,500,000 it is safe to take the power requirements at 1 H.P. to two inhabitants.

Assuming an ultimate demand of 450,000 kw. and a load factor of 50 per cent., which is well within the range of probabilities, the total output required for industrial power purposes will amount to 2,000,000,000 units per annum, excluding any supplies to railways or new industries. A further field for the use of the supply lies in the substitution of electrical heating and cooking apparatus for the existing domestic fires. The consumption of coal for this purpose amounts to about three-quarters of a ton per individual per annum, or, say, nearly 2,000,000 tons in this area, all of which is burnt in notoriously inefficient grates This quantity of fuel if consumed at a power station would enable upwards of 2,000,000,000 units to be supplied to meet these requirements. Provided a low scale of charges is adopted and reliable heating appliances are available at a reasonable cost, there seems no reason why this important duty should not be carried out electrically.

After making some provision for railway electrification, the establishment of new industries and domestic developments, it is not at all improbable that the total electrical requirements will amount to 5,000,000,000 units per annum at the end of the next two decades with a maximum load approaching 1,000,000 kw.

Bulk Supply.—As the question of "bulk supply" is likely to come more to the front in the near future, it will, I think, be of interest to consider what cost is likely to be incurred in generating such supplies at a large modern power station and to what extent the cost is affected by the conditions which obtain after the supply is delivered by the main generators to the station 'bus bars.

It is necessary to point out that all the figures used as estimates are based on pre-war prices.

Assuming a convenient site is available possessing ample natural water and good facilities for obtaining deliveries of fuel, the capital expenditure in providing an installed capacity of 100,000 kw. should not exceed £900,000, or at the rate of £9 per kilowatt.

The cost per extra-high-tension unit delivered to the 'bus bars under the load factor conditions specified would be as follows :—

Table I.

Plant installed	100,000 kw.		100,000 kw.
Maximum load	75,000 kw.		75,000 kw.
Units to 'bus bars...	220,000,000		300,000,000
Load factor	33·5 p.c.		45·7 p.c.
	Cost per unit.		Cost per unit.
Fuel —	d.		d.
2 lb. per unit at 12s.	0·128	1·8 lb. per unit at 12s.	0·115
Oil, &c.	0·002		0·002
Salaries and wages...	0·018		0·014
Repairs	0·012		0·010
	0·160d.		0·141d.
Rates, taxes and management	0·019		0·015
Capital depreciation obsolescence at 10 per cent.	0·098		0·072
Total cost	0·277d.		0·228d.

In the coal figures I have taken an average calorific value of 12,500 B.Th.U. per lb., which works out at an overall thermal efficiency of 13·8 per cent. and 15·3 per cent. under the two sets of conditions

It has been generally assumed that any given set of costs for a definite maximum load and output can be resolved into a compound charge of £x per kilowatt demanded per annum, and rd. per unit supplied, and that a tariff so prepared might fairly be applied to all classes of consumers with load factors varying from 1 per cent. to 100 per cent. The I.M.E.A. and the I.M.T.A. suggested in 1912 the following method of dividing the costs: Fuel, 25 per cent. standing, 75 per cent. running ; oil, &c., 25 per cent. standing, 75 per cent. running ; wages, 50 per cent. standing, 50 per cent. running ; repairs, 75 per cent. standing, 25 per cent. running ; rates, management, and capital, 100 per cent. standing. Applying this principle to the costs given the charge becomes £2. 0s. 11d. per kilowatt maximum load plus 0·110d. per unit in the case of 33·5 per cent. load factor, and £2. 3s. 8d. per kilowatt maximum load plus 0·098d. per unit in the case of 45·7 per cent.

The I.M.E.A. and I.M.T.A. method of ascertaining the standing and the running cost only holds good in connection with the load factor conditions then obtaining. For the purpose of further illustration I propose to assume that a charge of £2. 2s. 6d. per annum per kilowatt of maximum demand at the 'bus-bars plus a charge of 0·102d. per unit supplied would provide sufficient income to cover all the costs incurred.

It is at this point that the "diversity factor" begins to affect the charges for the supply. Radiating from the power station will be a number of extra-high-tension feeders transmitting to various centres for such purposes as : Railway goods and passenger service, road transport, chemical and metallurgical processes, industrial power,

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bulk supplies, domestic heating and general lighting. The maximum demand on all the feeders will not occur simultaneously, and if the metering and charging is done at the junction between 'bus bars and the feeders, the requisite income will be obtained if the cost of £2. 2s. 6d. per kilowatt is multiplied by 75,000 and divided by the sum of all the feeder demands, the unit charge remaining unaltered.

Very little information is available to enable one to estimate what the feeder "diversity factor" will be on a large system supplying all kinds of load. Assuming the ratio between the maximum load on plant and the sum of the feeders maximum demands to be 75,000 kw. to 86,250 kw., or, say, 1 to 1·15, the cost of £2. 2s. 6d. per kilowatt per annum at the 'bus bars becomes £1. 17s per kilowatt demanded on the feeders.

A further item affecting the charges is the diversity factor of each feeder. This figure will probably be less than the allowance mentioned above. Taking a ratio of 1 to 1·1 the cost of £1. 17s. per kilowatt demanded at the point of origin of the feeder becomes £1. 13s. 7d. per kilowatt demanded at the point of usage subject to the additional costs incurred in transmission.

The cost of an extra-high-tension main transmission and distribution system will necessarily depend on the requirements of a particular area, but I roughly estimate that the sum of £660,000 would enable a maximum load of 75,000 kw. to be supplied over an area of 400 sq. miles by means of underground cables. Allowing 10 per cent. per annum for capital, depreciation and maintenance, the annual cost for these items will be £66,000. This amount divided by the total demands at the point of usage gives an average cost of about 12s. 6d. per kilowatt per annum.

It is obvious that the cost incurred in connection with transmission to supply areas near to the power station will be much less than that incurred in supplying areas at a distance. It is, however, an undoubted fact that by reason of the cost of transmission systems the annual cost may vary, say, between 2s. 6d. and 22s. 6d. per kilowatt demanded per annum.

The losses in transmission will usually vary between the limits of 5 per cent. and 15 per cent., depending on the distance and the load factor of the supply. The cost of £1. 13s. 7d. per annum per kilowatt demanded at the users' premises and the cost of 0·102d. per unit supplied will require adjusting to include these allowances.

The total cost at the point of usage of the extra-high-tension supply will be as follows :—

Table II.

—	(1) Cost minimum.	(2) Cost average.	(3) Cost maximum.
	£ s. d.	£ s. d.	£ s. d.
Kilowatt charge	1 13 7	1 13 7	1 13 7
Loss	0 1 10 (5%)	0 3 8 (10%)	0 5 6 (15%)
Transmission	0 2 6	0 12 6	1 2 6
Cost per kilowatt .... plus	£1 17 11	£2 9 9	£3 1 7
Charge per unit	0·107d. (5%)	0·112d. (10%)	0·117d. (15%)

The capital charges and working expenses of static transformer sub-stations will vary from 5s. to 10s. per annum per kilowatt supplied, depending on the size of plant and the purpose for which it is used. The kilowatts demanded on the extra-high-tension side will be from 2 per cent. to 4 per cent. higher than the kilowatt demanded on the low-tension side, and the units delivered to the extra-high-tension switchboard will be from 3 per cent. to 9 per cent. more than the units delivered to the low-tension switchboard.

The cost of the extra-high-tension supply when transformed to ow pressure alternating current will be as follows :—

Table III.

—	(1) Minimum cost.	(2) Average cost.	(3) Maximum cost.
	£ s. d.	£ s. d.	£ s. d.
Kilowatt charge.....	1 17 11	2 9 9	3 1 7
Loss	0 0 9 (2%)	0 1 6 (3%)	0 2 6 (4%
Transformation	0 5 0	0 7 6	0 10 0
Cost per kilowatt ..... plus	£2 3 8	£2 18 9	£3 14 1
Charge per unit	0·110d. (3%)	0·118d. (6%)	0·126d. (9%)

The capital charges and working expenses of a sub-station containing rotating plant for converting extra-high-tension alternating current to direct current will vary between 15s. and 30s. per annum per kilowatt supplied, depending on the size of the plant and the purpose for which it is used. The kilowatt demanded on the extra-high-tension side will be from 6 per cent. to 10 per cent. higher than the kilowatts demanded on the low-tension direct-current side and the low-pressure units delivered to the switchboard will be from 10 per cent. to 20 per cent. lower than the units delivered to the extra-high-tension switchboard.

The cost of the extra-high-tension supply when converted to low-pressure direct current will be as follows :—

Table IV.

—	(1) Minimum cost.	(2) Average cost.	(3) Maximum cost.
	£ s. d.	£ s. d.	£ s. d.
Kilowatt charge.....	1 17 11	2 9 9	3 1 7
Loss	0 2 3 (6%)	0 4 0 (8%)	0 6 2 (10%)
Conversion	0 15 0	1 2 6	1 10 0
Cost per kilowatt .... plus	£2 15 2	£3 16 3	£4 17 9
Charge per unit	0·118d. (16%)	0·129d. (15%)	0·140d. (20%)

Having ascertained the cost incurred in generating and transmitting an extra-high-tension supply over various distances and of transforming or converting such supply into low pressure alternating and direct current, it will be of interest to compare these costs with those that would be incurred in connection with a local plant.

There are a number of undertakings in operation having outputs approximating to 4,000,000, 10,000,000 and 17,000,000 units per annum. The following costs for these outputs are appreciably lower than most of those published, but they may be considered well within the range of attainment.

Table V.

	(a)	(b)	(c)
Units supplied	4,000,000	10,000,000	17,000,000
Load factor	22·5 p.c.	28·5 p.c.	32·4 p.c.
Total cost per unit	0·99d.	0·61d.	0·47d.
Cost per kilowatt	£5 12 3	£4 6 9	£3 14 6
Plus per unit	0·310d.	0·198d.	0·160d.

In these figures I assume that the output under (*a*) is generated by reciprocating plant in the form of low pressure direct current and that the additional output under (*b*) and (*c*), together with a portion of the original output is generated by turbine plant in the form of three-phase extra-high-tension alternating current, and subsequently transformed or converted.

The author then gives figures of cost for three cases when the power is partly generated locally and partly purchased.

By summarising these results a comparison can be made between the cost of affording a supply in different forms to a local area where the consumption is 4,000,000, 10,000,000 and 17,000,000 units per annum respectively, and the supply is generated : (1) Wholly in the area ; (2) partly in and partly outside the area ; and (3) wholly outside the area. Some of the results are given in Tables VI.–VIII. :—

Table VI.

Units supplied per annum, 4,000,000. Maximum demand, 2,000 kw.

Source of supply.	Form.	Distance and losses.	Price per unit.
Bulk	A.C.	Average.	0·470
,, ...	D.C	Average.	0·586
Local and bulk	D.C.	Average.	0·828
Local	D.C.	Actual.	0·984

Table VII.

Units supplied per annum, 10,000,000. Maximum demand, 4,000 kw.

Source of supply.	Form.	Distance and losses.	Price per unit.
Bulk	A.C.	Average.	0·400
,, ...	D.C.	Average.	0·495
Local and bulk	A. & D.C.	Average.	0·567
Local	A. & D.C.	Actual.	0·614

Table VIII.

Units supplied per annum, 17,000,000. Maximum demand, 6,000 kw.

Source of supply.	Form.	Distance and losses.	Price per unit.
Bulk	A.C.	Average.	0·366
,, ...	D.C.	Average.	0·452
Local and bulk	A. & D.C.	Average.	0·470
Local	A. & D.C.	Actual.	0·475

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The three preceding tables emphasise the advantage of a low pressure three-phase alternating-current supply in preference to low-pressure direct-current when energy is purchased in bulk.

The cost of supplying from a local power station compared with an alternating-current bulk supply is considerably higher.

I think it desirable to state that the estimated working expenses for the large power station and also the local power stations were very carefully prepared before I had any intention of making the comparisons in Tables XVII., XVIII., and XIX.; in other words, the costs have not been specially "cooked" in order to point a moral. On reviewing the position I am inclined to think the cost of operating both the large and the small power stations are somewhat on the low side, but at the same time I feel sure they are obtainable under favourable conditions.

Bailie WILLOCK (Glasgow) proposed a hearty vote of thanks to the President, and advised all members to take it home and read it carefully, and if the councillor members found the engineers not coming up to time they could refer them to it. He was pleased to see many old friends present, including Ald. Pearson, of Bristol and Ald. Smith, of Liverpoool.

The PRESIDENT, having acknowledged the vote of thanks, called upon Mr. S. L. Pearce (Manchester) to open the discussion on:

The Future of Electric Power Supply.

Mr. S. L. PEARCE said he thought it was a truism to say the subject was one of the greatest importance ever brought before the Association. The discussion could conveniently turn upon the reports of the Coal Conservation Sub-Committee and the Committee on Electric Power Supply appointed by the Board of Trade. He gathered that the former was now superseded by the latter and therefore it was not his intention to go over again in detail the ground covered in the Manchester debate. It would perhaps suffice if he summarised briefly the grounds of objection which were taken to certain aspects of the Coal Conservation Sub-Committee's Report. The first was the disparagement of the work of the local authorities, the second the proposed wholesale condemnation of all existing plants and consequent waste of capital involved; the third the proposal to stop all extensions of existing stations and to erect the super-stations suggested, which would entail very heavy costs. Fourthly, in regard to the objection to private enterprise, Was the Board of Trade fitted to be entrusted with the future conduct of electric supply in this country? Transmission cost was a vital factor in any scheme of reorganisation. At a meeting of the Newcastle Local Section of the I.E.E. some time ago, Mr. Vernier rather took him to task in regard to certain figures contained in the pamphlet report of the Manchester debate relating to transmission costs, on the ground that they were exaggerated. He took Mr. Vernier's chief objection to be that he (Mr. Pearce) considered only a point-to-point transmission line, which he said was a wrong conception and was what the Coal Conservation Sub-Committee had in mind, and that he would include other centres of distribution en route. He (Mr. Pearce) had gone over the figures again, and for the particular conditions referred to, viz., a point-to-point transmission, he believed they were, if anything, understated. Deviation from point to point transmission caused the capital cost to go up in proportion to the extent of the deviation. There would be further increase by reason of this fact: Local authorities were debarred from taking extra-high-tension overhead lines into thickly populated districts and that would necessitate a large amount of underground cable and probably second transmission, depending on the voltage of the overhead line. So he was not so sure that even a distributed line would show so favourably as Mr. Vernier suggested. In any point-to-point transmission scheme the question of transmission would be the chief point to be considered, and in any general linking-up scheme it might not be the deciding factor, but would have a very material bearing. In all probability future generating stations would not be placed more than 20 or 25 miles apart, and their size would be in proportion to that condition. He gathered that Mr. Vernier pronounced definitely in favour of underground cables working at the highest possible voltage for the main transmission lines, using overhead lines as subsidiary. Overhead lines had marked inherent defects. Probably in this country they could not adopt a higher figure than 100,000 volts. The Electric Power Supply Sub-Committee of the Institution proposed 66,000 as the maximum which should be adopted. He thought a favourable case could be made out for underground cables as against overhead lines, especially having regard to the higher rate of depreciation of overhead lines and the higher maintenance cost. In the pamphlet he had referred to he stated that underground cables would cost about 25 per cent. more for the example given than overhead. It was a matter of great satisfaction that the report of the Board of Trade Committee was a unanimous report, in view of the conflicting views of the personnel of the Committee. It was of necessity of the nature of a compromise. For example, there was no one definite solution put forward for application to the whole of the country. Rather, the report contained a series of alternative proposals to be adopted according to local conditions. They, as engineers, ought not to cavil at its flexibility. The principal recommendations followed pretty well defined lines, including the formation of the tribunal to be known as Commissioners and the creation of district boards, the representation on which would be based on a combination of existing interests. As these boards would be debarred from making any divisible profits they would be in the nature of public trusts. These boards were to acquire the existing generating stations and transmission lines, and would have vested in them the future of generation, including the establishment of power stations and transmission lines. One of the most important points was the retention by existing undertakings of their powers as distributors, and the benefit of State financial assistance was suggested without the drawbacks of State control or operation. The report differed from that of the Coal Conservation Sub-Committee in its advocacy of the principle of public ownership as against capitalistic ownership and control, in its advocacy of an amalgamation of the existing interests as opposed to the creation of gigantic electrical trusts, and in its proposal to work more upon the basis of existing conditions. There were no definite suggestions as to the establishment of super-stations of great magnitude, but it was rather proposed that these matters should be left to the district boards, with the approval of the Commissioners. Presumably the district boards, on the advice of their technical advisers, would decide which stations should be retained, in which direction interlinking mains should be put down, and what were the economical limits of transmission. Generally speaking, he thought these proposals of the Committee might do a very fair measure of justice to the various interests involved, and offer a reasonable basis for the solution of the problem. One was glad to find many of the recommendations of the majority report of the Lancashire and Cheshire Committee found a prominent place in the Report of the Board of Trade Committee. He thought the case had been established on engineering grounds for generation on a large scale, and transmission over a large area, so that the needs of all consumers could be met, by an interlinked network, and he thought it followed that a unified control must be brought into existence. The question was whether that could best be done by putting into operation the provisions of Section 8 of the 1909 Act or by the formation of smaller district boards, as suggested by the Board of Trade Committee. The 1909 Act did not provide any powers to combine companies with local authorities, and he thought provision for this was desirable. In paragraph 37 the Committee gave weighty reasons why the proposal to set up joint boards should be adopted, and some of those connected with undertakings in that part of the country knew those reasons were sound and valid. Much would depend on the personnel of the boards, in view of their wide powers. It was to be hoped they would be engineers who commanded the support of the electric supply industry. The greatest possible autonomy should be given to the district boards technically and from an administrative point of view. There was a certain amount of ambiguity in the Report in regard to the appointment of two of the five commissioners. It was not clear whether they were to be regarded as whole time or part time officers. The proposed constitution and methods of operation of the district boards would come within the four alternatives suggested in the Manchester debate, not even excluding the possibility of mutual ownership and operation. Under the second section of paragraph 55 it seemed that a board could be set up with municipal ownership and municipal control. It would be simpler if the whole of the district boards were nationally financed. There was great difficulty in securing unanimity on the Committee with regard to distribution. The paragraph relating to bulk supplies appeared to offer reasonable safeguards for the interests of the distributors. Paragraph 65 would give rise to some heartburnings in regard to the right of the district board to supply individual consumers in any area. How would the distributors be satisfied if this procedure were adopted? The district board should pay a reasonable financial acknowledgment to the local distributors. Para. 36 of the Report pronounced against local authorities having power to supply outside their areas. Was that quite consistent with the second section of para. 55? Having pronounced in favour of public ownership, it was unfortunate that they had admitted the principle of contracting out. So far as local authorities were concerned, it would appear to be giving preferential treatment to the larger authorities. The chief ground of criticism of this Report would turn upon the financial terms proposed in para. 56. He imagined the Committee had ignored the question of goodwill, in view of the all-important national necessity for cheap electricity. While the proposed terms of acquisition might deal fairly with undertakings who had made sufficient provision for depreciation in the past, they would unfairly benefit those undertakings who had shirked making adequate provision, and had divided their profits in relief of rates or among shareholders. One would have thought they would have been unanimous in the recommendation that there should be no relief of rates out of profits, but the pronouncement of the minority was ambiguous. It was not clear on what the 4 per cent. was to be calculated. He thought, after all, there would remain much that would be acceptable to the large majority of engineers. Now was the psychological moment to secure legislation to solve the problem. He hoped members would not turn it down on the ground of interference with local autonomy. They must recognise that changes had to be brought about in the national interest, and these would not affect merely the smaller local authorities, and they should try and look at the problem as a wide one.

Bailie SMITH (Glasgow) said he was glad to hear Mr. Pearce say so much in favour of the Report. He thought the Committee intended to be fair to all authorities. Delay in this matter would mean more than a loss of money. It would mean a serious handicap in the struggle for commercial position when peace was declared. They must get the cheapest possible supply of power if they were going to succeed in the competition with other countries. The Committee had decided that the generating stations and transmission lines should be publicly owned, and it was at the option of the local authorities whether they worked them or leased the working to a company. What Mr. Pearce called flexibility was the

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provision made for exceptional circumstances. Difficulties often arose in legislation because the possibility of exceptions was not foreseen. Para. 55 provided for the case of a large local authority which might be considered fit to form an area of itself, and para. 56 provided for the case of a smaller undertaking which did not lend itself to a general scheme of supply. Para. 56 precluded any fictitious valuations. Only the book value would be paid for undertakings except perhaps in exceptional circumstances on account of the good done by the undertakings in the past. The basis proposed for taking the concerns in was a good one, because the thing would start on a lower capital cost, and there would be less interest to pay on the capital.

Mr. S. E. FEDDEN (Sheffield) said the Coal Conservation Sub-Committee's Report was fallacious and a great deal of it was not true. He confirmed some of Mr. Pearce's figures in regard to long distance transmission. He had considered the respective merits of an ideal site at a distance as against a power house in Sheffield with the use of cooling towers. His figures were: For a 100,000 kw. station with 66 per cent. load factor (which he thought would come in the future) and 0·8 power factor; bulk supply at 11,000 volts one mile from the cooling tower station in Sheffield, the total cost would be 0·275d. per unit; and with the power station 10 miles away with 30,000 volts, and underground cable the cost was 0·274d. He thought in the future the main cables for bringing in large blocks of power or for interconnecting would be underground, although no doubt overhead cables would be used for the small loads. At 20 miles, with 30,000 volt cable, the cost was 0·314d.; overhead cables and 20 miles distance, 30,000 volts, 0·304d.; and 30 miles, 40,000 volts, overhead, 0·331d. He came to the conclusion that he could put down a power station near to his main load (where his concentrated load came within an area of four or five miles) with cooling towers and supply to his consumers at about 20 per cent. less cost than he could from an ideal station 30 or 40 miles away. Therefore they decided to put down a power station practically at the door and he could pick up 30,000 kw. within a mile, or half a mile. Consider what a super-power station meant. Take a load of 100,000 kw. One would want 5 or 6 million gallons of water an hour and 2,000 tons of coal a day, there would be 50,000 or 60,000 tons of ashes per annum to be handled at one spot. Unless one had many acres on which to put parks of railway sidings and to deal with the ashes, super-power stations were not going to be the huge things they had heard talked of. They had heard of 400,000 kw. at one spot. If anything of the sort were attempted, how was the distribution to be done? It would take the whole countryside to accommodate the mains going out. He thought they would have to take advantage of the water they had. If there were a concentrated load near that water and there was not enough they must put up cooling towers. Speaking generally, he thought the recommendations of the Board of Trade Committee's Report would be for the good of the nation in years to come. Some of the bigger concerns who to-day were supplying at a cheap rate might suffer in the meantime. If his district had to take in a lot of smaller concerns which were highly capitalised and had expensive distribution mains it would considerably increase the costs for a time. The creation of a central authority to control generation and distribution would be universally welcomed, because they had suffered in the past through the restrictions they had had up against them. He supposed it was generally realised that Clause 39 meant the municipal authorities, as such, would cease to exist as authorities for the generation of electricity. In regard to the method of generation and operation of generating plant three alternatives were suggested, but no preference was expressed. The provision that the Board shall make no divisible profits might result in large consumers controlling the policy in accordance with their private interests. That should be carefully considered. They must have clear definitions of the terms "national finance" and "local finance." Para. 54 was totally inadequate to safeguard parties interested on a large scale because in the event of a large undertaking having a number of representatives in proportion to the number of units, a collection of representatives from a number of smaller authorities might outnumber the representatives of the larger authorities and regulate by ballot any representation of the larger authorities on the district board. Clause 55 looked as if it had been put forward for the North East Coast. Would a rate-aided municipality take the responsibility of financing an area of 20 miles round it? He did not think that was a fair proposition. Taking the consumers off the trunk main was a revolutionary thing. If half his consumers were taken away on that basis it would kill his interest in the smaller consumers. The finance clauses were unfair and penalised thrift.

Councillor DYMOND (Hereford) agreed with the previous speakers as to the Board of Trade Committee's Report. His criticism was rather with regard to what was not in it. By the terms of their reference they were asked to consider what steps should be taken to ensure an adequate and economical supply of electric power, particularly for industries which depend on such supply for their development. The foundation of such supply was the cost of fuel, and there was not a word about that in the report. If the cost of fuel were disregarded super-stations would not improve matters. He deprecated the opinion that a large station *per se* must be more economical than a small one. The Government should go into the matter of the coal prices and leave the electricity undertakers to decide their own policy.

Mr. C. H. WORDINGHAM (president of the Institution of Electrical Engineers) said the Board of Trade Report was epoch-making, and on the action taken as the result of it depended the future of the industry. He intended to suggest for the consideration of the Council of the Institution that there should be a thoroughly representative Committee of all parties concerned, municipalities and companies and manufacturers, to consider this report, and he would like to see the Committee subdivided into two or three sub-divisions to deal with the technical and financial interests so as to get a concensus of opinion of the electrical industry. Criticism of objectionable points would be listened to by the Government if the full weight of the industry were behind it. Dr. Ferranti enunciated the broad principles underlying the Report some 35 years ago, and they were appreciated and ventilated by the City of Manchester 20 years ago. The principle that electricity supply must not follow parochial ideas was acted upon by Manchester 20 years ago when it set out to deal with the area of surrounding authorities extending to about 140 sq. miles. A great amount of discussion would gather round the financial proposals, and they should be gone into carefully. Maximum coal economy could be obtained by higher cost of production, and it might be in the national interest that they must make the coal economy paramount. It was not the cost of generation, but the cost to the consumer that mattered to the industrial world. The scheme finally decided upon should offer some inducement to those charged with carrying it out to secure maximum economy. Otherwise the best results would not be obtained. The matter was most urgent, and he hoped when the scheme was finally settled upon it would be British from the top of the highest chimney to the tail of the longest service line, and that the plant would be of British manufacture and design.

Mr. GEO. WILKINSON (Harrogate) thought the main thing was not that the demand of the public for electricity should be met, but that they should get as much as possible in the way of useful work from the coal they had in the country. If a manufacturing concern using a large amount of steam for other purposes than power and electric driving wanted 1,000 kw. of electrical energy it could obtain a supply at a cheaper rate than anything foreshadowed by this national effort. It had been his lot for years to work in areas where the density of demand was small. There were immense tracts of country and a large number of important towns which, given sound commercial administration, would remain outside this scheme. They could not be reached by the extra high pressure mains on economical lines. Such places would find the solution of this problem in the establishment of local electric supply works in conjunction with the distribution of steam heating for domestic purposes, and so forth. He went into this question carefully 5 or 6 years ago, and had it not been that the Harrogate electricity works were half a mile away from the town he thought they would have had steam distribution for heating purposes in that town some time ago. For every ton of coal burnt in the electricity works at Harrogate more than 12½ tons were burnt in the domestic grates. It might at first sight appear that steam turned out at 20 lb. pressure could not be distributed and sold, but the fact that 12½ times as much coal was burnt in the domestic grates as in the power house showed one could easily sell the steam. The Americans had tried the system, but they had had no suitable meters and no temperature control, so we started out with advantages. Large dyeing, woollen, cotton and like industries required large supplies of low-pressure steam. One of the main conditions ruling the location of the contemplaetd super-power stations was that they should have ample water available for condensing purposes. All textile industries used low-pressure steam, and 70 per cent. of the heat in the steam at electricity works was dissipated in the condensers. A pound of steam at 20 lb. pressure contained 1,160 B.Th.U.; at 260 deg. super-heat it contained 1,343 B.Th.U., the difference being 16 per cent. With 660 deg., super-heated, and 20 lb. pressure at the exhaust, turbine makers would guarantee a kilowatt-hour for 25 lb. of steam; or 12½ lb. per kilowatt hour with a good vacuum. One would be using 1,343 B.Th.U. in the latter case, and in the former 183×2, so that one got 1 kilowatt hour for 366 B.Th.U.; *i.e.*, far less than 25 per cent. of the heat expended by any power supply company. He suggested that the Bradford Corporation should keep their works at Valley-road right in the centre of the huge steam-using undertakings and sell their exhaust steam for the purposes of manufacturing. That was the solution of the coal saving project in many centres.

Mr. R. A. CHATTOCK said he advocated in his presidential address four years ago most of the matters recommended in the Board of Trade Committee's Report, including compulsory granting of wayleaves, abolition of existing boundaries for generating purposes. At the time he advocated the formation of a scheme by the larger municipalities for organising the supply throughout the country it did not bear fruit. If it had it would have been valuable now from the national point of view. He was satisfied with the general outline of the scheme and the proposal to appoint electricity commissioners and district boards in particular, but he did not care for the suggestion that the board's powers should be delegated to other bodies. If they were delegated to a company the company must make a profit in order to exist, and as a result the consumers in one district would have to pay more than those in another district. The aim should be for the district board to control the generation and distribution. With regard to an incentive to the generating authorities to work economically, the Commissioners should put the district boards in competition with each other and they might give some extra remuneration to those who did better. The purchase terms were not equitable. Undertakings which had been properly depreciated would get off much worse than those which had been prodigal. A valuation board should be set up to value all the undertakings on a consistent basis. If consumers were supplied direct from the transmission lines the prices charged should be the same as those charged by the distributors, and in that case the boards could not help making some profits. Any profits they made should be handed over to the distributors. Consumers in the district of a company which was allowed to make profits would be at a disadvantage compared with the customers of a local authority which was not to be allowed to make profits. A way out of it might be to pay distributors a commission—say 2½ per cent.—

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on the turnover. It was a point in favour of the Board of Trade Committee's Report that it did not deal with engineering aspects in the same way as the Coal Conservation Committee's Report had done. It was impossible to generalise. Each district must be considered separately. He had come to the conclusion that 20 miles was about the limit at which transmission could be economically worked, and in some districts even less. It was more economical to have cooling tower stations close up to the demand. There was a loss of about 10 million units per annum on a 20-mile transmission line from a station generating 150 million units. Assistance should be given to undertakings which were obliged to develop under the present conditions of high cost. The cost of coal was a comparative matter, and the high price affected private buyers as well as electricity works.

Mr. F. W. PURSE (Carlisle) said the Board of Trade Committee gave no indication as to what the price of current should be, or what would be the cost of establishing the proposed stations. Mention was made of many privileges which undertakers were to have, but there was no indication as to how these were to be got. Figures which he had prepared were nearly identical with those of the president. He took the maximum load for the Manchester district as 73,000 kw., the output as 180,000,000 units, and the capital charges as £230,000, and this, with coal at 15s. meant a cost of 0·28d. per unit, whereas it would be 0·38d. with the bulk supply. It all came back to the fact that they must have State assistance, but why should electricity have State aid more than other national requirements? When electricity was made cheaper still what would become of the municipal gas works whose consumers would all go over to electric power. Take the case of an article which was produced for 12s. The cost of electricity on that article was to be reduced from 3d. to 1½d. That meant about ¼ per cent. Was that going to be our salvation? They should go on linking up and unifying the supply, but not give the boards power to spend unlimited money unless the ratepayers were safeguarded.

The meeting was then adjourned until the next morning.

In the afternoon a number of power stations and works in the neighbourhood were open to inspection, but the visitors mainly broke up into two groups. One of these went to the Stuart-street generating station of the Manchester Corporation. The other party travelled to the works of the British Westinghouse Co. Here, in the absence of the managing director, Mr. Chandler, they were welcomed by Mr. Blunt, who gave some brief details of progress. Since the last visit of the I.M.E.A. in 1909, the work handled by the Company had increased threefold, and the finance was now wholly British. During the war the Company had received much consideration, under difficult circumstances, at the hands of municipal engineers. Mr. Blunt expressed the view that it would be easier to do business in the future than in the past, owing to the better feelings that present circumstances had brought about between purchasers and manufacturers.

No special exhibits had been arranged as on previous occasions, but visitors had an opportunity of inspecting a large amount of work in progress. This included two turbo sets of 18,750 kw. and 14 transformers of 7,825 k.v.a., 20,000 volts star/6,500 volts delta, 25 ~.

Visitors also had an opportunity of attending a lecture and demonstration by Mr. C. J. Beaver, on the "Test-Sheath Cable," at the works of Messrs. W. T. Glover & Co. We hope to refer in detail to this method of protection in our next issue.

In the evening there was relaxation in the form of a smoking concert at the Engineers' Club.

On Friday (the 21st inst.) the discussion on "The Future of Electric Power Supply" was resumed.

Councillor BARGE (Poplar) said he thought the previous day's discussion might convey the impression that they were heartily condemning the Board of Trade Committee's Report. He felt that the Bill was inevitable, and should be welcomed. The fact that the report was indefinite was in its favour so far as some of its points were concerned. He thought that under the proposed scheme current would not be produced as cheaply as it was produced at some places now, but some of the companies were charging a fairly stiff price and the new scheme would level up prices. He thought they had passed over the compensation clause very lightly on the previous day. The Report said compensation might be provided for displaced officials in case of hardship, but he thought the engineers should have agitated to secure an undertaking that it *would* be. He was bringing the matter before his Committee and would ask them to circularise other authorities—in London to start with—to ensure steps being taken to have this matter regarded as essential.

Mr. H. S. ELLIS (South Shields) said in the Council's Report it was stated that the North-East Coast undertakings were not included in certain observations made by the Council, and he did not quite know where they stood. Were they to fight their own battles, or would the I.M.E.A. look after their interests? The man in the street thought he was going to get electricity at ½d. That was a fallacy. The Newcastle Electric Supply Co.'s charges for lighting were as high as those in South Shields and higher than those in Sunderland and other towns, and for heating the charges were higher than those in South Shields. The super-stations would not reduce the coal consumption from 5 lb. to 1¼ lb. per unit as assumed in the Coal Conservation Committee's Report. The Board of Trade Committee's Report was much better as it did not attack municipal trading. What was done on the North-East Coast could not be done in Lancashire. He could sell electricity at 1d. to docks and engineering works at South Shields, and they were delighted to have it. At Bradford people wanted it for 0·3d. or 0·4d. The present was a golden opportunity for looking into the question of supplying cheap electricity from existing plants. Where mills were shut down at 5 in the evening until 6 in the morning 2,000 or 3,000 H.P. of plant might be standing idle. That might be run for supplying electricity for electro-chemical and other purposes at extremely low rates.

Mr. J. W. BEAUCHAMP (West Ham) said when the Board of Trade Committee's Report came to be a Bill they must make the best fight they could to get good terms. Cheapness of electricity was not so essential as some people endeavoured to make out. Most industries could pay a fair price, as it only meant a small percentage of the total cost of their product. Much industrial unrest might be relieved by the provision of electric tramways for carrying workers out to factories, also equipped with electric power, outside the congested areas. On the point of the conservation of coal, if the authorities would rub that in they would do more good than by talking about cheap prices of electricity. A centralised authority might guide their efforts in the right direction and the central authority might purchase coal in bulk collect it, and even wash and grade it, and there would be an immediate saving to the electricity works and the community.

Councillor HIGHAM (Accrington) said he spoke mainly as a large user of power—a cotton manufacturer of Lancashire. He was also chairman of the Accrington Electricity Supply Committee. He wanted to discourage some of the optimistic statements that had been made as to the probability of the textile trade coming over to electric driving. Electricity could not, starting *de novo*, compete against steam. The expert steam engineer said to the mill owner, "I can give you your power at such a price that you cannot afford to use electricity," and he could put up such a proposition that the mill-owner could not afford to pay even 0·4d. for electricity. There was a prospect of great increase of other load, and that should be provided in the way in which that scheme in the main proposed. A good deal of latitude would be required to permit extensions of what had hitherto been called uneconomical stations. They must have a carry-over scheme, and he hoped the weight of that Association would be used to enable them to carry on before the Report became an Act. If the Council would make a further report on the Board of Trade Committee's Report and send it to the undertakers affected they would be making some ground. The proposed Commissioners had powers that were too drastic. The interests involved were too large to be entrusted to three men if they were heaven-sent, and we had none of those men in this country. There should be another authority over them, and they should be given their powers temporarily at first. The whole scheme would get little sympathy in the House of Commons unless it could be fully justified, particularly in its financial proposals.

Mr. H. FARADAY PROCTOR (hon. secretary) said Clause 3 of the Report stated that three of the five Commissioners should be appointed to give their whole time services and there was provision for pensions for them on retirement. The other two might be appointed for a short time. The Council thought the other two Commissioners should also be full-time officers. The Coal Conservation Report advocated that companies were more suited than municipalities to carry out most of these works, on account of the incentive of bigger profits. In his evidence in November, 1916, he had said it was the incentive to bigger profits that made it imperative to have the board composed of full-time officers with no such incentive. The resolution put before Sir Charles Parsons' Committee and before the Board of Trade Committee also expressed the same opinion.

Ald. SMITH (Liverpool) agreed with Mr. Wordingham's suggestion that a Committee should be appointed so as to prepare a definite scheme and one which could be upheld when the Bill was discussed in the House of Commons. He thought that unless they had influence behind them many of the electrical engineers might lose their jobs and suggested that there was a big field for them in Africa where industrial areas would doubtless grow up near the coalfields.

Mr. R. LOMAX (Stockport) thought the Coal Conservation Committee and the Electrical Power Committee knew very little about the power supply of Lancashire and Cheshire, and that they assumed conditions which were only to be had on the North-East Coast. Nothing in the Reports justified the revolutionary proposals in them. The present system of municipal boundaries would have to be altered for electric supply purposes so that they could extend the mains in every direction, which would assist in cheapening electricity.

Bailie WILLOCK (Glasgow) said in Glasgow they never took money from the electricity department to give to the rates, and he hoped the Commissioners would take that into consideration. He thought more might be done to recover by-products from coal consumed at electricity works. The Glasgow gasworks got a quarter of a million of money from by-products, and at the electricity works where they consumed 500,000 tons of coal a year they were now going into the question of recovering some of the by-products.

Mr. CHAS. TURNBULL (Tynemouth) said if coal was to be saved they must make use of the 50 per cent. of the heat which was now sent into the condensers. In the summer it might be used for agricultural purposes.

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Mr. T. D. CLOTHIER (Bootle) said even if the Commissioners were no better than the various Government authorities and controllers it would be an improvement to have only one authority over them. That cheap electricity would be the result of the scheme was, he thought, problematical. Cost of transmission would probably go up at a greater rate than generation cost would be reduced. It was not cheaper electricity that was required but a much more abundant supply. The Bill, which was to be framed, should receive their support.

Mr. PEARCE, in dealing with the points raised in the discussion, said it would be unfortunate if any general consensus of opinion went forth from that meeting that our supplies of electricity were cheap enough. They looked forward to big developments, and abundant supply was the chief thing, but the one thing hinged on the other. For railways and electro-chemical works cheapness was the first consideration. Councillor Higham said the textile load would not be dealt with electrically, but there were sometimes circumstances that made it desirable to equip a new mill electrically. If the appointment of a central body only resulted in a new delimination of the areas of supply it would be a great step. Although a considerable period must elapse before the scheme was put into force it would be wise to vest in the Commissioners appointed to deal with the present state of affairs as they would probably be men who would envisage the whole problem and do the best that could be done in the carry-over period. If the financial proposals in the Report were dealing with existing local authorities only, he thought no great hardship would be done, as authorities who had been giving profits in aid of rates had given the ratepayers a return, and those who had not done so had given a return in kind. The injustice was done in areas where local authorities and companies were intermingled, because the companies had been paying away their profits to the shareholders in dividends, but if the Government provided reasonable terms for the future it did away with the demand by ratepayers for a return on the capital for the relief of rates. The difference between the price charged by the district boards to consumers supplied by them (after adding depreciation, &c.) and the price the distributing authority would have charged might be the amount of the compensation to the distributing authority. He was sorry to see in the Report the proposal to suspend the sinking fund and to pay interest out of capital. The gas industry was taking up the position that this scheme was preference in a rather virulent form for the electrical interests.

The PRESIDENT, in proposing a hearty vote of thanks to Mr. Pearce, said when the Bill was tabled it would probably be necessary to call a meeting of the Association to consider what steps should be taken.

ANNUAL GENERAL MEETING.

At the annual business meeting, which followed the above discussion, the report of the Council was adopted.

In the course of the discussion on the clauses of the report,

Mr. J. W. SPARK (W. Hartlepool) referred to the paragraph in the statement agreed by the Association of Municipal Corporations and the Council of the I.M.E.A. (referred to in the Report) that observations made in regard to other undertakings were not intended to apply to London and the north-east coast. He wanted to know on what grounds the Council took up the position of giving evidence on their behalf without their authority?

Mr. FARADAY PROCTOR said the resolution was that Council prepared a report and outline for the Association a scheme of reorganisation of electricity supply. The question of giving evidence was not referred to. The evidence before the Board of Trade Committee was supposed to be secret and the Coal Conservation Report was a private document at that time.

The PRESIDENT said the matter was urgent, and they were specially asked to give evidence. They realised that the north-east coast was in a very special position, and much the same remarks might be made with regard to London, and therefore they stated that the consideration applying to other districts did not necessarily apply to them.

Mr. SPARK said he thought they ought to have been consulted before they were dropped overboard. They were not asked to turn up until after the report was published and the evidence given.

Mr. PURSE said 12 months ago when they were fighting for three representatives on the Board of Trade Electric Power Committee the whole thing was referred to the north-east coast and London members as well as others, but the whole thing had been wrapped up in secrecy by the Government.

Mr. WORDINGHAM supported strongly the proposal to found local centres of the I.M.E.A. Such centres were the greatest possible source of strength to the I.E.E., and the Institution of Mechanical Engineers looked upon the example as one which should be followed, and he believed they would follow it before long. Local Centres could deal with local questions better than the central body, but it was necessary that they be linked up with the Central Institution which would put its weight behind any action the Local Centre desired to take. He was impressed with the need for the federation of every electrical interest. The Institution had felt that to be true to their principles they could recognise only one municipal electrical authority—the I.M.E.A., but, personally, he would have liked to have had the advantage of connection with the London Electrical Engineers. He thought all these and the B.E.A.M.A. and other electrical associations should be federated together under the Institution.

Councillor LINDSAY (Leith) said steps were being taken in the direction of forming local sections in Scotland. Many months ago representatives of municipal corporations of Scotland got the length of suggesting a title for the association, and appointed a committee to carry out the details. A draft constitution had been sent to Mr. Faraday Proctor. The suggested title was "The Scottish Municipal Electrical Association, Allied or United with the I.M.E.A."

He moved: "To remit to the Council to prepare a constitution for Local Centres, allowing those centres a large amount of local autonomy and representation on the Central Council. This suggestion, in draft, to be submitted to the Scottish Centres and other Centres now in course of formation."

Mr. PURSE seconded the motion.

Mr. J. A. ROBERTSON (Salford) strongly supported the motion that Local Centres should be formed. They had already a Lancashire and Cheshire Association.

Mr. A. C. CRAMB (Croydon) said the local sections of the Institution should be taken as the basis for the local sections of the I.M.E.A.

Councillor LINDSAY's motion was then put and carried.

Mr. L. L. ROBINSON (Hackney) dealing with the clause on Staff Salaries, said he was responsible for telling Sir George Askwith that the chief engineers did not want to come into his award of bonus to trade union members, which had been obtained by trade union methods, but he thought the chief engineers would have received decent treatment from their Councils. He wanted to move that the Council take this question up and find out whether Sir George Askwith's award did apply to chief engineers.

Mr. ROBINSON's proposal was agreed to.

Mr. WORDINGHAM said the Institution was about to put forward a comprehensive scheme for dealing with the central station engineering staffs. Unity in the matter was important. He asked members to attend the mass meeting which would be held in London in about a fortnight, to hear the Institution's proposals, and to endeavour to form a strong homogeneous body to fight the battle of the staffs in regard to their remuneration and recognition of their status.

The following were elected members of the Council:—

President—F. Ayton (Ipswich).

Representing Large Towns.	*Representing Small Towns.*
R. A. Chattock (Birmingham).	C. M. Shaw (Worcester).
J. W. Beauchamp (West Ham).	E. E. Hoadley (Maidstone).
A. S. Blackman (Sunderland).	*Committee Representatives.*
L. L. Robinson (Hackney).	Bailie Smith (Glasgow).
	Coun. Thompson (Wolverhampton).

The President announced that Mr. T. Roles went on as vice-president. He (Mr. Watson) went on as past president under the new constitution, Ald. Pearson went on as hon. solicitor, and Mr. Faraday Proctor went on as hon. secretary, and Mr. Mr. A. C. Cramb became treasurer.

A resolution was passed that a general meeting of the Association should be summoned to be held at Birmingham at a date not later than six months hence or such earlier date as might be necessary, or in any event, when the Bill for carrying out the proposals of the Board of Trade Committee's report was tabled.

The proceedings closed with votes of thanks to the President, the retiring hon. treasurer (Mr. J. E. Edgecombe), the honorary officials, Lord Mayor and Corporation of Manchester, the Engineers' Club, and the firms who had given facilities for visits by the members to their works.

Report of the Council of the I.M.E.A.

The twenty-third annual report of the Council for the year ending June, 1918, states that the membership of the Association stands at 385 (an increase of 10). During the year the Council have held 10 meetings, and Standing and Special Committees and Sub-committees appointed to deal with specific matters have reported to the Council. The Board of Trade Committee, having invited the I.M.E.A. to give evidence on the subject of electric power supply, and limited the Association to representation by one witness only, the honorary secretary (Mr. Faraday Proctor), delegated by the Council, gave evidence. A committee was also appointed to deal with the subject. Meetings were subsequently held with representatives of the Association of Municipal Corporations, the Urban District Councils Association, and other witnesses who had given evidence, as a result of which an agreement was reached on fundamental points, and a joint statement was prepared for the consideration of the Councils of the respective bodies. The Urban District Councils Association, on further consideration, was unable to accept the joint statement and suggested certain amendments which the Council of the I.M.E.A. were unable to approve. The statement as agreed by the Association of Municipal Corporations and the Council of the I.M.E.A. was sent to the Board of Trade Committee and attention was drawn to the fact that some of the smaller electricity undertakings might not be in complete accord with the views therein set forth. At a later date a deputation from the I.M.E.A. waited upon the Minister of Reconstruction, as a result of which the I.M.E.A. Council was assured that it would have an opportunity of making representation in regard to the proposed national scheme for electricity supply before any Bill is promoted to give effect to the recommendations of the Board of Trade Committee.

In regard to the invitation sent at the request of the Institution of Electrical Engineers to undertakings represented in the I.M.E.A. to

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upport financially the Institution in the work of research on buried cables £106 was contributed by the I.M.E.A. members.

The Council are of opinion that the time has arrived when the Association should have branches, to be called Local Centres, in different localities throughout the kingdom. This matter should be thoroughly discussed at the Annual Meeting.

At the request of the Ministry of Labour the Council considered the Report on Joint Standing Industrial Councils and agreed generally with the principles set forth, but thought that special treatment would be necessary in the case of undertakings controlled by committees on which labour may already have direct representation.

At the first Annual Conference of the National Association of Local Government Officers since the re-organisation was held on May 18 and 20, 1918, Sir Homewood Crawford in his presidential address stated that the President of the Local Government Board had been approached in regard to the question of superannuation and a deputation from the N.A.L.G.O. had been received by Mr. Hayes Fisher, who admitted that a strong case for early consideration had been made out, and expressed the opinion that it was desirable to appoint a committee of inquiry at the present time. A resolution was passed to issue warning advertisements in regard to appointments proposed to be made by any local authority which had been treating its officers in an unjust manner. The Council is of the opinion that an increase or bonus should be granted to officials serving under local authorities. An increase in the charges for current to controlled establishments had been authorised. A Joint Standing Conference, representative of the electricity supply industry, has been formed with Mr. C. P. Sparks as chairman and Mr. H. Faraday Proctor as hon. secretary, and several meetings have been held with beneficial results.

Mr. H. Faraday Proctor having informed the Council that he had been invited to assist in the formation of an association to safeguard the interests of the staffs of electricity undertakings, the Council expressed their sympathy with the proposal and agreed that Mr. Proctor should afford such assistance in his personal capacity. The Council approves the formation of the British Electrical Engineers' Association, and recommends members to support it. The Council has decided to defer a decision on the question of increasing the annual subscriptions. The Council heartily endorse the proposal for the extension of Municipal control of electric supply in accordance with the agreed memorandum of the I.M.E.A. and the A.M.C.

As the work of the Sub-station Attendants' Sub-Committee of the Trade Advisory Committee for Electricity drew to a close it was decided that the Ministry of Labour should be approached with a view to expanding the Committee so as to make it representative of other branches of the electrical trade, and there now exists a Trade Advisory Committee (Disabled Soldiers and Sailors) Electricity (Power and Supply), upon which the I.M.E.A. is represented by the President, so that the work of the Sub-Station Attendants' Committee may be regarded as completed.

The Electricity in Agriculture Committee, representing the I.M.E.A., the Incorporated Association of Electric Power Companies, the National Farmers' Union and other interests, have attempted to make some progress with electro-culture, the use of electrical energy upon farms, particularly with regard to electric ploughing and cheap methods of overhead transmission. Applications have been made to the Treasury for a grant from the Development Fund and the Ministry of Munitions for a permit for small quantities of materials. These applications were submitted to the Board of Agriculture, and as they did not receive the support of the Board, were refused.

The year's expenditure was £583 (compared with £554 in the previous year) and the deficit for the year was £20.

Report of the Electric Vehicle Committee.

The report of the Electric Vehicle Committee states that during the year ended March 31 last members have been added to the Committee representing the Association of British Motor & Allied Manufacturers, the Motor Trade Association, Agents for Electric Vehicles and the London Electric Supply Companies; Mr. Percy Still became the official representative of the London Electric Supply Companies, and Mr. J. P. Kemp, of Birmingham, was invited by the Committee to act as representative of Electric Vehicle Agents. The work of the Committee has been concerned chiefly in negotiations with Government Departments with a view to securing greater facilities for the manufacture in this country, as well as the importation from the U.S.A., of electric vehicles for work of national importance. The Committee's efforts have not been unfruitful, but it is hoped that some further concessions may be obtained in the future, having in view the beneficial effect that the extended use of electrics would have in the matter of conserving grain and petrol supplies. In July the Committee was requested by the Mechanical Transport Department of the Ministry of Munitions to co-operate in a scheme, proposed by the Director of Mechanical Transport, for getting more electric vehicles put into service, and a concomitant to this scheme was a proposal to provide facilities for the building of electric vehicles in quantities by certain British firms, and the import of electric vehicles from the U.S.A. The Committe met in conference with the Director and collected information from local authorities as to motor vehicles in use and those on order. Owing, it is understood, to the increasing stringency of the steel position for war purposes the contemplated scheme did not, unfortunately, admit of adoption. Owing to the scarcity of lead, difficulties arose in 1917 in obtaining new lead-plate electric vehicle batteries, and in the maintenance of batteries already in use. The Committee has been in more or less constant touch with the Ministry of Munitions on this important matter and a promise was obtained from the Munitions Overseas Transport Department to allot shipping space up to a total of 6 tons per week for the import from the United States of lead battery plates for electric vehicles. The Committee has, from the first, hoped for the friendly co-operation of the motor traders with electric supply authorities in promoting and facilitating the adoption and use of the electric vehicle. In some quarters there have been signs of opposition on the part of the motor traders to electric supply authorities taking up the care and charging of electric vehicles, but this is proved to be due to a misunderstanding of the position which, now that the motor manufacturers and motor traders are represented on the Committee, it is hoped to remove. Two special Joint Committees have been formed, comprising members of this Committee and of the Executive of the Agents' Section of the Motor Trade Association. One Committee is to consider and recommend to the I.M.E.A., through the E.V.C., such alteration or modification in clause 23 of the I.M.E.A. Supply of Electricity Bill as may seem desirable in order to afford adequate and reasonable protection to the existing motor traders. The other is to consider terms and conditions of sale of electric vehicles. The adoption of electric commercial vehicles for short distance haulage continues to make what may be regarded as satisfactory progress, when it is remembered that under present conditions these machines can only be obtained for use for war work or work of supreme national importance. The Committee is receiving an increasing number of inquiries as to how and where such vehicles can be obtained. Commercial electric vehicles are being produced in England to-day which in design, workmanship and performance compare most favourably with, and are in no way inferior to, the best of the imported vehicles.

The balance sheet shows that the financial position of the Committee is satisfactory, and it may be asked why the Committee still appeals for donations. The answer is that the Committee aims at adopting a propaganda and publicity effort of the most intensive form possible after the war, and such propaganda and publicity work can only be inaugurated if the Committee has in hand sufficient funds for the purpose. Expenditure was £576 (against £448 in previous year) and the surplus was £87 (£94)

The National Kitchen in New Bridge Street, London.

Last Tuesday the Press were given an opportunity of inspecting the new National Kitchen which has now been opened in New Bridge-street, London, by the Director of National Kitchens. There is accommodation for 170 people at one time, and it is expected that four or five times this number will be served during the day. The restaurant will be open from 11.30 a.m. to 8 p.m., but the hours will be extended, if need be, for night workers in the newspaper and printing trades. The equipment has cost between £800 and £900. Cooking is carried out by electricity, steam and gas, the roasting being by electricity and the boiling by gas. The electrical equipment consists of a double-deck 5½ kw. pastry oven, two roasters, each taking 7 kw., a 5½ kw. grill with draw-off for fat, a 2½ kw. fish fryer and three small hotplates for serving. These are all made by the Jackson Electric Stove Co. (Ltd.). In addition there is a three-deck B. & K. oven. The daily menu will consist of soup (2d. per portion), fish (4d. and 6d.), roast meat (4d. and 6d.), two meat entrées (4d. and 6d.), vegetables (2d. per portion), sweets (3d. and 4d.), bread (½d.), coffee (2d. per cup), and tea (1d. per cup). An innovation consists in the exchange of one meat coupon for six vouchers, so that the holder can have meat every day if desired. The restaurant is to be conducted on the canteen principle, customers going to the counter to receive the food they wish to purchase.

At the Press view Mr. C. F. Spencer, Director of National Kitchens, stated that this particular kitchen had been equipped for two reasons. One reason was that a demand had been received from 2,000 workers in the neighbourhood that such a kitchen should be established; and the other object was to show what could be done in this direction. The idea hitherto had been to provide soup kitchens, but the present restaurant had been equipped to suit all wants at low prices.

Judging by the luncheon which was served to members of the Press, and which was certainly most excellent, we do not doubt that the restaurant will become extremely popular, and that there will be a demand for other establishments of this kind.

A New Form of Experimental Cell.—In a recent Paper before the American Electrochemical Society, Mr. S. A. Reed described a form of primary battery for experimental purposes. The electrolyte consists of fused borax containing manganese, while the negative electrode consists of broken carbon in contact with a graphite grid. The positive electrode is made of gold foil strip. The electrolyte in contact with the outer gold strips is oxidised by the air, and subsequently reduced by the carbon inside, mixtures of carbon dioxide and monoxide being formed at the anode. An E.M.F. in the neighbourhood of 0·8 volt is stated to be obtained.

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Correspondence.

ENGINEERING ASSOCIATIONS AND THE I.E.E.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: All corporate members of the I.E.E. who value independence and virility of thought and action should hasten to endorse the protest made by six engineers in your issue of June 21 against the action of the Council in giving active and financial support to the operations of the British Electrical Engineers' Association. And the sturdy, open way in which the Yorkshire groups of supply engineers have stood up against this peril at this very critical juncture merits the thanks and admiration of all engineers who have real engineering interests at heart.

For myself, I care not whether or no it is against the rules of the Institution. It remains a course that ought not to have been taken, especially as the Council must have known that this interference would be in opposition to the views of many of the best members, viz., those who take a very live and passionate interest in their profession and are entirely dependent thereon. If the Council did not know this, it ought to have, and its constitution should be changed to keep it better informed. I submit that the occasion demands an immediate explanation and a full statement of what the British Electrical Engineering Association is, and of the terms of membership which it offers to the great bulk of the real workers in the engineering profession, as distinct from those whose interest is mainly in keeping financial and legal control of all the operations of the engineering industries.

I would point out that these movements for the formation of professional trade unions address themselves to men of mature years and judgment, many of whom have arrived at some sort of settled position in the industries. And I would personally appeal to the President to say whether he can conscientiously advise such men to adopt as their union any association in which the voting power of each is some fraction of unity; and to state why they should be condemned to this inferior position. I cannot believe that in these times any president of a learned institution, least of all Mr. Wordingham, will contend that the power of a man's vote in his professional union shall be determined by the financial grip rather than by the brain grip he has in his profession. Yet I believe the original proposals of the B.E.E.A. promoters gave about 80 per cent. to finance and 20 per cent. to brain.

Have the men who conceived these degrading terms resigned their control of the B.E.E.A.? Or are they still trying to trap employed engineers into their organisation on a basis of membership, which classes them as sycophants brought in simply to pay homage to the money gods of the industries? And is the Institution to give its support to mere tactics of this kind as against movements pulsing with the very heart-blood of the engineering profession, born out of its struggles, instinct with its aspirations, and in contact with all its trials of existence? Surely the first really bold incursion of the I.E.E. into regions confining the general well-being of its members should not take this form. I submit it is a question to be settled by the general body of the members, and that a meeting should be called.

I confess I was (and am still) expecting greater things of our President. As a crusted senior, I heard and applauded with fervour, almost with emotion, his opening address. At last, I thought, we have a leader who will realise and act in the strength and justice that is behind him. Engineering intellect will claim more stoutly its place in the counsels and administration of the Nation and Empire, as well in the terrible need of now as hereafter. And, I thought, now at long length it will seek and find a reward, which, in all honour, it can take from the country it has served, and esteem and cherish above all other. I refer to the Charter which has long been due in equity to the general body of engineering intellectuals.

How, I would ask, now stands our fate in this? Or was the desire for it but an aspiration to be wafted aside by a flight of petty decorations to the breasts of pets of fortune in the engineering industries?

Ruislip, June 25. JAMES WHITCHER, A.M.I.E.E.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 SPECIFICATIONS.

7,191 BROOKE, W. Electric motor control systems. (18/5/17.) 115,301.
7,239 GOULD, L. W. (Katayama, H.) Searchlight apparatus for submarine purposes. (19/5/17.) 115,303
7,354 HOLT, W. & BROOKS, B. Self-regulating dynamo-electric machines. (22/5/17.) 115,509.
8,300 DAY, G. ST. J. Switch-controlling means for electric lampholders and like coupling devices. (11/6/17.) 115,318.
9,092 MAUDSLAY, R. W. & STANDARD MOTOR CO. Control mechanism for the electric fittings of motor vehicles. (25/6/17.) 115,532.
11,079 CHLORIDE ELECTRICAL STORAGE CO. & DEAN, H. Secondary electric batteries or accumulators. (1/8/17.) 115,551.
12,414 REYNOLDS, F. A. & REYNOLDS, A. Fittings for electric lamp shades, reflectors and the like. (29/8/17.) 115,561.
12,478 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Control system for electric motors. (30/8/17.) 115,563.
12,480 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Phase balancers or phase converters for polyphase distributing systems. (30/8/17.) 115,564.
13,286 WATSON & CO., T. H., GREAVES, H. A. & ETCHELLS, H. Electrical system for electric furnace (17/9/17.) 115,570.
15,419 MIDDLETON, V. G., & BAKER, C. J. Electrical switches, fusible cutouts and the like. (23/10/17.) 115,373.
15,815 DEAN, H., & CHLORIDE ELECTRICAL STORAGE CO. Electric accumulators (30/10/17.) 115,374.
16,265 B.T.-H. CO., YOUNG, A. P. & WARREN, H. W. H. Distributors for magneto-electric machines. (7/11/17.) 115,375.
16,849 SVENSKA TURBINFABRIKS AKTIEBOLAGET LJUNGSTROM. Means for cooling the collector rings of dynamo-electric machines. (6/8/17.) 115,378.
16,917 MARKS, E. C. R. (Soc. Anon. des Etablissements L. Bleriot.) Method of assembling the armature plates in magnetos having a fixed armature. (18/12/16 Divided application on 18,144/16.) 115,380.
17,335 STERLING TELEPHONE & ELECTRIC CO., BELL, F. G. & DAVEY, W. C. Electrical signalling systems. (8/5/17.) (Divided application on 6,542/17.) 115,590.
17,769 GOODFELLOW, M., & BRITISH EVER READY CO. Electric flash lamps. (30/11/17.) 115,381.
18,070 STERLING TELEPHONE & ELECTRIC CO., BELL, F. G. & DAVEY, W. C. Electrical signalling systems. (12/6/17.) (Divided application on 8,416/17.) 115,594.
18,216 WAYGOODS-OTIS (LTD.) (Otis Elevator Co.) Alternating-current relays (8/12/17.) 115,595.
18,502 AUTOMATIC TELEPHONE MFG. CO. Telephone systems. (8/1/17.) 112,774.

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

April 25, 1918.

6,975 B.T.-H. CO. (G.E. CO.) Elastic fluid turbines.
6,978 GRAHAM & RICKETTS. Telephone systems.
6,981 QUESTA. (Officine Elettro-Meccanicale.) Electric starter for internal combustion engines.
6,986 CROOKES. Measurement of radiation.
6,988 FARBER. Electric lamp fixtures.
6,991 MARCONI'S WIRELESS TELEGRAPH CO. & RICHMOND. Apparatus for eliminating interference in wireless telegraphy.
7,006 GES. FUR ELEKTRISCHE INDUSTRIE. Coin freed telephone call boxes. (25/5/14, Austria.)
7,008 KENNINGTON. Electric ignition devices for internal combustion engines.
7,011 GES. FUR ELEKTRISCHE INDUSTRIE. Coin freed telephone call boxes. (19/3/17, Austria.)

April 26, 1918.

7,022 KRAUER. Apparatus for magnetic galvanic treatment of the human body.
7,033 WATFORD ELECTRIC & MFG. CO. Automatic switch for furnace control, &c.
7,037 CREED & POLLEY. Apparatus for reproduction in ordinary characters, messages received as electric impulses or as perforations.
7,047 B.T.-H. CO. (G.E. CO.) Electric induction apparatus.
7,052 ARMSTRONG, WHITWORTH & CO., DALBY & WILSON. Variable electric resistances.
7,074 BRAZIL, STRAKER & CO. & SHEPHERD. Electro-deposition of iron.
7,083 LATOUR. Audion or lamp relay or amplifying apparatus. (30/4/17, France.)

April 27, 1918.

7,092 WILKINSON. Thermo-electrically controlled valves.
7,129 ACCUMULATORS (LTD.) & HUNTER. Portable electric batteries.
7,132 POGUE. Maximum demand instruments.

April 29, 1918.

7,138 GODWIN. Control and protection of compound-wound electrical machines.
7,164 VILLIERS. Electromagnetic brakes, clutches, ratchets, &c.
7,166 WIRTZ. Devices actuated by sound waves.
7,175 BOWEN & MARINO. Secondary batteries.
7,178 BOSCH AKT. GES. Distributors for high-tension ignition devices.
7,180 WESTINGHOUSE ELECTRIC & MFG. CO. Control mechanisms. (31/5/17, U.S.)
7,181 PARSONS & ROSEN. Dynamo-electric machines.
7,188 MAYROW. Apparatus for chemical and electro-cleaning and depositing metals.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain of the Week.—Capt. W. Darley Bentley.
Next for Duty.—Capt. E. G. Fleming.
Monday, July 1, to Friday, July 5.—Drills as usual.
Sunday, July 7.—Commandant's Parade at Waterloo Station 8.45 a.m. Work: Revetments at Heywood. Dress: Service Dress, Drill Order with Haversacks and Waterbottles. Mid-day and tea rations to be carried.

SPECIAL NOTICES.—All drills will take place at headquarters unless otherwise stated.

The medical officer will attend for the examination of recruits on Thursday evening at 6.30.

Summer Camp. This Camp will be held at Esher from Aug. 3 to Aug. 11, both dates inclusive.

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Legal Intelligence.

Kensington & Knightsbridge and Notting Hill Co.'s Arbitration.

On the 18th inst. the Court of Appeal (Lords Justices Pickford, Bankes and Warrington) dismissed the appeal of the Kensington & Knightsbridge Electric Lighting Co. from a judgment of Mr. Justice McCardie varying an award of Mr. James Swinburne.

Mr. P. O. Lawrence, K.C., Mr. Vesey Knox, K.C., and Mr. C. D. Marriott appeared for the appellants and Mr. Tomlin, K.C., and Mr. Bruce Thomas for respondents. After hearing Mr. Vesey Knox and Mr. Tomlin, the Court dismissed the appeal with costs.

Lord Justice PICKFORD, in delivering judgment, reviewed the facts of the case at the date of the agreement with which the Court had to deal. The Kensal New Town district was now within the municipal borough of Kensington. In 1910 the Notting Hill Co. obtained what was called a "fringe" order, *i.e.*, a permission or licence by the Board of Trade to supply certain premises in the Kensal Town district, which was outside the area of supply of the Notting Hill Co. He thought there was no doubt that the effect of those fringe orders was not to add the premises to the area of supply, but was merely to authorise the company to supply those premises, although they were not within the area of the company. By the agreement it was agreed that for a certain period "each of the two companies shall from time to time take from the joint station all such electrical energy as such company (having regard to its other sources of supply) may require for the purposes of its business, in accordance with the provisions of the principal agreement or such other provisions as may from time to time be agreed upon between the two companies or settled unanimously by the committee." The question before the Court was, whether under that agreement the electrical energy which was required by the Notting Hill Co. for supplying the lighting under the fringe order to Kensal Town district must be taken from the joint station. The one important question was whether the electrical energy was required for the "purposes of its business" in accordance with the provision in the principal agreement? For the purpose of supplying those premises in Kensal Town the Notting Hill Co. had connected the mains they had laid in the district with the Metropolitan Electric Supply Co.'s system, and they took the required energy from the Metropolitan Co. Having referred in some detail to the relevant clauses and provisions of the principal agreement between the two companies (dated July 12, 1899) and also in the agreement of Oct. 25, 1900, and the 1899 Act, which legalised the contract, his lordship said that Sec. 5 of the Act provided in effect that the two companies might respectively distribute the energy in such proportions and manner as the two companies might from time to time determine for the purpose of supply within their respective areas of supply as for the time being authorised, or of giving effect to any agreement made under the provisions of the Act. The agreement of October, 1900, was made for the purpose of protecting the debenture holders in the sense that it would secure that there should be an adequate amount of business carried on at the joint station to keep the undertaking going and sound so far as the debenture holders were concerned. The first question one had to consider was to what extent the word "business" in the clause in the agreement of Oct. 25, 1900, went. It was obvious that some limitation must be put upon it. There was nothing to prevent either company from obtaining Provisional Orders in any other part of the country, and in such a case it would or might be impossible that the electrical energy should be taken from the joint station. It was said on behalf of appellants that Court ought to say that the business obtained by the "fringe" orders was the kind of business contemplated at the time the agreement was made. It was not contemplated, because it was not until about 10 years afterwards that the thing became possible. It was only after the passing of the Electric Lighting Act, 1909, that such a thing became possible. It was to be observed that the whole of the recitals referred to the areas of supply, and that the operative part of the first agreement referred to the fact that the energy to be generated was to be transmitted to the respective areas of the two companies. Therefore the "business" with which they were then concerned was the business of supplying electrical energy to the respective areas of supply, which was authorised by the special act, or as might from time to time be agreed upon. At the time the agreement was made they did not contemplate supplying electrical energy outside the area of supply, because at that time it was not possible. Taking all those things together it seemed that they had not to look outside the agreement in order to see what limitation was to be put on the word "business," because they found the limitation in the document where the word was used. He thought that Mr. Justice McCardie was right in saying that he must limit the meaning to the supply of electricity to defendants' statutory area, and to the business of the parties at the time of the agreement. That being so, the supply by the fringe orders was not "business" which came within the terms of the agreement.

Lords Justices Bankes and Warrington also delivered judgments dismissing the appeal.

Munition Workers' Wages.

Last week a Divisional Court (Justices Shearman and Sankey) decided a test case which raised a question as to the terms of the employment of munition workers. The point arose on an appeal from the decision of Judge Spencer Hogg, at the Oldham County Court, that the Munitions of War Acts had imported into a workman's contract of employment the implied term that he should receive a week's notice or damages in lieu of notice. In May, 1917, Edwin Hulme, a moulder, was employed as a pieceworker at the works of Ferranti & Co., Hollinwood. A section of the workmen went on strike and the company stopped the whole of the work at their establishment. Hulme did not take part in the strike, but the company failed to provide him with any work from May 3 till May 10. Hulme brought an action to recover a week's wages in lieu of notice, and the County Court judge gave judgment in his favour. The company appealed, contending that Hulme was not entitled to any notice, and that even if he was his remedy was to apply, not to the County Court, but to the local Munition Tribunal.

The appeal was allowed, with costs.

Damages for Glasgow Tramcar Accident.

In the Court of Session last week Lord Anderson heard two actions arising out of the tramcar accident on Dec. 5 last, when a tramcar left the rails, and was overturned. The driver of the car was 16 years of age. A brass turner named Robt. Graham claimed £750 damages from the Corporation in respect of injuries. Defenders admitted liability, pleaded that the sum sued for was excessive, and tendered £125.

Lord Anderson, holding that the pursuer's health had been seriously impaired, awarded him £500, with expenses. In the second case, Wm. Welsh, toolsmith, sued for £500 damages. Defenders tendered £75, and his Lordship awarded him £200, with expenses.

Parliamentary Intelligence.

ROTHERHAM CORPORATION BILL.

Last week the Local Legislation Committee of the House of Commons commenced the consideration of this Bill, which (inter alia) provides for the transfer of the electricity undertaking of Mexborough & Swinton Tramways Co. to the Corporation; to extend the electric supply area of the Corporation and to make further provisions in regard to their electricity, gas and water undertakings, &c.

The Corporation contended that owing to the necessity of meeting the power demands it was essential that extra provision should be made for giving an increased supply. Arrangements with local authorities had been arrived at in practically every case. If the Bill went through the Rotherham, Sheffield and Yorkshire Electric power stations would be linked up, which would result in great economy.

Sir JOHN SNELL gave evidence in support of the scheme. He considered £45,000 a reasonable price for the purchase of the company's electrical undertaking. At least £15,000 would be obtained by the sale of plant, which the Corporation would not require. Rotherham would be able to supply the district with electricity at a much cheaper rate than the company could, and might look for an immediate revenue of £31,000 a year.

On the 20th inst. the Chairman of the Committee (Sir Wm. Middlebrook) said that, in regard to the construction of the dam on the Don they were prepared to grant the powers asked for. They were also prepared to grant powers to extend the area of electric supply to the limited extent proposed. With regard to the abstraction of water from the Don, the Committee desired to have further evidence as to the conditions which should be imposed upon Rotherham as to the temperature at which the water abstracted should be returned to the river.

Sir JOHN SNELL said he thought they should be allowed to return the water at a slightly higher temperature than was imposed upon Sheffield. He suggested a maximum of 90 deg., and an average over a period of 24 hours of 85 deg.

The Committee, by a majority, decided to give Rotherham statutory powers to abstract water from the Don on condition that it was returned at an average temperature not exceeding 90 deg.

The Committee also passed part 3 of the Bill, which confers powers to enter into agreements for the purchase of crude gas, waste heat and steam in a large district, but the area of the Wath Gas Co. was excluded.

LONDON UNITED TRAMWAYS BILL.

A Select Committee of the House of Commons has approved the preamble of this Bill, which provides for a reduction of capital, an increase of the fares, a postponement of the date, and an alteration of the terms of purchase by the local authorities, &c. The accumulated surplus revenue is to be applied to putting the system into good condition and repair.

ELECTRICITY SUPPLY AND GAS CHARGES.

In the House of Commons on Monday Sir A. Stanley (President of the Board of Trade) stated that he proposed to introduce a Bill as soon as possible to carry out the recommendations of the Select Committee on Gas Undertakings, and to include provisions with regard to tramways, electricity and water undertakings.

Electric Light Provisional Order Bill.—The Bill to confirm the Wednesbury Corporation Electric Lighting Order was read a second time in the House of Commons on the 19th inst.

Price of Coal.—The Board of Trade have made an Order increasing the price of all coal as from the 24th inst. by 2s. 6d. per ton, except in the case of shipments to France and Italy, in which cases the increase is 5s. per ton.

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Commercial Topics.

Water Power Resources.

The Board of Trade have appointed, with the concurrence of the Ministry of Reconstruction, the committee to examine and report upon the Water Power Resources of the United Kingdom and the extent to which they can be made available for industrial purposes. The members of the committee are :—

Sir John F. C. Snell, M.Inst.C.E. (chairman), Mr. G. S. Albright, Sir Dugald Clerk, D.Sc., F.R.S., M.Inst.C.E., Dr. J. F. Crowley, Mr. H. F. Carlill (Board of Trade), Mr. Philip Dawson, Prof. Gibson, D.Sc., M.I.M.E., Mr. Vernon Hartshorn, J.P., Dr. H. R. Mill, D.Sc., LL.D., Mr. A. Newlands, M.Inst.C.E., Mr. G. C. Vyle (representing Associated Chambers of Commerce), Mr. A. J. Walter, K.C., Mr. Ralph Walter (Ministry of Reconstruction), and Mr. D. J. Williams.

Mr. R. T. G. French is the secretary, and communications intended for the committee should be addressed to him at 10 Princes-street, Westminster, London, S.W. 1.

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Risks of Holding Trading Stocks After the War.

On Monday the Birmingham Chamber of Commerce approved a report by the special committee on the question of financial risks attaching to the holding of trading stocks after the war.

The report stated that on the whole there did not at present exist a financial inability to hold trading stocks. Such stocks were, however, becoming dangerously depleted. After the war there would be considerable financial inability to hold stocks, and this inability would be accentuated if adequate quantities were likely to be available. Taking trade as a whole there would be serious depression after the war owing to many factors. Regarding remedies or palliatives, the following suggestions are made : (*a*) A certain amount of control, both in price and distribution of materials and commodities, will be desirable and necessary, but this should be withdrawn at the earliest possible moment; (*b*) treasury restrictions on the issue of new capital should be removed ; (*c*) further State aid or intervention in regard to credit facilities is not recommended ; (*d*) dividends should not be limited ; (*e*) anti-dumping legislation should be enacted providing at least for an additional Custom duty equal to the difference between the invoice price for export and the fair home market value in the exporting country ; (*f*) with the view of stimulating the production of the United Kingdom, Customs duties should be imposed upon imports of manufactured and partly manufactured articles from all countries, subject to any arrangements that may be made for mutual preferences between the units of the British Empire and reciprocal treatment between the United Knigdom and its Allies and any other foreign countries ; (*g*) a certain portion of the excess profits duty should be earmarked and placed to reserve for the purchase and holding of trading stocks after the war ; (*h*) repayment of excess profits in recoupment of later losses or deficiencies should operate over a period of at least four years instead of two years as at present.

* * * *

Electric Cables in Australia.

The Commonwealth Dept. of Trade and Customs has decided to regard the letters "C.M.A." on the labels attached to imported wires and cables as an indication that the manufacture of the goods are associated with the British Cable Makers' Association, and that the goods have been manufactured in accordance with the specifications of the Association.

The use of the word "Association" when unqualified is likewise to be regarded as having similar implications ; and the Department has also decided that statements such as the following : "Guaranteed equal in all respects to 'C.M.A.' product of similar grade," may be used on wires and cables manufactured by non-members of the British Cable Makers' Association, provided the goods are thereby correctly described.

A statement of country of origin is required to be marked in conjunction with any English wording applied to any goods made in a country where English is not the ordinary language used, and which are imported into the Commonwealth.

* * * *

Insuring Against Foreign Bad Debts.

The British Trade Corporation has formed the Trade Indemnity Co. (with a capital of £100 000), for the purpose of assisting British merchants and manufacturers in developing overseas business by insurance.

Policies are to be issued insuring the payment of commercial debts, thus enabling an exporter to increase his present volume of trade without incurring greater capital responsibilities. Under approved conditions, the company will advance to the assured the amount of its liability in respect of any debt insured, against transfer of the debt and payment of interest on the amount advanced, until the net outcome of an estate is ascertained. The company grants policies insuring up to two-thirds of a client's whole turnover against ultimate loss. Policies will also be granted to cover a proportion of such losses as may arise should a forced re-sale of goods become necessary in consequence of buyers becoming insolvent. The company will grant policies insuring against a proportion of trader's losses in any one year in excess of an agreed percentage of loss on turnover to be borne by the assured, and to grant policies insuring approved accounts up to three-fourths of the amount of a debt. The last-named policies will be issued on three different bases.

British Empire Trade Mark.

We have received a circular, signed by a number of leading manufacturing industrial firms, in which a précis of the arguments against the above Mark is given.

It is pointed out that on Oct. 20, 1914, the Board of Trade directed that the application for the registration of the mark be not permitted to proceed. At the beginning of last year a deputation from the British Empire League waited upon the President of the Board, and the League state that the deputation were informed that if they could obtain sufficient evidence of support to their application the Board of Trade would allow the matter to be re-opened. The circular warns traders not to be misled by the suggestions of the British Empire League that the war has weakened the arguments in opposition to the mark. It is denied that the French Government have (as suggested by the League) established a mark of origin. An application has been lodged in the French Trade Marks Office by the Union Nationale Inter-syndicale, but the latter is a private body, representing various commercial interests.

Electricity Supply.

Extensions.

Elland.—The Urban Council has been authorised to borrow £2,000 for extensions of the electricity works.

Glasgow.—The Electricity Sub-committee has authorised its chairman and the city electrical engineer (Mr. W. W. Lackie) to purchase a site at Linthouse for a new sub-station.

Ipswich.—Last week the Council decided to apply for sanction to borrow £43,000 for additional generating plant.

The chairman of the Electric Supply and Tramways Committee (Mr. E. C. Ransome) explained that the matter was a very important one. The industrial prosperit yof Ipswich was undoubtedly bound up with the policy the Council adopted in connection with the undertaking. Unless adequate and cheap power was available not only would manufacturers be placed at a serious disadvantage in competition with other manufacturers, but the working classes would ebadversely affected, and no incentive would be aiven to new industries to come to the town. They had had more than one inquiry lately from firms desirous of coming to Ipswich and establishing works, who had laid it down that they must have available electrical supply.

Mr. W. REAVELL, in seconding the adoption of the committee's report, said he could well understand the Council hesitating to spend £43,000, but the saving in coal alone would amount to between £5,000 and £7,000 a year, which would cover the cost of repayment, &c. He estimated that when the reciprocating engines now in the station were supplanted by turbines there would be a saving of 50 per cent. of the steam consumption of the station. Ipswich must prepare to supply electricity in bulk at such a low price as to attract consumers to adopt that form of energy.

Luton.—The Council has now received authority to proceed with the scheme for extending the generating plant at the electricity works, and the contractors for the turbo-alternators and boilers are proceeding with their work.

Redditch.—Owing to the increasing demand for power the Council has decided, on the recommendation of the consulting engineers (Messrs. Handcock, Dykes & Trotter), to obtain additional boiler plant and a cooling tower.

General.

Arklow.—The Council is negotiating with Messrs. Kynoch for a supply of electric current for public lighting.

Brighton.—Last week the Council adopted a recommendation of the Lighting Committee as to the payment of war bonuses to the employees of the electricity department.

All employees of the department whose salaries do not exceed £500 per annum will be paid the 12½ per cent. bonus granted under the Askwith Award on their salaries up to £250 per annum, such increase to date back to the first pay day after Oct. 1, 1917. The bonus will also be paid on all overtime worked.

The Municipal Employees' Association having also asked that the shift hands be paid at double time rates for working on Easter Monday, Good Friday, Christmas Day, Boxing Day and for Sunday work, and that the war wages of employees under 18 be increased by 2s. 6d. per week, the committee recommended that the increase of 2s. 6d. per week be granted, and the other question be referred to the engineer, and this was approved.

Colwyn Bay.—The electrical engineer (Mr. A. R. Tuckman) has resigned, owing to having received an appointment with a Manchester firm.

Hornsey.—There was a deficit of £2,007 on the past year's working of the electricity undertaking due to the high price of coal, increased wages, &c.

Poplar (London).—It is proposed to revise the agreement with Stepney for reciprocal stand-by and bulk supplies.

Each party is to endeavour to reciprocate any supplies taken during any quarter. Cost of fuel is the basis of charge, and it is proposed to include handling up to actual delivery into bunkers, testing for calorific value and disposal of ashes. In the event of breakdown and the neces-

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sity to supply during heavy load the receiving party is to pay an additional 50 per cent.

Estimates of £1,000 for extending the Millwall sub-station and of £5,500 for a motor converter and feeder machine panel have been approved.

Slough.—The Slough & Datchet Electric Supply Co. has applied for permission to supply electrical energy in bulk to the Windsor Electrical Installation Co.

Stafford.—The Council is recommended to increase the salary of the electrical engineer (Mr. W. H. Robins) by £20 per annum.

Electric Traction.

Ayr.—The Tramways Committee recommend the withdrawal of the Sunday services.

Birmingham.—Ald. Ellaway has been elected chairman of the Tramways Committee in succession to Mr. Harrison Barrow, resigned.

At last week's meeting of the Corporation, the Lord Mayor (Ald. Sir David Brooks) referred to the valuable services rendered to the tramways department by Mr. Harrison Barrow, and, on the motion of Ald. Ellaway, seconded by Councillor Bishop, a resolution was passed expressing the regret of the committee at the circumstances which had led to the resignation of Mr. Barrow of the chairmanship, a position he had occupied for 10 years, and placing on record their high appreciation of his services.

Brighton.—There is a surplus of over £15,000 on the past year's working of the Corporation tramways. Nearly 17 million passengers were carried during the year.

Cardiff.—The Tramways Committee propose to increase each of the existing tramway stages by ½d. and workmen's fares by ½d. per mile.

Electric Vehicle Progress.—Aberdeen Cleansing Committee has asked the Director of Mechanical Transport for permission to purchase a 5-ton electric motor wagon, at £1,600.

Hull Works Committee has authorised the borough engineer (Mr. F. W. Bricknell) to purchase a 3½-ton electric vehicle, at a cost not exceeding £1,163.

Swansea Health Committee has ordered two "Edison" electric vehicles, at £2,457. 17s.

Fewer Tramway Stopping Places.—Many tramway undertakings including those of Liverpool, Sunderland, Birmingham and Nottingham Corporations, have decided to reduce the number of stops on the various tram routes in their districts. At Liverpool about 300 stops, or roughly about 20 per cent. of the whole, have been abolished.

Keighley.—Last week the Corporation decided to appoint an assistant electrical engineer and tramways manager, at a salary of £200 per annum.

L.C.C. Tramways.—The estimates for 1918-19 were submitted at the meeting of the County Council on Tuesday.

The total receipts are estimated at £3,321,750, and the working expenses at £2,593,140, leaving £728,610, and with interest and sundry rents, the total working surplus will be £751,889. The charges amount to £739,774, leaving a net surplus of £12,115. The estimates are based on the assumption that the car-mileage during the year will be 50,000,000.

The Highways Committee, reporting on the estimates, say that the realisation of the improved revenue required in 1918-19 is dependent on the revision of fares. The new scale was applied on the tramways south of the Thames last month, and on June 8 certain fare changes were made on the lines on the north side of the river. Owing, however, to the time occupied in negotiations with other undertakings concerned in through running services, the complete fare revision has not yet been brought into operation. Provision of £204,000 is made for allowances to officers and employees on war service.

Plymouth.—Ald. T. Baker has been elected chairman of the Tramways Committee, in succession to the late Ald. S. H. Phillips.

The gross profit of the tramways for the year ended March 31 was £33,230, and after paying capital charges, &c., the net profit is £12,338, of which £4,300 is to be applied in relief of rates, and £8,038 placed to reserve.

Southend-on-Sea.—With a view to minimising the consumption of power by tramway drivers, the Electrical Engineer has drawn up a merit bonus scheme for drivers.

Telegraphy and Telephony.

Radio-Telegraph Progress.—The new radio-telegraph station on the island of Lobos, off the coast of Tampico (Mexico) has been equipped mainly for the purpose of affording the various petroleum companies facilities for communicating with their vessels while great distances at sea.

The station will be able to communicate with the wireless stations at Mexico City, Tuxpan, Tampico, Vera Cruz, Progreso, Frontera, Mazatlan, Santa Rosalia, La Paz, Queretaro, Monterrey, Saltillo, Torreon, and by way of Havana with various stations in the United States.

The Ecuadorian Government has contracted with Sociedad Francesa Radio Electrica (Paris) for the installation of three wireless telegraph stations in Ecuador, and $42,667 have been paid on the contract.

A consular report from Basse Terre, Guadeloupe, states that the Destrellan radio telegraph station was completed on March 6. During the war the station will be of a military nature, and the staff will be provided by the Navy.

Mr. Edward Nally, president of the Compania Telefonica Telegrafica Sin Hilos Pan-Americana and vice-president and manager of the American Marconi Co., is paying a visit to South America in order to establish in various parts of Latin America, high-power wireless stations which will allow of direct communication between South America and the United States and Europe.

Wireless Telephony on Spanish Ships.—H.M. Consul at Bilbao States that successful trials of wireless telephone apparatus were recently made between a vessel in Barcelona harbour and another vessel a few hours out upon a voyage to Palma (Majorca). The communications from the latter vessel were heard on the former, and also at land stations in Barcelona. The apparatus is supplied by a Madrid company.

Imperial Notes.

Australasia.—Wellington (N.Z.) Harbour Board has carried out urgent engineering works and increased storing accommodation for cheese.

The new plant includes two electrically-driven circulating pumps, ammonia condenser and two air batteries. Stacking the cheese will also be done by electric power.

The Victorian Railway Commissioners intend to supply the power needed for the Footscray trams, and also to supply electricity for other purposes to Footscray and Williamstown, and industrial concerns along the banks of the Yarra.

The Commonwealth Minister for Trade and Customs (Mr. Jensen) has prohibited the importation from any country of magnetos bearing the word Bosch.

Research Work in Canada.—The Honorary Advisory Council for Scientific Research, which has been studying measures to foster the scientific development of Canadian industries, proposes to establish a research institute for the Dominion.

Foreign Notes.

Competition in Chinese Electrical Trade.—The "Japan Advertiser" of April 5 stated that Japanese electrical engineers have an ambitious scheme of replacing German electrical goods in the market in China, and of engaging in a contest with American and British engineers for that big commercial theatre after the war.

Recently a Chinese party of business men went to visit various electrical engineering works, and also the electrical laboratories of the Department of Communications of the Imperial University and some technical schools. Japan has supplied China with electric lamps, wires and cables through their establishments at Shanghai. The latest of them, the China Industrial Development Co., has also the supply of these goods in sight.

In a recent report, H.M. Commercial Attaché at Yokohama stated that the manufacture of electrical machinery and appliances in Japan had undergone great development since the first electrical industry was established some 30 years ago. The object of the recent Tokio electrical exhibition is to demonstrate the progress that has been made. The exhibits covered a fairly wide range of goods. They were divided into six sections: Domestic appliances, electro-chemical industry, electric transmission apparatus (two sections), and electrical engineering, machinery, &c. (two sections).

Electricity Supply League in Germany.—The third annual meeting of the League of Electricity Supply Undertakings of Germany was held on May 23. The League now includes all companies of any importance in electricity supply, and the affiliated concerns have about 2¾ milliards of capital.

Miscellaneous.

Application for Extension of Patent.—The petition of Dr. J. A. Fleming and Marconi's Wireless Telegraph Co. (Ltd.) for an extension of the term of patent No. 24,850, for "Improvements in instruments for detecting and measuring alternating electric currents" is directed by Mr. Justice Sargant to be heard not before Oct. 30.

Enemy Firm Wound-up.—The controller of the Schorch Electrical Co., 35, Basinghall-street, E.C., has applied to the Board of Trade for a release.

Coal Output.—The Coal Controller (Sir Guy Calthrop) has addressed a letter to the secretary of the Miners' Federation of Great Britain, urging an increase in the output of coal.

After referring to the 400,000 men who have already left the mining industry to join the Colours, appeals to their comrades still at the collieries to play their part in the struggle for peace and freedom in which the nation is engaged. More and cleaner coal is needed for domestic consumption for essential industries at home and for our Allies. It is not proposed to ask miners to increase the length of the shift, because the Controller is convinced that by increased effort and improved attendance the necessary output can be obtained. An increase of 10 cwt. in the weekly output of each coal getter would increase the output by about 10 millions tons a year. The Controller asks that voluntary "absenteeism" should come to an end, and that the serious loss of output brought about by sporadic strikes may cease.

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Local Authorities and Industrial Councils.—Salford Corporation has referred to a special committee on war bonuses the question of forming Works Committees for the trading departments of the Corporation.

Ald. PHILLIPS, in introducing the subject, said the Whitley scheme opened out prospects of a new era in the relations between employers and employed, and would benefit all sections of the community. In regard to the tramway undertakings of Lancashire and Cheshire, considerable progress had already been made on the lines of the Whitley recommendations.

The question has also been before the Birmingham Corporation, and a committee has been instructed to present a report.

Utilisation of Blast Furnace Gases.—At the annual meeting of the Ebbw Vale Steel, Iron & Coal Co. (Ltd.) last week the chairman (Col. Sir Charles Allen) stated that the rapid growth of the use of electric power was becoming a matter of vital importance to all manufacturing concerns and a most valuable asset to those who possessed cheap means of production.

In the large extensions to their blast furnace plant, coke-oven and by-product plant, they had an enormous increase in the volume of "waste gases," which not many years ago were thrown to the winds. Those were now being turned into a most useful and profitable purpose in the production of sufficient electric power to enable them to electrify the whole of their iron and steel works and the collieries in Ebbw Vale and the adjoining valleys. That alone was an immense saving upon antiquated practices. Work was now in hand and nearly completed which would connect their newly-acquired coal properties with their central power station at Ebbw Vale, so that those mines situated several miles distant would derive their power from the so-called "waste gases" available from the production of iron and coke.

Tenders Invited and Accepted.

Meters.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. July 3 for the supply of 21 electric meters for power circuits. Specification from Commissioners' Office, Spencer-street, Melbourne

Electric Lamps.

NEW ZEALAND Public Service Tender Board, Wellington, require tenders (by July 1) for supply of 9,290 Electric Lamps.

COLCHESTER.—The tender of Mumford & Co. has been accepted for the supply of a new pump at £171.

HAMPSTEAD (LONDON).—The Borough Council has accepted the tender of John Thompson for the supply of two water-tube boilers, with super-heaters and mechanical stokers for £8,205.

POPLAR (LONDON).—The Council has accepted the following tenders:—

Underfeed Stoker Co., chain-grate stoker, £2,887. 10s.; Pirelli (Ltd.), 3,221-yds. e.h.t. 15 in. cable, 6,600 volts, £2,188, 436 yds. l.t. 2 in. cable, £247. 10s., 770 yds. l.t. 15 in. twin cable, £263; Western Electric Co., 1,965 l.t. 5 in., £2,856. 10s., 301 yds. l.t. six-core cable, £447.

SALFORD.—The Electricity Committee has placed an order with the British Westinghouse Co. for the supply of four 1,666 k.v.a. transformers at £5,460.

ST. PANCRAS (LONDON).—The Borough Council has accepted the tender of Babcock & Wilcox for the supply of an induced draught fan, at £1,085; and that of Dick, Kerr & Co. for a shunt-wound variable speed motor of 150 H.P. and starter at £648. 10s.

SWANSEA.—The Council has placed an order with the Rail Welding Co. to repair 100 defective tramway track joints, at £141. 7s.

WHITEHAVEN.—The Council has placed an order with Greenwood & Batley for a 200-kw. set for £2,100.

Appointments Vacant.

An electrical draughtsman is required for diagram lay-out and record work by controlled shop, with high-tension and low-tension three-phase system. *See advertisement.*

An electrical engineer is required with good experience in general electrical installations in warships. Applications to the Director of Electrical Engineering, The Admiralty, Great George-street, London, S.W. 1. *See advertisement.*

An experienced electrician is required for country upkeep and management of electrical plant.

Mr. H. E. Munday, of Cheltenham, has been appointed engineer-in-charge at Bedford, in place of Mr. F. H. Bond, who has joined H.M. Forces.

Colwyn Bay Urban Council has appointed Mr. J. Smith, gas manager, as engineer and manager of the electricity undertaking in succession to Mr. A. R. Tudman. Mr. Smith's salary has been increased from £400 plus £17 bonus, to £600 per annum.

Business Items.

Thermit (Ltd.), 675, Commercial-road, London E., informs us that the whole of the company's shares, which in August, 1916, were sold by the Public Trustee to the Birmingham Metal & Munitions Co., have now been taken into their own holding by Nobel's Explosives Co., and under the new auspices the activities of Thermit (Ltd.) are being considerably extended.

The company owns many valuable engineering patents, and, by their scientific application, it is enabled to execute certain classes of work by methods other than those usually adopted. The company has a highly trained staff, and is specialising in the manufacture of high-grade metals and alloys in connection with munitions of war, also welding in all its branches by up-to-date methods and engineering repairs generally. The company is now wholly British, the elimination of all alien enemy interests having been effected.

The partnership between Wm. P. Thompson and Herbert Sefton-Jones (trading as W. P. Thompson & Co., patent, design and trade mark agents, and the Trade Mark Protection Association), 285, High Holborn, London, W.C., has been dissolved as from Oct. 1, 1917. Debts by Mr. H. Sefton-Jones.

Liquidations.

Claims against the R. E. T. Construction Co. (Ltd.) (in vol. liq.) are to be sent by July 25 to the liquidator, Mr. Alfred Page, 28, King-street, Cheapside, London, E.C.

Winding-up Order.—Mr. Justice Younger has made an order for winding-up compulsorily Hills, Menke & Co. (Ltd.), electrical and mechanical engineers, on account of the company's enemy associations.

Winding-up Petition.—A petition for winding-up the A.E.G. Electric Co. (Ltd.) will be heard by Mr. Justice Younger on July 2.

Companies' Meetings and Reports.

ALUMINIUM CORPN. (LTD.)—The report states that as a final settlement has not yet been arrived at with the Ministry of Munitions and the Inland Revenue Authorities in respect of the corporation's liability for excess profits duty, the usual accounts for the year's trading ended Dec. 31 cannot be submitted. The directors are satisfied, however, that the result of the year's trading justifies them in recommending the payment of a year's preference dividend at the rate of 7 per cent. per annum.

Mr. K. M. Clark, who presided over the meeting last week, stated that their general office had been removed from London to the works in North Wales Some years ago they removed the carbon works from Wallsend to North Wales with satisfactory results, and they now had a rolling mill in work upon the same site as the reduction works. They had been successful in purchasing the total share capital of the Aluminium Foil Co., and that business was being conducted as a subsidiary business of their company. They hoped to concentrate all their various processes in North Wales. The directors had been satisfied that the result of the year's trading justified them in recommending payment of a full year's preference dividend, and they hoped to submit in the near future a scheme for finding the three years' preference dividend in arrear. Work had proceeded upon the construction of the new dam and upon other work necessary to increase the company's water power; a considerable amount of property had been acquired to enable the company to obtain the greatest benefits from the water power available. They had found the direct railway connection with the L. & N.W. line of the greatest possible service, and they could claim that their works were in a position to compete with any other similar factory.

BRITISH ELECTRIC TRACTION CO. (LTD.)—Mr. E. Garcke, who presided over the meeting on Tuesday, said that the position presented the same general features as last year, but they were intensified. They had made more profit because they had done more work, and, having done more work, they had had greater difficulties to overcome. The increased profits made by the associated companies had been applied mainly to strengthen the financial position. About two-thirds of the increased profits had been added to reserve and renewals account, and only about one-third had been applied to increase of dividends. A substantial portion of those reserves was rendered necessary by reason of the repairs which had been unavoidably deferred. After giving an analysis of the accounts, he said that the recent reports on the electrical trades and on electricity supply were a condemnation of the electrical legislation of the last 36 years and a vindication of the men who had persistently opposed that legislation and its tendencies. He remembered the time when the Government encouraged, and, indeed, demanded, the establishment of rival systems of electrical distribution in London in order to provide competition for the supposed benefit of the consumer. Parliamentary Committees, the working classes and some sections of the Press were in opposition to the policy of allowing kindred concerns to amalgamate so as to secure economy and efficiency of administration; large output at low cost and economical distribution of the finished article. The popular view was that the consumer had to be protected against the producer; that cheapness was the first principle of economics. The general result was expressed in sparse profits, which meant low wages, inability to make research and unwillingness to undertake extensions. German manufacturers, who had a protected home market, were able to compete in this country and they were invited to do so by our municipalities. The conditions were bad enough for the manufacturer, but

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they were much worse for tramway and electric supply undertakings, which were surrounded by special Acts of Parliament subjecting them to the municipal veto. A remarkable change had come over the scene. They were now told that cheapness had not been an unmixed blessing, and that trade combinations were not an unmitigated evil. The prevailing feeling now was that the numerous and various restrictions must be removed; that facilities for new enterprise and for extensions must be provided; that competition, and especially enemy competition, must be excluded, and that capital properly invested in the industry must be allowed to fructify, so that labour can be adequately paid; that inventors may be encouraged, and that the highest technical talent may be attracted to the production of electrical machinery and distribution of electrical energy. The Committee on Electric Power Supply suggested that district electricity boards under the control of Government should be constituted to take over all electrical power-houses, and that the local distribution of electricity shall in most cases be left in the hands of present undertakers for a time. There could be no doubt that if that difficult problem was tackled in a comprehensive and equitable manner when the war was over the electrical industry would prosper to an extent and in ways which would surprise many of them, especially those who had in the past been confronted by discouraging obstacles which had greatly diluted the hopes with which they commenced their enterprises. The pioneers of the electrical industry in this country had had a hard time; but they had made the path easier for the battalions that followed them. The suggestions of improvement gave cause for satisfaction, and if effect was given to the recommendations investors in electrical undertakings might be congratulated, especially those who had made sacrifices in the past.

GLOBE TELEGRAPH AND TRUST CO. (LTD.)—The net revenue for the year ended May 31, 1918, after deduction of expenses, was £228,394, and makes, with £55,176 brought forward, a total of £283,570. From this amount £75,000 has been transferred to reserve for contingencies and £115,468 distributed in interim dividends, leaving £93,102. The directors now recommend payment of the following final dividends, viz., 3s. per share on the preference shares, making, with previous distributions, a total dividend for the year at the rate of 6 per cent. per annum (less tax) and 8s. per share (tax free) on the ordinary shares, making, with previous distributions, a total dividend at the rate of 7 per cent. (tax free) for the year. These dividends will absorb the sum of £91,922.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—The profit for 1917 was £15,911, against £18,818 in 1916. Out of this £6,000 was distributed as preference dividend, and a further £6,000 has been placed to credit of debenture redemption fund. The debenture debt has been reduced from £61,200 to £30,000, and a further reduction of £7,500 has to be made at the end of this year.

At the meeting last week the chairman (Mr. Edward Pope) said the decrease of £2,906 in the past year's profit was a measure of the depreciation which had taken place in the prospects of Kalgoorlie, due largely to war conditions. There was a decrease in the profit made during the last four months of the year beyond their anticipation, and consequently no dividend was paid in April. The conditions prevailing at Kalgoorlie tended to decrease receipts and to increase costs; it seemed unlikely that there would be any beneficial change during the war. The gross profit for the five months of the present year was £6,317, compared with £8,109 last year. Their future was intimately bound up with that of the Kalgoorlie Goldfield. The field would be a considerable producer of gold for many years, and favourable reports had been received from the Great Boulder and Golden Horseshoe mines. From those and other developments there was good reason to hope that the company, freed from its debenture debt, would continue to work at a profit and be able to pay reasonable dividends after the great war.

LANCASHIRE POWER CONSTRUCTION CO. (LTD.)—The report for the year ended March 31 states that the trading profit of the Lancashire Electric Power Co. for the year 1917 amounted to £41,548, and with interest on hire purchase plants, &c. (£483), the total was £42,031, compared with £39,839 in 1916. With the balance from 1916 the amount available is £49,734. After paying debenture interest (£4,500), placing £15,000 to reserve, and paying a dividend of 5 per cent. on the issued share capital (£24,513. 14s), a sum of £5,721 has been carried forward. During 1917 the Power Co. generated 43,744,919 units, against 40,842,652 in 1916, and 35,768,064 in 1915; the maximum load was 13,300 kw., against 11,900 kw. and 10,740 kw., and the horse-power connected 34,000, against 30,600 and 29,000 respectively.

The revenue account of the Construction Co. shows that the total interest, dividend and other receipts for year ended March 31 amounted to £29,024, and after debenture interest, &c. (£18,455), the available balance is £10,570. The directors recommend payment of a dividend for the half-year ended March 31 (less tax) at rate of 7 per cent. per annum, on the preference share capital, and £7,507 will be carried forward.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—The gross revenue for 1917 was £470,658, an increase over 1916 of £200,476, derived principally from rentals of additional ships fitted. The profit was £192,056, and after deducting £50,000 for obsolescence of plant, the net profit was £142,056, against £96,748 in 1916. The losses sustained in consequence of attacks upon the mercantile fleet during the year have been debited to profit and loss. The total number of public telegraph stations owned and worked by the company on the high seas increased from 1,472 at the end of 1916, to 2,265 at the end of 1917. The directors recommend payment of a final dividend of 10 per cent. for the year, which, with the interim dividend of 5 per cent. paid in February last, will make 15 per cent. for the year. The Amalgamated Wireless (Australasia), Ltd., paid a dividend of 5 per cent. in respect of the year ending June 30, 1917. The increase of capital to £600,000 became necessary in consequence of the decision of H.M. Government to make the provision of wireless telegraph apparatus compulsory on all merchant ships of 1,600 tons gross and over, and to require two operators to be carried on all vessels fitted. At the request of the Board of Trade the company undertook to provide the necessary apparatus and trained operators.

J. G. WHITE & CO. (LTD.)—There was a net profit of £13,362 on the past year's trading. The directors did not pay an interim dividend in January, and are now recommending a dividend on both classes of shares at the rate of 6 per cent. per annum. The balance, after bringing forward £41,678, is £55,041, and after paying the dividends of 6 per cent. on the cumulative preference and ordinary shares for the year to Feb. 28 (less tax), the balance to be carried forward is £43,041.

YORKSHIRE (WOOLLEN DISTRICT) ELECTRIC TRAMWAYS (LTD.)—The revenue for 1917 was £84,585, against £76,140 for 1916. After deducting all expenses chargeable to revenue, including repairs and maintenance, payments to local authorities, debenture and other interest, and setting aside £10,600 for renewals fund, there remains £19,258,—and with £3,487 brought forward, the available total is £22,746. The directors recommend a dividend at rate of 6 per cent. per annum on the ordinary shares, to place £5,614 to reserve, and to carry forward £5,129.

City Notes.

CLARKE, CHAPMAN & CO. (LTD.)—The directors have declared an interim dividend of 2s. per share (less tax) on the ordinary shares.

EASTERN TELEGRAPH CO. (LTD.)—The company announce the payment on July 15 of dividend at rate of 3½ per cent. per annum (less tax) on the preference stock for the quarter ending 30th inst., and a first quarterly interim dividend of 1½ per cent. on the ordinary stock (tax free) in respect of profits for the year ending Dec. 31, 1918. The transfer books of the ordinary stock will be closed from July 6 to 13, inclusive.

INDIA RUBBER, GUTTA PERCHA & TELEGRAPH WORKS CO. (LTD.)—An interim dividend of 2½ per cent. (5s. per share), tax free, has been declared on the ordinary shares.

LA PLATA TRAMWAYS CO. (LTD.)—The accounts for 1917 show after payment of interest on debenture stock, &c., a balance of £10,359 to be carried forward.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—A final dividend of 5 per cent. on the ordinary and 7 per cent. on the preference shares, making 10 per cent. for the past year, have been declared.

The Round Table.

By "kVA."

Event of the Week.—Glovers' Prize Pigs at the I.M.E.A. Convention (served as an hors d'œuvre to Beaver's Protective and Detective Cable system at Trafford Park).

* * * *

There were no official invitations to manufacturers to the Convention, which explains why so many of them had important business in Manchester last week.

* * * *

Councillor Higham (Accrington) had the meeting in a roar on Friday morning, when, in the course of his remarks on coal by-products he said: "You know we have a coal carbonisation plant at Accrington, and supply gas to gas engines; for anything I know, they are running at this moment!"

* * * *

The same speaker said the commissioners recommended in the B.O.T. Electric Supply Committee's report "would be wonderful men even if heaven sent; we have no such men in this country!" This reference also brought forth a burst of laughter, in which even the ex-presidents joined.

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, June 25, 1881.]

MRS. FAWCETT.—On Tuesday last Mrs. Fawcett addressed a meeting of women, warmly advocating the formation among them of trades unions. It is not stated whether any women telegraphists were invited to be present.

ELECTRICITY AMONG THE NIHILISTS.—Amongst the officers arrested as implicated in the proposed plot on the guardship off Peterhoff against the Czar's life, was a certain Lieut. Khotinski, who is also implicated in the Mala Sadowastreet mine. He has been connected with electric light production, and is said to be a man of scientific mark.

MORE ELECTRICAL PAPERS.—Paris is becoming the headquarters of electrical publications just now. We suppose that the excitement caused by the preparations for the Electrical Exhibition has given the motive force to the publishers. The "Telephone," a weekly paper, has just made its appearance, and we are promised the first number of the "Electrophone" shortly.

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CONTENTS.

NOTES 199
Arrangements for the Week 201
An Experimental Study of the Fahy Permeameter. By Charles W. Burrows and Raymond L. Sandford. Illustrated 202
Yield of Electro-Chemical Products 203
The Test Sheath Cable and its Potentialities. Illustrated 204
Electric Winding Engines and Mine Hoists. By H. H. Broughton. Illustrated 206
Experiments on Tribo-Electricity. By P. E. Shaw, B.A., D.Sc. .. 209
PUBLIC UTILITY UNDERTAKINGS AND THE WAR 210
REVIEWS 210
CORRESPONDENCE 211
Trade Parliaments and Their Work. By E. J. P. Benn.—*Concluded* 213
LEGAL INTELLIGENCE 213
Patent Record 214
Volunteer Notices 214
Commercial Topics 215
Electricity Supply 215
Tenders Invited and Accepted 217
Companies' Meetings and Reports 217

Notes.

Detection of Faults in Cables.

WHEN an electric cable is in use, although tests may be applied from time to time by disconnecting it, there is the standing disadvantage that not much information is obtainable as to what may be termed the variation in health of the insulation. The cable is either all right or all wrong. If a breakdown occurs it is all wrong. Sometimes, no doubt, a breakdown occurs due to a cause which acts quickly, such as damage during excavation. As a rule, however, the formation of a fault is a slow process. It may be due, for example, to the intrusion of moisture, or to electrolysis. Some of the difficulties that are thus experienced were pointed out by Mr. C. J. BEAVER in a comprehensive Paper which he read before the Institution of Electrical Engineers in 1914. Take, for example, the question of intrusion of moisture. If circumstances permit, an hydraulic test at 100 lb. per square inch may be made, but this does not necessarily lead to much information. Moisture may be introduced by such a test, but even if it is so introduced it will tend to flow along the length of the cable rather than radially; consequently, only the outer layers may be affected. Similarly, electrical tests may fail entirely to indicate the presence of water, which, however, may cause serious trouble when it has had time to distribute itself. In order to overcome this difficulty, Mr. BEAVER proposed to employ in the cable what is known as a test sheath, consisting of a copper strip which is wound round the main insulation. Outside this sheath is a layer of hygroscopic insulation, and outside this again is the usual lead covering. If, now, moisture finds its way through the lead coating the hygroscopic insulation will take it up rapidly and distribute it, and thus the insulation resistance between the test sheath and the lead coating will fall. This provides for detection of damage from the outside. If, on the other hand, there is damage from the inside, the internal insulation will begin to fail, and in that case an indication is rapidly obtained of what is taking place. It is well known that some faults take months and even years to develop, but by means of the test sheath here proposed these preliminary changes which will lead finally to a breakdown are shown in their progress. In other words, faults are detected in their incipient stage, and thus it becomes possible to remedy without inconvenience a state of affairs which would ultimately lead to an interruption of supply. During the Convention of the Incorporated Municipal Electrical Association at Manchester, members had the advantage of attending a lecture and demonstration of this system by Mr. BEAVER and of inspecting the system of protection to which this idea has given rise. In another column our readers will find an account of this demonstration. When we say that an incipient fault on a power supply system was not only detected but located by a fall in potential test along such a test sheath while the feeder was kept alive, and was supplying power at 6,600 volts, our readers will realise that this system places another useful means at their disposal for maintaining continuity of supply.

The Coal Trade After the War.

WE doubt if the Report of the Departmental Committee on the Coal Trade After the War, which was issued last week, will be read with general satisfaction. Among the recommendations we notice that two of the most important are, firstly, to the effect that the policy of export should be maintained and if possible the export should be increased; and, secondly, that all restrictions on the free export of coal imposed during the war hould be removed as soon as possible after the termination of hostilities. On the one hand, we have a committee making certain recommendations for the conservation of our coal supplies, and on the other hand, the present Committee suggesting that our exports should be increased. Surely, in such a matter, our home needs and the needs of our own shipping should take the first place. The present report shows that the cost of production has increased considerably during recent years. From two-thirds to three-fourths of the cost of production are represented by wages, and these in some districts were 15 per cent. to 20 per cent. higher in 1913 than in 1909. Since 1913 the increase under this head has been very great. Apart from this, however, we have the fact that the best and most cheaply worked coal is becoming exhausted and that other coal seams can only be worked with a larger expenditure of capital, and consequent higher charges for interest, depreciation, &c. And lastly there is the important fact that the output per person employed is steadily falling. Th s output was 360 tons in 1906 and 321 tons in 1913, showing a fall of 11 per cent Now it is obvious that f we increase our exports of coal these adverse factors in the cost of production can only be aggravated. Our home industries depend largely upon cheap coal and upon cheap power obtained from coal. Surely, then, our policy should be one of restricting, rather than increasing, our exports in this direction.

Electric Winding Engines and Mine Hoists.

ELSEWHERE in the present issue will be found the first of a series of articles on this important subject. Apart from the thorough manner in which the mechanics of the subject has

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been treated, the article is characterised by detailed analyses of winders of many different types and by a large amount of technical data on existing winders. Those in any way concerned with winding machinery will find of particular interest the examples on the plain and geared alternating-current and simple and equalised Ward Leonard systems. A number of cases are worked out in later sections of the article which show the advantages and disadvantages of the several systems of winding. It may be mentioned that the whole of the examples and data are taken from actual winders, and that the methods adopted by the author are those in everyday use in the engineer's office. This rules out many of the so-called refinements in the calculations. In our opinion, in many of the articles that have been written on the mechanics of the winder —particularly in those which have been published on the Continent—fundamental principles have often been observed by lengthy discussions on matters having little or no bearing on the problem. When it is remembered that the whole of the calculations for a winder are based on assumptions which are seldom, if ever, realised in practice, the folly of attempting to justify three-figure accuracy is apparent. In addition to a large amount of tabulated matter likely to be of service to the maker and user, the author gives extracts from many Papers on the subject and which as far as we are aware, have not hitherto been collated in a convenient form. Those not having access to a technical library—and under existing conditions few engineers have such facilities—will find helpful the notes on these important Papers. When the series of articles is completed they will be amplified and issued in book form as a volume in "The Electrician" Series.

Substitutes for Platinum in France.—According to "L'Industrie Electrique," great difficulty is being experienced in France in getting sufficient platinum for electrical work, and the Société des Experts-Chimistes de France has suggested a tax on all luxuries using this metal. Various alloy substitutes are proposed, including gold-palladium, which costs about half the price of platinum, and certain nickel-chromium and iron-silicon-alloys.

Royal Institution.—A general meeting of the members of the Royal Institution was held last Monday, Sir James Crichton-Browne, J.P., F.R.S., treasurer, in the chair. His Grace, the Duke of Northumberland was elected president and Sir Thomas Wrightson, Bart., was elected a visitor. The treasurer announced that the managers at their meeting had appointed Sir James Dewar, F.R.S., Fullerian professor of chemistry.

Improvements in Hydro-Electric Plant.—Mr. J. P. Jollyman, in the "Journal of Electricity," gives some account of the improving efficiency in hydro-electric plant used in the United States. One Pacific company has obtained an over-all efficiency of 77 per cent., while the best attainable efficiency obtained from impulse wheels is estimated at 82 per cent. and with Francis turbines from 85 to 87 per cent. Importance is attached to accurate continuous records of the amount of water supplied to hydro-electric plant by Venturi meters. Improvements in efficiency may be often achieved by change in the form of the buckets—*e.g.*, if the latter are obsolete in type, pitted or holed through use, or worn at the entrance to any appreciable extent.

Rivetless Ships.—Since the outbreak of war electric welding has been of great value in the repair of ships, and according to "Marine Engineering," it may even prove a substitute for rivetting in the near future. This point is being tested in four large ship-building yards in the United States, and the results so far are highly promising. It is hoped that the new process will increase the strength of the joint by at least 25 per cent. and decrease the time necessary to complete a hull by 50 per cent. The saving in labour will, however, possibly be the greatest gain, and has been estimated at 60 to 70 per cent. At present plates are being lap-welded, but ultimately but-welding may be used. There remains, however, a certain amount of rivetting necessary in attaching plates to frames. It is estimated that 30 welders can do the work of 125 rivetters.

A New Heat Insulator.—A new heat insulating material is being produced in Sweden which is said to be very promising. The chief constituent in this new material is a kind of fine clay found on the island of Mors. This "molera," as it is termed, is very porous, and each grain appears to be hollow. This fact is no doubt largely responsible for the good heat-insulating properties. After it has been burnt the molera becomes extremely light, and therefore a very poor conductor of heat. Before it is burnt, however, it is mixed with cork, bricks of the mixture being burnt, when the cork is consumed. The new insulator is said to be primarily suitable for the lagging of steam pipes and boilers, but may also have uses for the production of sound-proof chambers, and as a medium to check the transmission of vibration.

Data on Incandescent Lamps.—Some indications of progress in the manufacture of incandescent lamps are given in an article by H. W. Mateer in the Canadian "Electrical News." Gas-filled lamps are now being made for 75, 100 and 150 watts suitable for burning in any position. The life of these lamps is rated similarly to that of lamps used with the tip downwards—namely, 1,000 hours. Such lamps are stated to consume 0·78–1·09 watts per mean spherical candle-power, according to size. Some information is also given on the new lamps having blue glass bulbs designed to imitate daylight. These lamps are stated to work at 1·12–1·58 watts per mean spherical candle-power, which must be considered a very moderate consumption in view of the special colour value assigned to them.

Regenerated Rubber.—According to "Engineering," objects made of a new regenerated rubber product called Agatit were shown by Prof. M. Le Blanc at the April meeting of the Bunsen Gesellschaft. This product has been worked out in the institute for Physical Chemistry of the University of Leipzig by Le Blanc and Lüttke, in conjunction with industrials. It is supplied either in a fine emulsion or colloidal solution, which is convenient for many applications, or as a solid. The latter is much used, it was stated, in packing for condensers and on U-boats. It also serves as a substitute for leather, and is in one respect superior to rubber for this purpose, because it can be nailed and sewn. Rubber gloves for medical men and feeders are also made entirely or largely of Agatit. It was mentioned that rubber gloves were hardly obtainable at all in Germany now, whilst these new gloves only cost 2.50 marks.

A New Process of the Fine Deposition of Metals.—According to the "Zeitschrift für Angewandte Chemie," a German patent has been taken out involving a new process for spraying metals on to surfaces of any kind. The metal to be sprayed forms one of the electrodes of an arc, and a blast of gas impinges on this electrode, directed, however, in such a manner as not to play on the arc and extinguish it. The gas used for the blast is of a non-oxidising nature, and its effect is to carry away fine particles of metal, which can thus be deposited on any kind of surface forming a very thin skin. When polyphase currents are used the electrodes may either be convergent or so placed as to cross the streams of gas. In one form of the apparatus the arc is started by means of the instantaneous discharge from an auxiliary high-tension circuit.

Telegraphy Through the Ground.—Some months ago interest was excited in France by the report that the German army is using a method of communication known as "telegraphy through the ground." The method appears to be a compromise between wireless and one-wire telegraphy. The two communicating stations are not connected by wire. According to "Le Matin" a wire is placed along the fighting front with both ends extending into the ground, and current from a Rhumkorff coil or kindred apparatus is conveyed along it. Installed parallel to this wire, and some distance in advance of it is another similar wire, in which current is induced by the

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first, thus permitting the sending of signals. The method is thus broadly similar to wireless, except that the ground forms the medium instead of the air. One would imagine, however, that although the method has the advantage that there are no intervening communicating wires to be cut, it would not be very difficult to tap such messages.

The Chemistry of the Flaming Arc.—While the developments of gas-filled incandescent lamps have rather modified the position of the flame arc as an efficient illuminant, it is too soon to judge how far the latter will retain its position for illuminating large areas in the future. Meantime it is worth noting that the possibilities of further development in flame arcs are far from being exhausted. In particular the chemistry of such arcs deserves study. An interesting investigation of this aspect, comprising experiments on a great variety of luminescent materials, was recently contributed by Mr. W. R. Mott, and appeared in the "Transactions" of the American Electrochemical Society. While the author does not record any very striking effect from the standpoint of more efficient light-production, the information given regarding the effect of various metals on the nature of the flame and the character of the crater is quite interesting. To one who has studied this subject, a mere glance at a magnified image of the arc affords information of its contents, and, in fact, presents a simple form of qualitative analysis.

Peat and Wood for Fuel.—Several Papers recently read before the Société Vaudoise des Sciences Naturelles discuss forms of fuel alternative to coal, of which there is a great shortage in Switzerland. Special machines for cutting peat are in use. Coal delivered at Lausanne has a calorific value of about 13,000 B.Th.U., and costs £4. 16s. per ton. Assuming that the calorific value of the peat is about half that of coal, and further that for various reasons, including difficulties in transport, two British Thermal Units from peat are only equivalent to one of coal, the cost of peat should be near 22s. 6d. in order to compete with coal. Actually the prices being paid are in excess of this figure. Another alternative to the Swiss householder is to use wood for fuel. The forestry laws in Switzerland are strict on this point, but if some relaxation could be made the temporary diminution in the wooded area could probably be made good in 15 to 20 years. A list of calorific values of various kinds of wood was presented by the author, Mr. A. Barbey, who suggested that pine and fir should be used for furnace work, and beach reserved for grates in the home.

Carrying Capacity of Copper Bus Bars.—In a recent issue of the "Electric Journal," Mr. F. M. Billheimer discusses the carrying capacity of bus bars, and in particular the possibility of increasing the capacity of very large bars by means of lamination. It is evident that a conduct or large enough to carry several thousand amperes could be replaced by several smaller conductors having the same superficial area greater than that of the single bar, but a smaller cross-section. In the case of alternating currents, skin effect and mutual induction must also be considered. For laminated bar conductors arranged with vent-ducts and carrying alternating current the distribution is made as nearly uniform as possible by separating the conductors to the most convenient limit, and keeping the thickness of individual bars to a minimum. No exceptional mechanical difficulties in applying such methods are encountered in handling currents from 2,000 to 3,000 amperes. For heavier currents differences in the method of treating bars for direct and alternating current may be needed. Tables and curves illustrating the effect of spacing on current-carrying capacity for direct and alternating currents, temperature, &c., are presented.

Mineral Developments in Germany.—In "L'Industrie Electrique" some information is given regarding researches recently carried out in Germany on the full utilisation of certain varieties of fuel and mineral ores. Coal treated at ordinary temperatures with sulphuric acid has been found to produce a viscous mineral oil of a yellow colour, while by treatment at a high temperature with napthalene in presence of chlorine an oil suitable both for lighting and power purposes is said to have been obtained. Lignite is being largely used especially in factories producing nitric acid from the air, and a process has been discovered which doubles the yield of paraffin from this material. Improvements are constantly being made in the fixation of atmospheric nitrogen, and the latest methods are said to give results 80 per cent. better than was formerly obtained. A considerable amount of work has been done on the extraction of scarce metals from low-grade ores and in the manufacture of alloys to replace copper, brass and bronze. Among the latter, alloys of zinc and lead are important. It has now been found possible to work copper schist containing only 0·7 per cent. copper, whereas 2·5 per cent. was previously the economic limit. Similarly, the grade of nickel ore that can be profitably worked has now been reduced from 2·5 to 1·5 per cent.

A Code on Lighting School Buildings.—A recent issue of the "Transactions" of the Illuminating Engineering Society in the United States contains the revised "Code on Lighting School Buildings," issued by the Committees on School Lighting and Legislation. In its general tenor the code follows principles very similar to those adopted by the joint Committee of the Illuminating Engineering Society in this country shortly before the war. Great importance is attached to the shading of lamps, proper distribution of light, and maintenance of lamps and accessories in good condition. It is recommended that ceilings and friezes should be white or cream, so as to have a good reflecting value, and that walls should be light grey, light buff, dark cream or light olive green; walls, desk-tops and other woodwork should have a dull finish. The following recommendations are made on the subject of intensity of illumination :—

Nature of work.	Illumination (foot-candles). Minimum.	Good practice.
Storage spaces	0·25	0·5—1·0
Stairways, corridors, &c.	0·5	1·0—2·5
Gymnasiums	1·0	2·0—5·0
Rough shop work	1·25	2·0—4·0
Auditoriums, assembly rooms	1·5	2·5—4·0
Class rooms, study rooms, libraries, laboratories, blackboards	3·0	3·5—6·0
Fine shop work	3·5	4·0—8·0
Sewing, drawing, &c.	5·0	6·0—12·0

Obituary.

W. PERREN MAYCOCK.—We regret to record the death of Mr W. Perren Maycock, which took place on Saturday last.

Mr. Maycock, who was born in London in 1865, entered the works of Messrs. Fuller & Son, at Bow, in 1882, and spent seven or eight years in the shops of that and other firms. In the evenings he studied at Finsbury Technical College under Profs. Ayrton and Thompson. Mr. Maycock's teaching work commenced when, at his employers' request, he delivered a course of lectures to his fellow-workmen on the then comparatively novel subjects of electric lighting and transmission of power. Subsequently he was head of the electrical engineering department of the Croydon Polytechnic for some time.

Mr. Maycock contributed numerous articles to the technical press, and was the author of several well-known text books on electric lighting and power distribution, wiring, switching, &c. Recently he was engaged by Messrs. A. P. Lundberg & Sons, and he was responsible for the conduct of this firm's popular scheme of electric light switching examinations. Mr. Maycock, who was a member of the Institution of Electrical Engineers, leaves a widow and two boys.

Personal.

Lieut.-Col. Vignoles' many friends in the electrical world will be pleased to learn that he has recently been awarded a bar to his D.S.O.

Arrangements for the Week.

TUESDAY, July 9th.

JUNIOR INSTITUTION OF ENGINEERS—NORTH-EASTERN SECTION.

7.15 p.m. At the Mining Institute, Neville-street, Newcastle-on-Tyne. Paper on "Raw Hide Gears," by Mr. T A Henderson.

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An Experimental Study of the Fahy Permeameter.*

By CHARLES W. BURROWS and RAYMOND L. SANFORD.

This permeameter was devised by F. P. Fahy, of the Pennsylvania Railroad Co., for the purpose of comparing the magnetic properties of two similar specimens of steel. There is comparatively little difficulty in measuring the magnetic induction.

The difficulties of measurement centre about the determination of the magnetising force, which has, in general, a number of components. The principal component is due to the magnetising current flowing through a coil of wire, which is susceptible of calculation. The other components are due to magnetic poles developed in the different parts of the magnetic circuit due to joints, yokes, non-homogeneities, &c. These components are not susceptible of calculation. They can, however, generally be measured and in some special cases may be neutralised by means of auxiliary magnetising coils.

The method of compensating for the effect of the yokes and joints by means of auxiliary magnetising coils has received considerable development by Searle, Esterline, Picou, Burrows, Ewing and others.

The joint reluctance of such accessories may be determined experimentally once for all by means of measurements in a given apparatus of a standard bar whose true magnetic constants have been determined in some other way. This is the procedure of the Physikalisch-Technische-Reichsanstalt, where a massive iron yoke is used to bridge the ends of the test specimen. The apparatus is calibrated in terms of the values obtained on an ellipsoid of revolution first measured magnetometrically and later machined down to a cylinder.

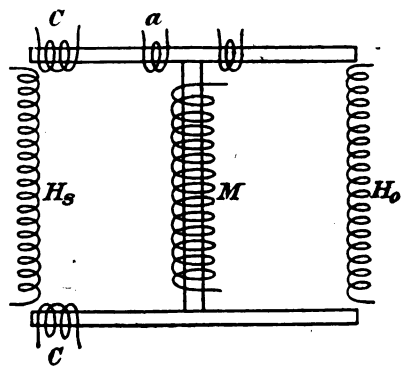

FIG. 1.—MAGNETIC AND ELECTRICAL CIRCUITS IN THEIR SIMPLEST FORM.

This method consists in the measurement of the difference of magnetic potential between the ends of a test specimen. Provided there is no source of M.M.F. between the ends of the specimen, this magnetic P.D. is the total M.M.F. required to maintain the flux in the specimen. If there is such a source of M.M.F., then the P.D. measured between its ends is the algebraic sum of the impressed M.M.F. and the drop in the specimen.

The Fahy permeameter, which is the subject of the present Paper, utilises this latter principle.

THEORY.

The basis of operation of this instrument is apparent from a consideration of Fig. 1, which shows the circuits of the instrument in their simplest form. The apparatus is H-shaped, with two test coils, H_0 and H_s, spanning the free ends of the H, and a magnetising coil, M, wound on the cross-piece of the H.

By reason of the symmetry of the two parallel magnetic circuits thus formed it is evident that the magnetising coil produces the same amount of flux in the two equal coils H_0 and H_s, and that either one may be used to measure the M.M.F. drop between the yokes, and from this value the mean magnetising force may be calculated.

If now we span the yokes by a steel bar placed within the coil H_s, the above conditions do not hold exactly. The H_0 coil still measures the M.M.F. drop between the pole faces which it spans. This drop, however, is not equal to the drop between the other pole faces. Due to the increased flux density in the yokes adjacent to the specimen, a greater proportion of the M.M.F. is used to force the greater flux through one set of yokes than through the other set. Consequently, since the available M.M.F.s in the two parallel magnet circuits are equal, the P.D. caught by the coil H_s is less than that caught by the coil H_0.

The magnetic P.D. between the ends of the coils can be reduced to equality by means of compensating coils, C, wound on the yokes near the pole faces. The criterion of proper adjustment for this compensating M.M.F. is equality of leakage through the air on the two sides of the apparatus. The leakage on each side is measured by means of a short coil, a, wound on the yoke near the core and connected differentially in series with the main test coil H_s. The two test coils, of course, have the same number of turns.

After the adjustment is made the magnetising force and magnetic induction may be measured in terms of the E.M.F.s induced in the coils H_0 and H_s on reversal of the main magnetising current. In the original Paper a full description of the apparatus and detailed instructions for the manipulation are given in the appendix.

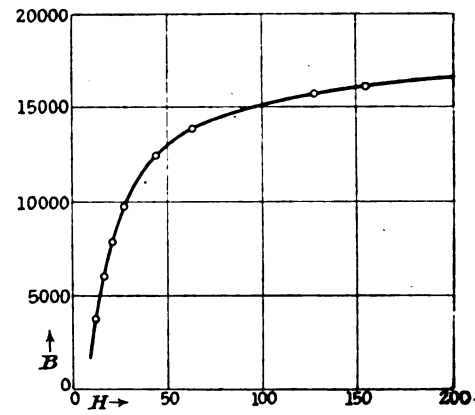

FIG. 2.—SHOWING CONSISTENCY ON REPETITION.

The solid curve represents a first determination and the circles represent points taken after removal of the specimen and reinsertion.

Consistency of Repetition.—The ability of this apparatus to repeat readings on the same specimen under the same conditions is all that could be desired. This is shown very clearly by Fig. 2, where the solid curve represents a first determination and the circles represent points taken on the same bar after it had been removed from the apparatus and reinserted. The consistency is so good that this apparatus may be used to detect small changes in magnetic characteristics, due to ageing, mechanical strains, or differences due to small variations in heat treatment.

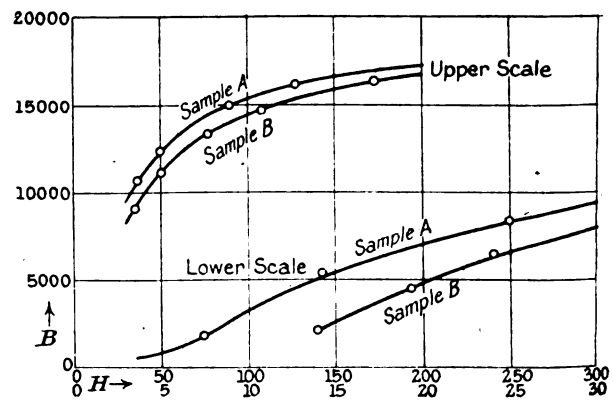

FIG. 3.—SHOWING VALUES OBTAINED BY THE METHOD OF COMPARISONS.

The solid curve represents the normal induction by the standard method and the circles represent points taken by comparison with a standard bar.

Length of Specimen and Reluctance of Joints, &c.—This apparatus is designed to take specimens of a fixed length. The particular piece of apparatus under investigation was designed for a specimen 25·4 cm. long. However, it frequently happens that it is necessary to test other lengths. Sometimes one wishes to know the magnetic characteristics of a portion of a long bar without cutting the bar. With this in view the end of a long bar was measured once with the whole bar intact and the free end projecting beyond the back pole face, and again with the excess portion of the bar removed.

* Abstract of scientific Paper (No. 306) issued by the Bureau of Standards (Washington).

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It was found that no appreciable error is introduced by the projecting end of the test specimen, provided this projection extends beyond the back yoke of the apparatus.

It is to be expected that in apparatus of this type the reluctance of the surface of contact will affect the accuracy. To get some idea of the magnitude of the influence of the joint reluctance, measurements were made with paper inserted between the specimen and the pole faces. In the original Paper curves are presented showing that a thickness of paper of 0·2 mm. may produce up to about 14 per cent. difference in induction; the effect of scale is very much less. However, in actual practice there is no such air gap. Imperfect contact is due either to the warping of the specimens, so that they do not seat well upon the pole faces or to the presence of scale. The paper separators undoubtedly cause a greater joint reluctance than would occur in practice.

Pieces of iron in contact with the test coil pole faces during measurement will cause an appreciable error. However, such a situation could arise only intentionally and need not be considered further. Pieces of iron placed otherwise than in very close proximity to the magnetic circuit do not produce any serious error. Some tests on this point are described in the original Paper.

In general, it is safe to say that all masses of iron at distances from the permeameter greater than a few inches are without any appreciable effect.

A very interesting point was brought out in an attempt to discover whether the exact position of the specimen on the pole face made any difference. With this in view, measurements were made with the specimen seated symmetrically on the pole faces, and with the specimen making contacts on the lower portions of the pole faces.

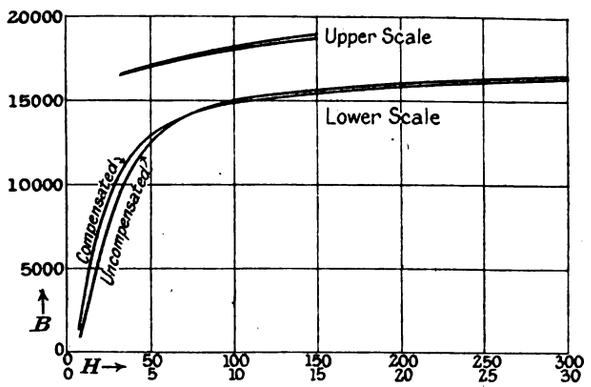

FIG. 4.—SHOWING NORMAL INDUCTION CURVES FOR THE SAME SPECIMEN WITH AND WITHOUT COMPENSATION.

The effect of strain may be either an increase or a decrease in permeability. Variations of the order of 2 to 10 per cent. were noted. Whether the change in permeability is an increase or decrease depends in all probability upon whether the tension or compression along the length of the specimen predominates. The observed differences can not be due entirely to an improvement in magnetic contact because the strained material shows a lower permeability in spite of the improved contact conditions.

ACCURACY.

In order to determine the absolute accuracy of the measurements taken by this permeameter a number of bars were measured in both the Burrows and the Fahy permeameters. The test rods for this investigation were taken from the magnetic standards of the Bureau. These standards have been carefully prepared and aged. They have been examined for magnetic uniformity, and are the best magnetic standards at present obtainable.

Measurements by the Burrows permeameter and the permeameter under examination for seven different materials were in every case within 5 per cent. of the true value. Such accuracy is all that is required by most commercial needs.

While the absolute method is the one most generally employed, it is of interest to note the accuracy that is obtainable when readings are taken by comparison with a standard. In Fig. 3 the full-line curves represent the true normal induction, while the circles indicate readings on the Fahy permeameter by comparison with a standard. It will be seen that the agreement is exceedingly close, nowhere showing a difference as great as 5 per cent. in the magnetising force required for a given induction.

UNCOMPENSATED DATA.

Fig. 4 gives two induction curves as obtained by this apparatus. In one the compensation is made, while in the second there is no compensation. A comparison of these data with the curves of the error introduced by failure to compensate is no greater than the error existing in several of the types of permeameters now in use. This permeameter may be used without compensation in certain kinds of shop testing. Such tests may be desirable where comparative results only are desired. No erroneous conclusions as to the relative merits of the two steels need be drawn. In materials very nearly alike the corrections would be nearly identical, so that the differences between the compensated and the uncompensated results would be the same. The advantage, of course, in omitting the compensation lies in the greater speed of operation.

The Fahy permeameter represents a distinct advance in the measurement of magnetic characteristics of steel and other magnetic materials. In accuracy it far excels the direct-reading permeameters which have been rather commonly used both in this country and abroad. Normal induction measurements of solid bars show errors no greater than 5 per cent. of the magnetising force required for a given induction. The consistency of its readings taken at different times on the same specimen is so close that comparative results on similar materials can be obtained to a much higher degree of precision. Commercial materials, however, are seldom uniform enough to warrant better precision than 5 per cent. Hysteresis measurements are accurate within certain limits of commercial requirements and the uniformity of commercial materials.

The apparatus has not as yet been adapted to the measurement of sheet materials, but preliminary experiments indicate that such adaptation is entirely possible.*

Yield of Electro-Chemical Products.

The following figures of yields were given in a recent issue of the "Journal" du Four Electrique :—

—	Kilos per kw.-year.	Units per ton.	Cost per ton at ¼d. per unit.	Cost per ton at ½d. per unit.
Ferrous and Allied Alloys.				
Manganese, pure	140	58,000	£181 5 0	£60 8 4
Nickel ferro, 50%	300	27,000	84 7 6	28 2 6
Silicon ferro, 90%	400	20,000	62 10 0	20 16 8
Silicon ferro, 75%	600	13,500	42 3 9	14 1 3
Chromium ferro, 8%	800	10,000	32 5 0	10 15 0
Molybdenum ferro	900	9,000	28 2 6	9 7 6
Silicon ferro, 50%	1,000	8,000	25 0 0	8 6 8
Tungsten ferro, 50% carbon	1,000	8,000	25 0 0	8 6 8
Iron, electrolytic, pure	2,000	4,000	12 10 0	4 3 4
Iron, cast (fine ordinary, rich ore, 50% 60% initial material)	3,500	2,300	7 3 9	2 7 11
Iron, cast (synthetic, produced from scrap iron, turnings and ore)	9,000	900	2 16 3	0 15 5
Iron, cast (synthetic, produced from steel turnings	10,000	800	2 10 0	0 16 8
Manganese, ferro	10,000	800	2 10 0	0 16 8
Steel, fine (*cold* charge, initial material	11,000	750	2 6 10	0 15 7
Steel, ordinary "castings" (cold charge with turnings)	14,000	600	1 17 6	0 12 6
Steel, tool (*liquid* charge, initial material)	20,000	400	1 5 0	0 8 4
Steel, refined (basic, direct from converter)	40,000	200	0 12 6	0 4 2
Steel, refined (acid)	80,000	100	0 6 3	0 2 1
Mangano-silicon, silicon spiegel, according to composition	...	...	...	...
Non-Ferrous Alloys.				
Calciummetallic	140	58,000	181 5 0	60 8 4
Manganese, pure	140	58,000	181 5 0	60 8 4
Aluminium 98% to 99%	250	32,000	100 0 0	33 6 8
Carborundum, crystallised	300	27,000	84 7 6	28 2 6
Magnesium	300	27,000	84 7 6	28 2 6
Carborundum amorphous	500	16,000	50 0 0	16 13 4
Sodium, metallic	550	15,000	46 17 6	15 12 6
Zinc, electro-thermic	1,200	6,800	21 5 0	7 1 8
Copper, electro-thermic	2,500	3,200	10 0 0	3 6 8
Copper, electrolytic	90,000	90	0 5 7	0 1 10
Chemical Compounds.				
Lime, synthetic nitrate of	300	27,000	84 7 6	28 2 6
Aluminium, nitride of (20% nitrogen)	1,600	5,100	15 18 9	5 6 3
Calcium carbide	1,700	4,800	15 0 0	5 0 0
Chlorine, electrolytic	7,000	1,150	3 11 10	1 3 11
Potash, chlorate of	7,000	1,150	3 11 10	1 3 11
Soda, electrolytic	7,000	1,150	3 11 10	1 3 11

* We understand that the British agency for the Fahy permeameter is in the hands of Mr. G. H. Alexander, of Coleshill-street, Birmingham.—ED., *E.*

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The Test Sheath Cable and its Potentialities.

During the I.M.E.A. Convention in Manchester on June 20th and 21st, at the invitation of Messrs. W. T. Glover & Co. (Ltd.), parties of I M.E.A. members attended a lecture and demonstration by Mr. C. J. Beaver, M.I.E.E., on the above subject in the Electrical Research Department of the firm's works in Trafford Park.

The following is an outline of the lecturer's remarks and experiments :—

The maintenance of cables in the past has been, he said, very far from ideal. In most cases little knowledge as to the existence of faults has been available until the trouble has arrived at a well-developed stage. Short of that stage, insulation resistance values, even though faithfully recorded at regular periods, meant little.

Intelligent comparison of figures and interpretation of test results has been difficult.

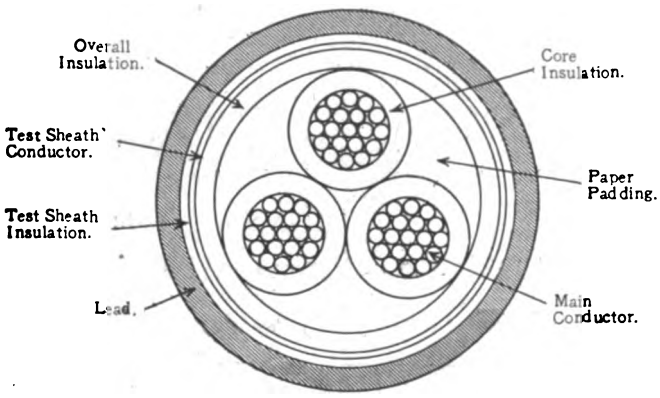

FIG. 1.

Much depended on the type of cable and the method of laying ; for instance, in the case of lead-covered armoured cables laid direct in the ground, although faults were generally of comparatively low resistance and readily declared themselves, it frequently happened that they burned themselves clear. On the other hand, in the case of non-lead-covered cables laid solid, the faults were usually of high resistance, and did not readily declare themselves until they had arrived at a considerably advanced stage; moreover, they were very difficult to locate.

It was generally accepted among cable users that more than 90 per cent. of faults which occur arise from extraneous causes, including joints. The majority of these extraneous faults were of a mechanical character, and these varied from heavy local damage to slowly-developing fractures, such as arose from expansion and contraction, vibration, subsidence, &c. Other extraneous causes, such as electrolytic action, were insidious and difficult to detect by tests, not only because of their slow development, but because the conditions which gave rise to them might be local and unforeseen. Faults from interior causes were very rare in modern well-made cables.

The time element in the development of faults was very important from the maintenance point of view. It was well known from post-mortem investigations that periods of months and even years were often involved in cases of breakdown from extraneous causes, but comparatively little was known about the time element in the case of internal failures, because the final burn-out usually masked or destroyed the evidence of cause. There were, however, good grounds for believing that the period of development was, in many cases, much longer than was commonly supposed.

Again, in heavily-insulated cables, such as are used for pressures of 30,000 volts and upwards, the chances of early detection of the ingress of water were remote, because much moisture might be absorbed and distributed laterally in the dielectric before it penetrated radially inwards to a sufficient extent to be traceable by insulation resistance tests.

It was therefore clear that it would be very advantageous if faults were readily detectable in their incipient stage, not only because widespread damage and interruption of supply would be obviated, but because in many cases the *causes* of such faults could be diagnosed and eliminated.

The Test Sheath cable (illustrated in Fig. 1), first described in the lecturer's Paper on "Cables," published in the "Journal" of the I.E.E., Vol. LIII. (Patent No. 22,355/12), was designed with the object of putting the miantenance of cables on a much higher plane of efficiency than hitherto possible, by providing for the detection of faults in their incipient stage.

It would be seen that the test sheath construction was such that *injurious effects from outside and leakage from inside the cable were bound to be intercepted by the test sheath conductor.* This, the lecturer pointed out, was the root principle on which the system of detective and protective devices referred to later was based.

Fig. 2 shows detective arrangements based on this principle designed for use with the cable "alive."

By switching the electrostatic voltmeter on to the test sheath conductor, an indication is obtained of any appreciable leakage to it from the main cores. The voltmeter or ammeter gives facility for examining the degree of leakage.

The fourth position on the switch connects the test sheath to an ordinary test set (such as the Kelvin), and enables the insulation resistance of the test sheath insulation to be determined. The test set also gives facilities, in conjunction with the uniform test sheath conductor (of accurately known resistance) for fault location by fall of potential methods.

The speaker emphasised the fact that the whole dielectric of the cable could thus be explored under working conditions, *leakage from inside* being indicated by the electrostatic voltmeter and measurable by volt or ammeter, *while injury from outside* was discoverable by the use of the test set. With these arrangements, therefore, an incipient fault from either internal or external causes was detectable, and its development traceable ; and, in the case of an external fault, its position was locatable.

The extremely important point was that all this advance information was rendered available without interrupting the supply or isolating the cable, and, in addition, the tests might be made as frequently as desired.

The detective arrangement illustrated in Fig. 2 has been in use on 6,600-volt feeders on an important power supply system for the past 18 months, and on one occasion an incipient fault from an external cause was discovered by the insulation resistance test and located by a fall of potential test along the test sheath conductor while the feeder continued to supply power at 6,600 volts. The lecturer added that the mains log book of the power company in question was, by the courtesy of the chief engineer, available for the inspection of the visitors.

Obviously, other devices might be used in place of, or in addition to, the equipment referred to, so as to give, for instance, visible or audible signals.

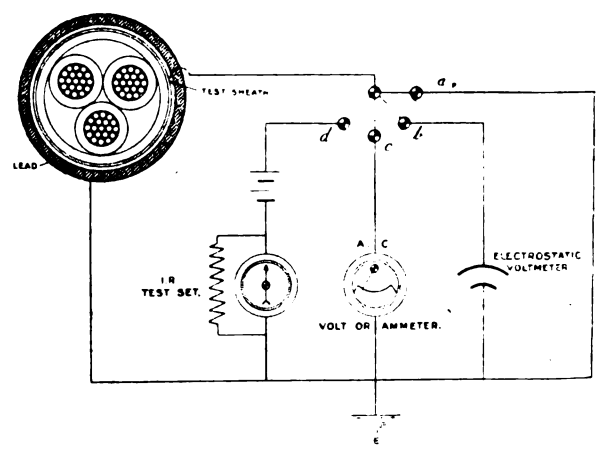

FIG. 2.

With the facilities afforded by such an arrangement an engineer might, on discovery of a fault, judge the necessity for prompt isolation of the cable, or the feasibility of deferring such action ; moreover, before isolating the cable, he could expose and examine the locality of the fault and possibly make preparations to repair it at a convenient time. In other words, he was enabled to take full advantage of the time element in the development of the fault.

With regard to the protective system—diagrammatically illustrated in conjunction with the detective devices in Fig. 3—the lecturer pointed out that its design followed the principle already enunciated with regard to the test sheath cable and its detective arrangements—viz., the interception of both internal and external effects by the test sheath conductor.

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The logical development of this principle resulted in what was virtually a special combination of leakage and core balance protection, which, in turn, permitted the operation of the protective gear to be accomplished in two steps (which might be regarded as preparatory and confirmatory), whether the faulty condition arose from external or internal causes. Subsidiary indicating or warning signals (not shown in the diagram) could, of course, be used to show the completion of the preparatory step.

It would be clear that this two-step operation allowed full advantage to be taken of the time element in the development of the fault, exactly as in the case of the detective arrangements; this constituting an important advantage over other protective systems. It also rendered the protective system absolutely discriminating, because the isolation of the feeder was dependent on the trip circuit current actually passing through the test sheath conductor.

It would be obvious from the diagram (Fig. 3) that the trip circuit current could not pass on a sound feeder, because the following conditions—in the sequence shown—had to be fulfilled for the operation of the trip coil

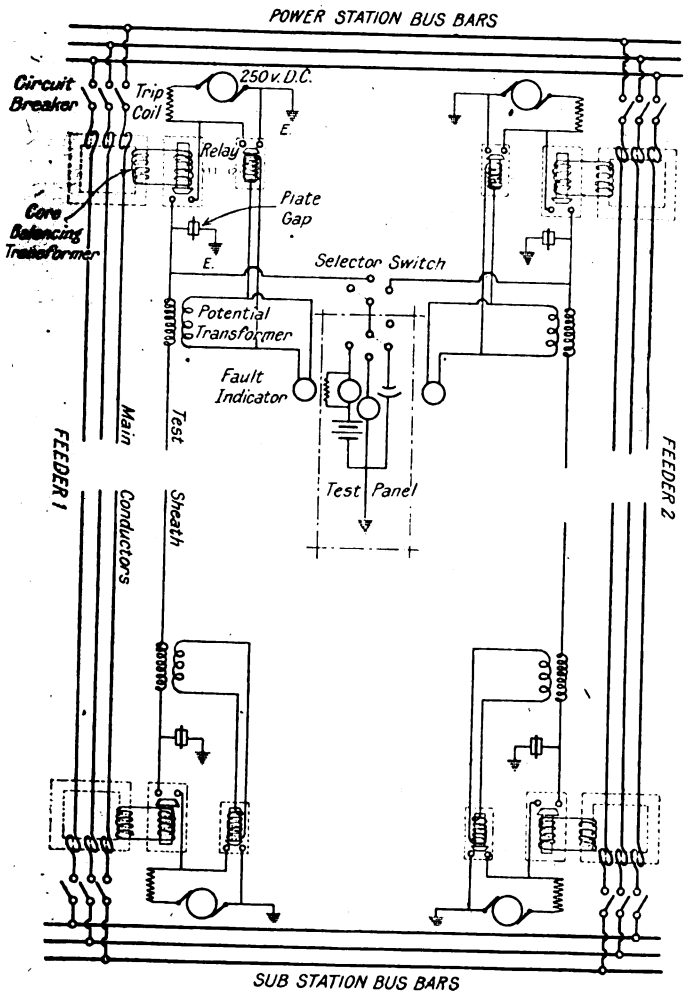

FIG. 3.—DIAGRAM OF SYSTEM.

(*a*) If the source of fault was *external*:—

1. The test sheath conductor was earthed.
2. Relay 1 was actuated by disturbance of the core balance

(*b*) If the source of fault was *internal*:—

1. The core balance was upset, actuating Relay 1.
2. Test sheath conductor was earthed (by breakdown of plate gap or by burn-out of test sheath insulation).

As the earthing of the test sheath conductor was therefore essential to the operation of the trip coil, it followed that very definite discrimination between sound and faulty feeders was attained.

The demonstration was carried out on a 225 yds. length of 0·1 sq. in. three-core, Diatrine-paper lead-covered double-wire armoured cable, carrying about 100 amperes per phase, with a pressure of 6,600 volts between phases. The detective instruments and the protective relays and plate gap were mounted on one panel, a few feet away from the circuit-breaker and instrument panels of the main power supply.

The experiments shown by the lecturer on the cable under these working conditions represented:—

1. Breakdown from *external* cause:—

(*a*) Slight damage, perforating the lead sheathing and allowing ingress of moisture.

(*b*) Heavy damage, penetrating to cable core.

2 Breakdown from *internal* cause

In the case of 1 (*a*) the first stage was represented by the insertion of an artificial fault (consisting of a thin pad of damp paper between plates connected to test sheath conductor and lead covering respectively) in the test sheath dielectric.

This was clearly indicated on the test set galvanometer.

The next stage—the gradual rise of potential on the test sheath conductor—was shown on the electrostatic voltmeter; the final stage of development representing current leaking from core to test sheath conductor causing an out-of-balance in one phase of about 30 amperes, resulting in the operation of Relay 1, the completion of the trip circuit via earth and the test sheath conductor, and the consequent tripping of the circuit breaker.

In the case of 1 (*b*) the conditions were represented by earthing the test sheath conductor and setting up the out-of-balance condition practically simultaneously, causing immediate tripping of the circuit breaker.

In the case of 2—the unusual case of breakdown from an internal cause—the first indication was seen on the electrostatic voltmeter, and when this had increased to about 1,000 volts the plate gap punctured, earthing the test sheath conductor, causing the potential transformer to be energised and operating Relay 2.

With regard to the matter of safety of operation, it was pointed out that the plate gap was a complete protection so far as the operator was concerned, and the high reactance of the primary of the potential transformer safeguarded the apparatus connected to the test sheath conductor.

A special method of bridging the test sheath conductor across joints was illustrated by a joint made between the cable above referred to, and a short length of unarmoured cable of the same size and type. The main cores were jointed in the usual way, and were surrounded by an openly woven network of insulated wires, subsequently drawn over the main cable joint, the trimmed ends of the wires being gathered together, bound down and soldered to the exposed ends of the copper tape test sheath conductor on each side of the joint.

The insulation of the wires of which the network or "stocking" is composed consisted of braided coverings, the stocking as a whole being impregnated by the jointer immediately before fixing in position over the joint.

In this way, it was pointed out, the continuity and insulation of the test sheath conductor was efficiently maintained across joints, and the essential condition of sheathing the main conductors was attained without interfering with the efficient filling of the joint with insulating compound.

The advantages claimed for the whole system were briefly summarised by the lecturer as follows:—

Facilities for exploring the whole dielectric of live cables.
Advance information of the earliest stages of fault development.
Facilities for tracing development and locating position of external faults without interrupting supply or isolating the cable.
Complete and discriminating protection in case of complete breakdown.

And, finally, that these advantages gave the user much more information as to the condition of his cables; afforded much greater scope for reasoned and discretionary action on his part than has hitherto been possible, and generally gave much better facilities for efficient maintenance than have previously been available.

The lecturer added that test sheath cables had been supplied during the past five years in large quantities for extra-high-tension power supply networks at home and for special and important power cables crossing rivers in India and South America.

Book Received.

[Copy of the undermentioned work can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"Annual Report of the Smithsonian Institute, for 1916." (Washington: Government Printing Office.) Pp. xii.+607.

"The Metric System in Export Trade." By Mr. F. A. Halsey (New York: American Institute of Weights and Measures.) Pp. 71.

"Studies in Electro-Physiology (Animal and Vegetable)," by Mr. A. E. Baines. (London; George Routledge & Sons, Ltd.) Pp. xxix.+291. 12s. 6d. net.

"Methods of Measuring Temperature," by E. Griffiths, D.Sc. (London: C. Griffin & Co., Ltd.) Pp. xi.—176. Price 8s. 6d.

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Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

Summary.—The Author deals with the technology of the electric winding engine or mine hoist. In this article, which is the first of the series, the scope of the work is defined, and notes of general interest are given on the question of power supply.

It may not be out of place to give a short prefatory statement setting out the origin of this article. Prior to 1914 the author had under him a number of well-grounded engineering students, and it was his endeavour to teach them how to solve the everyday problems of the engineer's office. In course of time the problems increased in variety and interest. During several sessions many winding engines and mine hoists were analysed, but the idea of writing on the subject did not occur to him till some time afterwards, when his work brought him into contact with winder problems.

In the work referred to it was his good fortune to be associated with men who were willing to teach and, through the kindness of his colleagues, to have access to the papers dealing with the electrification of a considerable number of winders. These papers enabled him to make his examples of a strictly practical character, and to fill in many of the blanks in his notes on subjects of which, at the time they were used in his lectures, he had little direct experience. After filling in the blanks it was thought that the work would be useful for purposes of reference, to those interested in the design, construction and operation of an important part of the machinery connected with a mine, as well as to those students of engineering who desire, and who have the "grit" to acquire, a knowledge of the application of elementary principles to the practical side of their profession.

At the outset, the author wishes to make it clear that he has no intention of writing a treatise on the design of electric winders and electric-winder equipments. Neither he, nor any man of his acquaintance, is competent to undertake such a task. The fact is, that the engineering and allied trades are becoming so highly specialised as to call for experts in every branch. In the design of an electric winder equipment, for instance, it is probable that half-a-dozen specialists would be engaged, together with a small army of draughtsmen working under them. This is the meaning of present-day engineering, and although more costly in the first place, it is a more profitable method in the long run than the cut-and-try method which at one time was practised successfully by engineers of the old school. Even at the present time there are those who are of opinion that a man must be clad in overalls and must have grimy hands to be worth his salt in the works. But there are signs which indicate that some of the most conservative firms are beginning to recognise—or, are being forced to recognise—that the non-producer is not necessarily an unprofitable investment. During the last decade many old-established firms (and in this country it is regrettable to find that old-established frequently means old-fashioned or out-of-date) have learned to their cost that the present generation gauges a man's worth by his own work and not by the work of his ancestors.

Although falling short of a treatise on design it is thought that a collection of constants and data may be helpful to designers, the more so since in their preparation neither time nor effort has been spared to ensure accuracy. The extensive literature has been searched and freely drawn upon, and the many references in the body of the article should be helpful to those requiring further information.

Judging by the appearance of the printed page the non-technical reader will be inclined to call much of the article theoretical or mathematical. Appearances are proverbially deceptive, and the whole of the mathematics fall within the range of a 10-in. slide rule, and of a set of drawing instruments. It is assumed that the reader can use both. If by "theoretical" is meant an endeavour to make good use of fundamental principles we agree that the work is almost entirely theoretical. At the same time many fully-worked-out examples of actual winders have been introduced in order to illustrate the immediate practical applications of the fundamental principles. It is well to remember that by means of methods at least as laborious as, and in some respects more elaborate than, those we are about to describe, engineering firms on the Continent secured orders for winder equipments by the hundred whilst we, with our contempt for "theory," with difficulty secured orders counted by tens. But it should be noted that not even theory will enable firms to sell large amounts of electrical machinery at cost price and, at the same time, declare big dividends. We shall have occasion to deal with the question of cost at some length in subsequent sections.

Had the article been written 10 years ago it would have been necessary to devote considerable space to the commercial side of the subject. From every point of view it is better to leave this side to the mine manager and to fill the pages at our disposal with what we consider to be profitable technical discussion. The installation of over half-a-million horse-power of electrically-driven winding plant in little more than 12 years is highly satisfactory from the commercial standpoint, and mine managers do not install expensive electric winding plant on account of its novelty, nor does the electrical manufacturer run the risk of losing his money, and his reputation, by engaging in the construction of something which he knows to be unsound, merely for the sake of calling it "electric."

Were steam operation more economical than electric operation he would be a poor kind of manager or engineer who used the electric motor in preference to the steam engine. The fact that the electric winding engine has made and is making satisfactory progress, hostile criticism notwithstanding, even in those countries having a plentiful supply of small coal, is the best testimonial to its efficiency.

The view that an abundant supply of small coal—to say nothing of the misuse of the exhaust turbine—makes the steam winder an economical machine is one with which the author does not agree. Rather does he regard the one as a means of supplying electric energy on a very large scale and at a low rate for the benefit of the entire community, and the other as a machine which, indirectly, encourages the waste of our natural wealth and which makes the possibility of an adequate power supply a thing of the remote future by giving an appearance of economy to something which, at root, is uneconomical. Great as is our natural wealth the industries of the country have been and are crippled on account of insufficiency of motive power. Moreover, the existing power stations are so ill-situated with respect to the coal fields that the country during the past three years has been treated to the ridiculous spectacle of power supply authorities buying coal by the truck, and at famine prices, from local coal merchants in order to see the load over the peak. It surely were the height of folly to encourage the introduction of appliances which tend to perpetuate such conditions!

Reference was made above to 10 years' progress in the electrical operation of mining plant and machinery. The adoption of the electric drive by home collieries gives one little ground for real satisfaction. Largely owing to the bovine stupidity of Parliament, and in some cases to please the vanity of consulting engineers, many of these collieries have provided their own generating stations. The idea of the small generating station is economically unsound, and no electric winder drawing its supply from such a station can compare with a modern steam winder either as regards first cost or economy. The author wishes to establish this point at the outset.

Every small generating station that is erected makes it increasingly difficult to drive home the necessity for reform on rational lines. The "Linking-up" committees at present considering the question of connecting together the small generating stations will in all likelihood draw up schemes which, if put into execution, may result in an annual saving

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of millions of pounds sterling; whereas the scrapping of 90 to 95 per cent. of the existing stations, and the erection of relatively few large and properly-situated generating stations, would, *ultimately*, result in an annual saving reckoned in tens of millions of pounds sterling, and would, at the same time, make possible an inexpensive power supply. In the days of the big power station it is to be hoped that it will be made illegal for neighbouring towns to erect their own power stations and for villages to ape the towns.

It must not be forgotten that the recovery of certain industries will imperatively demand an abundant and cheap source of electrical energy. Without exception, the industries referred to will improve the load factor and will, therefore, tend to an all-round diminution in the cost of industrial power. Furthermore, the demand created by these long-hour industries will be so great in the localities in which they are established, that the effect of a number of intermittent machines, such as electric winding engines, will be much less pronounced than at present, and the question as to the desirability of providing appliances for equalising the load will not arise.

There can be no doubt that, taking things as they are, the ideal plan at home is for the colliery company to co-operate with the power supply company, the former supplying waste heat to the latter; the power company guaranteeing continuity of supply to the colliery and offering attractive rates to long-hour consumers in the vicinity. The system, which is in successful operation in the North of England * and elsewhere, is due to the initiative and enterprise of Messrs. Merz & McLellan, and Fig. 1 † shows the daily output and load curve

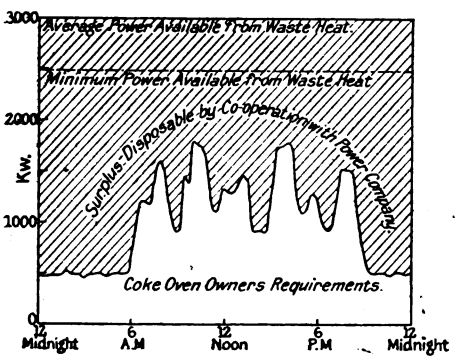

FIG. 1.—APPROXIMATE DAILY LOAD CURVE FOR A WASTE-HEAT POWER STATION.

of a waste-heat station. This station consists of five boilers, each evaporating 17,000 lb. per hour at 200 lb. pressure and 180°F. superheat, and two small boilers each evaporating 8,000 lb. per hour at 235 lb. pressure and 200°F. superheat, with turbo-generating plant aggregating 5,000 kw., the boilers being fired with waste heat and spare gas from a battery of 176 coke ovens.

In commenting on the great possibilities of such a co-operative system, Mr. A. E. du Pasquier † points out how extremely valuable a joint system of this nature or a supply from a power company may be to a colliery, in industrial crises, and how important it may be to be able to wind, ventilate and pump without having to get up steam.

The careful perusal of an article on "Public Electric Power Supply to Collieries," by Mr. W. B. Woodhouse ‡ is recommended. Mr. Woodhouse points out that there are three ways in which advantage may be taken of a public supply: (1) As the sole source of energy, (2) as a user of surplus power, and (3) as a standby.

"Whichever use is made of the supply, the general principle remains unaltered —that public supply, like the public supply of water or of transit facilities, is a form of co-operation in which advantage is taken of certain economic conditions to reduce cost.

"This principle is often obscured by a consideration of details, such as the relative efficiencies of various types of generating machinery; but it is firmly established on sound economic grounds, and the future must see an enormous extension of the use of the public supply."

A perusal of the voluminous discussion that has taken place on the two systems of winding, namely, steam and electric, convinces us that neither side understands the other's speech. Some engineers are of the opinion that when mines have their own power station it is cheaper to adopt an electric winder, even if it means an extension of the power station, on account of the lower operating expenses and attendance. Such opinions would be more valuable were they supported by figures giving the actual or probable saving resulting from an extension of the power station to supply the electric winder. In the absence of figures the author believes that such an extension, instead of being economical, would result in an appreciable all-round increase in the cost per unit, and his belief is based on the many systems of charging that have been devised by power supply authorities so as to enable them profitably to connect to their networks loads of a similar kind.

Other engineers hold the view that for most heavy winding schemes steam operation is the only commercial proposition. The existence of a large number of exceedingly heavy electric winding engines tends to discount this view, as also does the fact that the principal makers of steam winding engines have modified their designs in order that the machines may be electrically-driven.

In certain of the discussions before the engineering institutions, and in articles which have appeared in the technical Press, remarkable figures, supposed to represent working costs, have been given. One is compelled to view with suspicion all records in which small coal is said to be of no value, and in which comparisons are made between an obsolete steam winder and a modern electric winder. If small coal were of no value, the investing of considerable capital, to say nothing of the appointment of State-aided research committees, for the purpose of founding industries having small coal as the raw material, would appear to be misdirected enterprise.

Many of the figures that have been given, by both sides, are based on what the author considers to be wrong assumptions. For instance, the advocates of the steam winder persist in basing their arguments on guaranteed performance when the winder is working to the ideal cycle, whereas the only figure of the least commercial interest is the all-year performance, as it is this which makes or mars the balance sheet. Advocates of the electric winder sometimes base their reasoning on the local power station and introduce terms, such as peak, demand, load factor and diversity, which bewilder the would-be user. Figures as to cost have been given which, if they are not fanciful, are disgraceful. Thus, in one case, a large firm of manufacturers in arriving at the working costs per kilowatt-hour at the power station solemnly declares that the combined wages of a stoker, three assistant stokers, two fitters, one assistant and two electricians in a Belgian power-station amount to 28s. 6d. per day. This corresponds to a trifle over 3s. per man per day! Had the development of the power load to depend for its success upon sweated labour it were better to close down the power stations: but those most competent to judge are of the opinion that the power station will lead eventually to the elimination of such labour from industry. Were it otherwise the author, for his part, would join forces with those who oppose the electric drive.

A striking contrast is furnished by the Rand gold mining field, South Africa, where electrical energy is used to a greater extent than in any other mining centre. The supply area follows the reef over a length of about 50 miles, most of the shafts and surface works lying within a strip of a few miles in width. Power is supplied by the Victoria Falls and Transvaal Power Co., Ltd., and its subsidiary, the Rand Mines Power Supply Co., both concerns being controlled and operated by the same staff. Although this power scheme has been described on many occasions, it is thought that a brief reference may not be out of place since we shall be dealing at some length with the winders in this area. Moreover, there are many undeve-

* Some of the chief waste heat stations in the North of England are described, and the success of the movement generally is indicated in THE ELECTRICIAN (Mining Issue), May 12, 1911, p. 109.

† "Proceedings," South Wales Inst. of Engineers, Vol. XXVIII.

‡ THE ELECTRICIAN (Second Mining Issue), May 12, 1911, p. 45.

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loped areas in Britain which are potentially superior to South Africa from the point of view of power supply.

Fig. 2 * is a skeleton map showing the Power Companies' area of supply. The black dots represent consumers, and the circles the mines not connected to the system. There are four generating stations, three being situated along the reef and one at Vereeniging on the Vaal River, some 35 miles south of Johannesburg. The latter section feeds into the Rand system at Robinson, which may, therefore, be treated as a fourth source of output along the Reef.

The main features and size of the equipment may be gathered from the following figures :—

Number of generating sets	21
Total rated kVA of ,, ...	216,000
Number of large transformers	63
Total rated kVA of ,, ...	382,000
Number of smaller transformers	321
Total rated kVA of ,, ...	302,000
Mileage of 80,000-volt overhead three-phase circuits	136
,, 40,000-volt ,, ,, ,, ...	82
,, 20,000-volt ,, ,, ,, ...	93
,, 20,000-volt underground ,, ,, ...	49
,, 10,000-volt overhead ,, ,, ...	40
,, miscellaneous low-tension ,, ,, ...	21

In addition to the supply furnished by the above companies, three groups of mines, namely, Randfontein, East Rand Proprietary and Kleinfontein, furnish their own power, the three together representing generating plant of approximately 51,000 kW.

Contracts have been entered into for a period of not less than 12 years at 0·525d. per unit as long as the monthly load-factor is above 0·70, the load-factor being based on the hour of maximum consumption. Provision is made for a periodical revision depending on the cost of production, and for a division of profits with the consumers.

Exclusive of winches there were in operation in this area in 1916 no less than 143 electrically-driven winding engines, of a combined continuous rating of about 75,000 H.P., with an average of 520 H.P. The 13 mines of the Central Mining Rand Mines Group, which have contracted with the supply company for the whole of their power requirements, crush about 8·5-million tons of ore per annum, and produce about 36 per cent. of the total gold output of the Transvaal, or about 14·5 per cent. of the total gold output of the world.† Not counting winches, at the end of 1914 there were 69 electric winders in use by or on order for these mines alone.

Since the mines of South Africa work a low-grade ore, said to average about 26s. per ton,* it will be seen that strict economy is essential. The fact that coal having a calorific value of 12,000 British thermal units per pound can be obtained in South Africa at 8s. to 12s. per ton, negatives the idea that the electric winder is less economical than the steam winder when a supply of low-price coal is available. According to Mr. J. N. Bulkley † careful comparisons have shown the costs to be in favour of electric winding, the saving in the case of some of the deep shafts in South Africa amounting to at least 6·25d. per ton, one unlooked-for result being a marked decrease in the cost of maintenance of shaft guides owing to the steadier turning moment of the electric winder.

Those who prefer to think in thousands of pounds per annum, instead of in pence per ton, will find Mr. Bulkley's Paper helpful. In one station under his charge it appears that a complete change from steam-drive to electric was made. At the time of the change the milling capacity was increased from 15,000 to 17,000 tons per month, and a new compressor having 33 per cent. more capacity installed. A study of the steam power costs for the last two years the plant was in operation and electric power costs for a year's service showed the saving in favour of the electric drive to be £8,400 per annum, without making any allowance for the increased power required by the additional tonnage treated and additional air supplied.

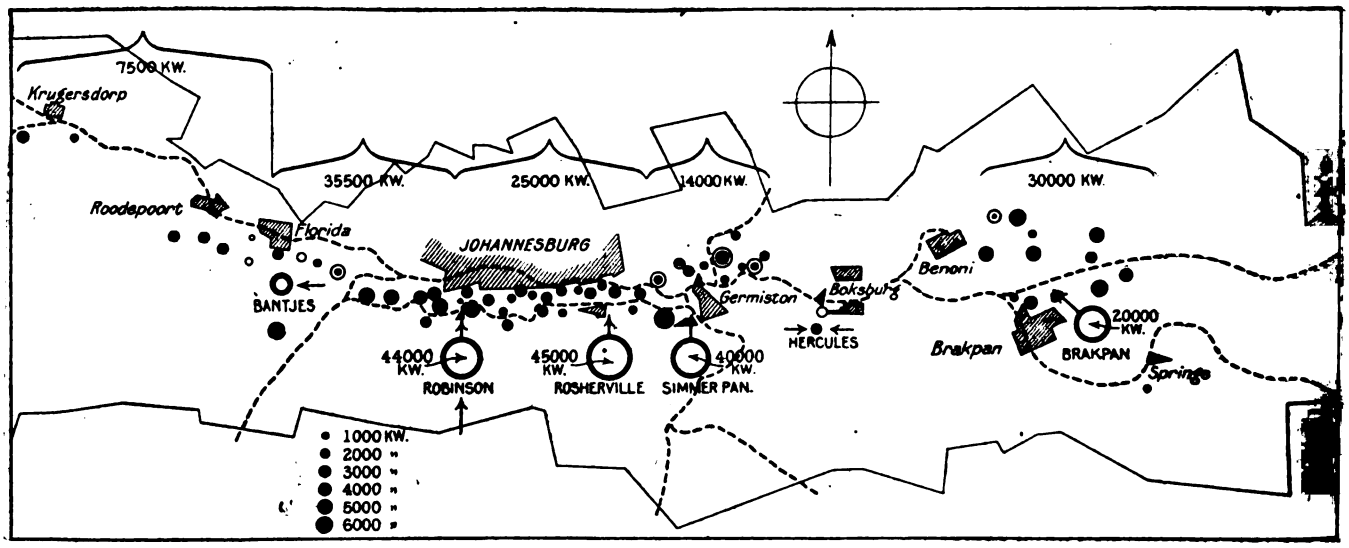

FIG. 2.—THE RAND POWER COMPANIES AREA OF SUPPLY AND DISTRIBUTION OF LOAD.

Dealing with the position of electricity in mining in South Africa, Mr. C. F. Mackness ‡ pays the following tribute to the engineers on the Rand :—

"The winding problem has been boldly faced and treated with the practical common sense that is one of the characteristic qualities of the engineers on the Rand, and the systems used have been adopted, not at haphazard, nor by slavishly following European practice, but after careful study and selection of the systems best suited to the conditions of the country and its mining methods."

If with only a single industry to rely upon an unqualified success can be made of the power scheme and of the electrical operation of heavy mining machinery in South Africa, it needs no argument to prove that the chances of success must be very much greater in countries having many heavy industries to fall back upon, particularly when the said industries are closely allied. But, as we have said, the verdict as to whether the electrically-driven winder is or is not a commercial proposition. can well be left to the mine manager to decide. The recent appointment by the President of the Board of Trade of a Committee "To consider and report what steps

* Mr. B. Price, "Transactions," South African Inst. E.E., 1916; also THE ELECTRICIAN, Feb. 23, 1917.

† J. H. Rider, "Journal" Inst. E. E., p. 609, 1915. The world's output of gold for 1916 was about £95,725,000. The Transvaal contributed £39,485,000, or 41 per cent. The mines under the administration of the Central Mining and Investment Corpn. (Ltd.) produced £17,000,000 or nearly 18 per cent. of the world's production

* J. N. Bulkley, "Transactions," Am. Inst. Min. Eng., p. 355, 1916.

† *Ibid.*

‡ THE ELECTRICIAN (Second Mining Issue), May 12, 1911, p. 15.

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should be taken . . . . to ensure that there shall be an adequate and economical supply of electric power for all classes of consumers," is decidedly encouraging. The only help we as electrical engineers can give to make the electric winder a commercial proposition at home, is to get rid of our present notions regarding the importance of lighting, heating and cooking, and to raise the power supply question from a parochial one to a national one. On this side of the subject there is nothing more to be said, and we are free to turn our attention to technical matters connected with the winder.

For the purpose of serial publication in THE ELECTRICIAN the article will appear in about 25 parts, which may be broadly divided into the following sections :—

(*a*) Mechanics of the Winder.
(*b*) Winders for Vertical Shafts.
(*c*) Winders for Incline Shafts.
(*d*) Winders for Compound Shafts.
(*e*) Electrical Equipment of Winders.
(*f*) Mechanical Equipment of Winders.
(*g*) Particulars of Notable Winders.

These will be considered in the order named, but before making a start on the first section it is desirable to give a few introductory paragraphs of a general character.

(*To be continued.*)

Experiments on Tribo-Electricity.*

By P. E. SHAW, B.A., D.Sc.

THE TRIBO-ELECTRIC SERIES.

The term " tribo-electricity " is used in O. D. Chwolson's " Traité de Physique." This term is a convenient equivalent for frictional electricity ($\tau\rho\bar{\imath}\beta\acute{\eta}$ = a rubbing).

Little exact knowledge of tribo-electricity has yet been accumulated, and this subject has certainly not been raised to the dignity of a quantitative science. This Paper contains an account of experiments in which the conditions of the solid bodies rubbed together have been greatly varied. Thus, temperature has been changed both before and during friction ; the surfaces used have been rubbed with considerable pressure while hot ; they have, wherever possible, been rubbed together when flexed ; and they have been prepared before rubbing by being ground and polished in various ways. Much information has thus come to light as to the electrical surface conditions of a variety of solids.

The data available on the subject lack coherency. The electrical effects obtained by friction were often found to be irregular, partly because rubbing necessarily affects, perhaps destroys, the surfaces under investigation, so that friction, especially if violent, may in effect give rise to surfaces of a new kind.

The author then proceeds to give a summary of recent investigations, from which various hypotheses emerge ; for example, that a polished surface is always positive to a small surface of the same material, that a more dense surface is positive to a less dense one of the same material, and that dust proceeding from a body is negative to the material it leaves. Anomalous results have been obtained from some substances, such as glass, which is positive to silk but becomes temporarily negative if the temperature is sufficiently raised. This behaviour is, however, characteristic of many and probably all solids.

An attempt is made to arrange solid materials in a tribo-electric series, and the tables presented by various observers are discussed. From these data, and from various experiments of the author, a fuller series is deduced, and some investigations on the behaviour of mercury and the peculiarities of flexible sheets are described.

On the simple electronic theory of tribo-electric phenomena there are free electrons close to the surface of solids which readily leave the surface when rubbed. The materials high up in the series are supposed to be characterised by having electrons specially free to leave. This theory, as it stands, does not account for the presence in the table, mixed in among insulating bodies which are poor in free electrons, of metals and alloys, all peculiar for their richness in free electrons, nor does it account for various effects which are striking and consistent enough to call for an explanation.

With more refined experimental methods the subject will advance, no doubt, from its present stage ; but the process will be slow. Quantitative work on materials *in vacuo* cannot easily be done when, as here, considerable mechanical force has often to be applied to the materials. But this is not the only reason for expecting slow progress. The materials possible to be tested are unlimited, and generalisations should not be based on a few instances only.

In the last few years the surface conditions of solids have been investigated from new standpoints. For example, H. L. Curtis has observed enormous change (as much as one hundred million-fold) in the surface conductivity of insulators as the relative humidity of the air over the surface varies from 20 to 90 per cent. This brings in the moot subject of adsorption, which one would expect to have a bearing on tribo-electric effects. Mr. C. Hayes and the author have observed a direct connection between dampness of a surface and the sign of the charges it gives when rubbed. Again, J. W. French has discovered that the surface of artificially polished glass to a depth of 5μ is of a peculiar nature, differing in cohesion from the main underlying material. Mr. Hayes and the author have found that the surface of polished glass has under some conditions a neutral state. In this state it yields neither positive nor negative charges. This effect is found only in the artificially polished material.

This Paper is meant to be the first of a succession on the subject of tribo-electricity. Some quantitative work has already been done on various branches of the subject—*e.g.*, the influence on the surfaces about to be rubbed of (1) low vacua ; (2) electric high-potential discharge ; (3) various liquids. The following is a summary of the chief conclusions so far arrived at :—

1. The tribo-electric series, in which solid materials are arranged in order according to the charge they acquire when rubbed together, is reliable with due precautions. Common solid metallic and non-metallic elements, interspersed with a great variety of compound materials, occur in this series.

2. Most solids are found to alter their place in the series if heated above a certain temperature, which is specific for each material. This temperature is called the critical temperature. The surface in its new condition is termed abnormal.

3. The series may be divided into an upper group (A) and a lower group (B). It is found that these groups have tendencies contrary to one another as the surfaces of the materials are rendered (*a*) matt, or (*b*) abnormal, or (*c*) pressed, or (*d*) flexed. If under any of these agencies Group A becomes more positive forming, Group B becomes more negative forming, and *vice versa*. This principle is here called duality. It is possible that the phenomena observed by Héséhous with radium may be another case of this duality of action, for glass is in Group A and ebonite in Group B.

4. Anomalous effects are observed when liquid mercury is used as one of the materials, its behaviour being quite unlike that of solid surfaces.

5. As to theory, it is suggested that the prevalent idea that the electric double layer, existing at the surface of solids, has the negative layer outermost in all cases is incorrect. Normally, the materials in Group A would have negative outermost, those in Group B having positive outer-most. Orientation of surface atoms would give rise to changes in the disposition of the two electric layers, and so account for observed effects.

6. Tribo-electricity undoubtedly affords a means of extraordinary delicacy of discriminating between materials apparently alike.

* Abstract of a contribution to the " Proceedings " of the Royal Society.

The "Overshooting" of Metal Filament Lamps.—The " over-shooting," *i.e.*, the excess of current that occurs when metal filament lamps are switched into circuit, was observed very shortly after the introduction of these lamps, and has been discussed by various observers. Although the duration of the effect is short—rarely exceeding a tenth to a fifth of a second—it may give rise to various difficulties, and has been observed particularly in the larger gas-filled lamps. According to the experience of Mr. C. J. Berry, given in the " Electrical World," the effect should not, however, be sufficient to cause fuses to blow or circuit-breakers to open, provided the protective apparatus is properly rated and has a suitable time of action. The maximum initial current was found to be about seven times the steady value. In gas-filled lamps the effect is accentuated somewhat by the cooling effect of the gas. When alternating current is used the heating and cooling of the filament may appreciably distort the natural wave form, and the degree of over-shooting depends to some extent on the conditions of magnetism in transformers. In general the presence of reactance tends to restrict over-shooting.

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Public Utility Undertakings and the War.

We think it will be agreed that it is of the greatest importance that utility undertakings should be maintained in a condition of prosperity during the war. This remark applies more particularly to companies engaged in this class of work because they are more dependent upon the public investor, but it applies also to a marked extent to municipal undertakings also. Under present conditions the public utility company is in rather a peculiar position. It has certain very defined obligations towards the public, and from this point of view its plant should be maintained in good condition so that a proper service can be rendered. At the present time, however, there are many difficutlies in permitting extensions to be made, even though such extensions are required in connection with war work.

There is the further point that a public utility company is not in the same position as a manufacturing concern. It is not able in the same way to take advantage of war demands, and consequently excess profits are improbable. On the other hand, no utility undertaking can profitably stand still; it should continually expand and it should supply a public demand which is increasing. In other words, it should be continually spending capital and, therefore, should be in a position to obtain capital on reasonable terms. Here it is that such an undertaking is at a disadvantage. It may be thought by some people that it is of no great consequence whether these undertakings pay a good dividend or whether during the war the dividends fall off. Actually, however, it is important from every point of view that the dividend should be maintained, and not only maintained but increased. Owing to the demands for money by the Government, and the higher rate of interest which the Government is willing to pay at the present time, it is obviously more difficult for undertakings of this kind to obtain capital on the same terms as hitherto. If, then, the dividends fall there is less inclination on the part of the public to invest their money in such directions. Further, there is the more remote effect, namely, that if dividends fall the shareholders have less money at their disposal and are, therefore, less able to support the claims which are daily set forth on behalf of the Government.

The position is more particularly difficult if dividends are limited. In this country, at least in the case of electricity undertakings, the limitation of dividends has not been introduced. In the United States, on the other hand, as is pointed out in an article by Mr. H. A. WAGNER in a recent issue of the "Electrical World," public utilities are regulated by Commissions. Consequently, their profits are not so much dependent upon the skill and foresight of the management, but are limited to what may be laid down from time to time as a fair rate of return upon the capital invested. On the one hand, the public is protected by virtual limitation of dividends; on the other hand, a loss by the utility is not so limited. Under war conditions this introduces a situation which is unsatisfactory to the investor. The purchase of public utility stock may become a gamble on the part of investors, and if this is to be the case it follows that the chance of obtaining adequate service must also become a gamble on the part of consumers. In Great Britain the tariff charged by electricity undertakings can be raised, and this has already been done repeatedly, and in some cases the aid of the Board of Trade has been invoked to allow alterations in the maximum charges. In the United States there is little doubt that similar steps must be taken by the Commissions. In other words, it will be necessary for them to eliminate the risk that the tariff may be insufficient to provide operating expenses, fixed charges and dividends; that is, it will be necessary for the Commissions to maintain a normally prosperous financial condition of the public utility undertakings. In Great Britain we are inclined to allow matters to proceed in a more haphazard fashion than in some other countries, and, therefore, the financial conditions in such cases are liable to be unsatisfactory. It is necessary, however, to realise that it is important to maintain the financial prosperity of these undertakings, and dividends are the true indication of prosperity in nine cases out of ten.

Reviews.

Practical Electricity. By TERRELL CROFT. (London: The Hill Publishing Co.) Pp. xiv.—646. 10s. 6d.

The choice of the title of this book seems rather unfortunate owing to the possibility of confusion with Ayrton and Mather's well-known book bearing this title, the first edition of which appeared in 1886.

This is a beginner's book, its object being, to use the author's words, "to present the fundamental facts and theories relating to electricity and its present-day applications in a straightforward, easily-understood way for study by any man, of little mathematical training, who desires to acquire a working knowledge of the subject." The avoidance of mathematics, however, has not led to unsound treatment, and the book will be found a safe guide to anyone desirous of obtaining an elementary knowledge of the fundamental facts of electrical engineering. The author has spared no pains to make his descriptions as clear as possible, and his illustrations—which appear on almost every page—self-explanatory. Ample use is also made of analogies to help the reader to understand various phenomena.

In the introductory part of the book, dealing with matter and the electron theory, the modern views of electricity are discussed. Instead of keeping to the usual way of expressing large numbers—*e.g.*, $16{\cdot}8\times10^{4}$—however, the author occasionally indulges in such expressions as "there being likely about 17 million, million, million, million—that is, 16,800,000,000,000,000,000,000,000 electrons in every ounce of every kind of matter." To us, such expresions are quite unintelligible, however clear they may be to the non-mathematical reader. If such numbers are merely intended to be imposing, the effect might be enhanced, for example, by estimating the number of electrons in the earth.

The fundamental ideas concerning magnetism and electricity are then considered at length. One or two points call for comment. The author's definition of the practical unit of resistance is out of date, for we must now specify the weight of the column of mercury of given length and uniform cross-section. Again, in discussing Ohm's law, we are told: "Ohm's law is merely a specific statement, as applied to the electric circuit, of the very important general law which governs all physical phenomena. This general law is: *The result produced is directly proportional to the effort and inversely proportional to the opposition.* (This general law applies to all circuits—electric, magnetic, hydraulic, pneumatic, heat, &c." The statement in italics would need a very broad interpretation to make it acceptable to physicists, and can scarcely be called a law in the same sense as Ohm's law. Electromagnetism is also

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treated fairly fully, and among the examples worked out, lifting magnets are included. We are not convinced, however, that practical calculations are simplified by using the ampere-turn as the unit of magnet motive force, nor do the units "rel" and "perm" for reluctance and permeance appear needful.

There is a good description of primary cells and of storage batteries, after which the author proceeds to consider self and mutual induction and their effects. This leads to practical applications, and the second half of the book is devoted to continuous-current generators and motors, alternating-current generators, vector diagrams and alternating-current circuits, polyphase systems and transformers.

It will be seen that the author covers a very wide range, and his work can be recommended equally as an introduction to more advanced treatises or as a text-book on the fundamental principles of electrical engineering.

STANLEY PARKER SMITH.

The Design and Construction of Industrial Buildings. By MORITZ KAHN. (London: Technical Journals, Ltd.) Pp. xii.+63. 7s. 6d. net.

Mr. Kahn deals with an important and fascinating subject. There have been very rapid developments recently in the design and erection of industrial buildings, especially in the United States. It is not too much to say that the history of a factory and its ultimate cost of production is largely determined by its initial lay-out. In his Introduction the author remarks that manufacturers in the United States are prone to think of the appearance of the works 10 years hence. Buildings are designed with a prophetic eye, commonly as a series of standardised units to which additions can easily be made without prejudicing the harmony of the whole. To acquire an old building and adapt the plant thereto is, the author holds, an essentially erroneous plan. The building should be erected round the equipment, and should be secondary to its proper lay-out.

In the following chapter on general planning of the works, the author explains how, the annual output being determined, the necessary floor area is allocated to each department, the natural course of operations throughout the factory being sketched out, and the plan gradually evolved. Methods of construction and relative costs, natural and artificial lighting, heating and ventilation, plumbing and drainage are discussed in succession and there is a final chapter on the architectural treatment of the factory building.

A feature of the work is the series of plates, representing typical factories, many of which are well worth studying.

Correspondence.

THE IMPROVEMENT OF THE TURBO-ALTERNATOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your readers who are concerned with the design or use of large turbo-alternators must have read Mr. Behrend's letter in your issue of June 7 with the greatest interest. Mr. Behrend has had a unique experience with the development of large electrical machines, and to have the benefit of his experience with this particularly difficult class of work, is of the greatest value. The construction that Mr. Behrend advocates, which for the sake of brevity may be called the unpierced-plate construction—the plates being unpierced at the vitally-important part, the centre—is ingenious in the extreme, and the writer would be the last to belittle the clever way in which Mr. Behrend has dealt with a difficult problem. Mr. Behrend's letter makes it clear that he and the writer have in common the sole ultimate object of producing the most perfect construction, and therefore, being in agreement in principle, it is most desirable that they should think clearly concerning the matters of degree on which they differ.

An important matter, and one that Mr. Behrend does not appear to apprehend clearly, is that soundness is not imparted to steel of the kind in question as a consequence of work that is done on it under the forging press. If the finished forging is to be sound, whether it be the plate or bolt or shaft end of the plate construction, or the rotor of the solid construction, the ingot from which it is made must be sound, and, conversely, if the ingot is unsound, then no matter what may be the form of the forging, it must be unreliable. Thus, whether the solid rotor, or Mr. Behrend's construction is used, there is equal and complete dependence on the soundness of the ingot. To obtain a sound ingot, the steel-maker knows that there are certain essentials to be observed. The materials must be pure, the steel must be thoroughly "killed," the temperature at which the steel is poured must have just the correct value, the ingot mould must be correctly designed, &c. The steel-maker knows that if the proper precautions are taken, the resulting ingot is entirely dependable.

It is, therefore, clear that forging does not impart soundness to steel. Then what is the object of forging steel? It is to improve the ductility appreciably and the strength slightly. Steel is not a homogeneous isotropic substance. It is essentially a complex combination of iron and carbon and the crystals of which it is composed are of the kind known as allotriomorphic, that is, the crystals internally have perfect symmetry but externally conform to no regular geometrical pattern. As the crystals separate out from the cooling fluid (with steels of the composition in question), the first that form are composed of iron in its purest and softest form, known as ferrite. The effect of this pure iron crystallising out is to increase the percentage of carbon in the remainder of the fluid. The temperature of freezing is thereby lowered and there has to

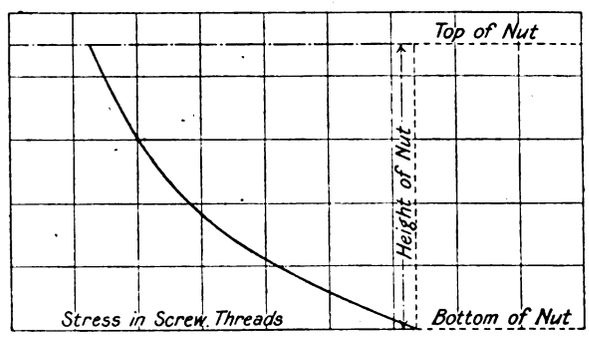

FIG. 1.—DISTRIBUTION OF STRESS IN SCREW THREADS OF NUT AND BOLT HAVING EXACTLY CORRECT THREAD PITCH.

be further cooling for further crystallisation to take place. As the cooling continues, more crystals of pure iron are formed and the percentage of carbon in the fluid increases until it reaches the value of 0·89 per cent., when the remainder freezes *en masse*. After complete freezing, steel of this kind consists of a network of soft iron formed round hard crystals of eutectic steel known as pearlite. Now, ductility represents the capacity of the ferrite to flow into the cracks that deformation causes in the hard pearlite. The result of forging is to elongate the ferrite masses in the direction in which the work is done and so the flow of the ferrite is facilitated when the steel is being deformed, preparatory to breaking. Further, the elongation of the ferrite masses in this way reduces the area of them in planes at right angles to the direction of working, and as the ferrite is much weaker than the aggregate, the strength of the section is somewhat increased. The question arises, is sufficient work done on the rotor forging to give the steel the required ductility? The question is answered by taking tests of bars cut in various directions from various parts of the rotor. Test pieces in the radial direction at the part corresponding to the bottom of the tooth, that is, in the direction in which the minimum work is done, show an elongation in the case of the steel in question of at least 16 per cent. on 2 in.—a perfectly satisfactory value. Test pieces taken from bars trepanned from the very centre of the rotor show a similar ductility and a strength only slightly lower than at the end of the shaft. As the writer pointed out in the Paper to which Mr. Behrend refers, by careless forging, internal

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cavities can be formed at the part where the rotor is forged down from the body portion to the shaft portion, but with ordinary care such fractures cannot occur.

Another important matter is the stress in the bolts of the unpierced-plate construction. Mr. Behrend's statement that he "believes" that very complete contact between the threads of the nut and bolt is ensured by employing ductile steel and by the initial stress in the bolt, indicates that this vitally-important factor of his design has not received the full investigation it merits. It has to be remembered that the part of the nut in the bolt is extending (elastically), due to the pull, and the nut is compressing (elastically). The result is that the stress on the threads at the bottom of the nut is decidedly greater than at the top, and the very complete contact that Mr. Behrend "believes" is obtained is not possible. Fig. 1 shows the variation in stress in the nut threads, and it will be seen how great is the concentration of stress at the bottom of the nut, where it is about five times greater than at the top. The calculations on which the curve is based are fully borne out by determining the stress optically by passing polarised light through an isotropic material according to Dr. Coker's discovery. Fig. 2 shows such a photograph taken with a nut and bolt having an absolutely accurate thread-pitch. The colour effects cannot be reproduced, but the areas of the stress circles at the bottom of the threads indicate roughly, nevertheless clearly, the variation of the intensity of stress in the length of the nut. Further, it will be seen that if the nut pitch is ever so slightly less than the bolt pitch, the threads at the top of the nut can carry but little of the load and the lower threads must be dangerously over-stressed. With a thread-pitch of four to the inch an error in pitch of less than

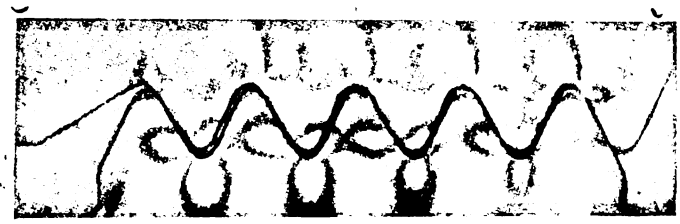

FIG. 2.—STRESSES AS SHOWN BY A PHOTOGRAPH.

half a thousandth of an inch would result in a stress in the lower threads greater than the ultimate strength of the material, even though the bolt extension might be indicating an average stress in the bolt of only 40,000 lb. to the square inch. The reason why a nut and bolt seldom give trouble, although so imperfect a piece of mechanism, is that local over-stress is relieved by the metal yielding plastically. In the presence of intermittent stress, however, plastic flow is the first step in the process of fatigue failure, and it is for this reason that whenever subject to rapidly varying stress, the nut and bolt has been found to be most unreliable. Mr. Behrend claims that the intensity of the intermittent stress is so low that it is incapable of causing trouble. It is to be remembered, however, what great local initial stress may be present and even a small superimposed intermittent stress may be fatal. Taking Prof. Field's own figures, it means that on each bolt a load of about 8 tons is applied and removed over two and a half million times a day—a duty that cannot be dismissed as having a negligible effect. The writer believes that Mr. Behrend would be well advised to study the question of the stress in screw threads, and in particular he would refer Mr. Behrend to the valuable work done recently by Mr. Stromeyer, and by Mr. Rowland of the Technical School, Leicester.

In summary, it will be seen that with either construction there is equal dependence on the soundness of the ingot from which the forging is made, and it becomes a question as to whether the chance of having the solid rotor forged improperly is so great that it is preferable to employ the unpierced-plate construction in spite of the indeterminate stresses in the bolts and the complete dependence on the accuracy of the many machined joints. Provided that it is backed by the full guarantee of one of our large steel-makers, there can be no doubt that the solid forging is as dependable as any material that can be obtained, and the writer is convinced that such a construction, with its determinate and quite low stresses, is to be regarded as a far sounder construction than cutting the rotor into a number of pieces and then holding the pieces together by bolts.

In his Paper the writer was careful to caution manufacturers that although the solid rotor is the ideal construction, the use of improper steel or carelessness in forging could quite well lead to disaster. The case to which Mr. Behrend refers serves no other purpose than to emphasise this point, which, however, should need no emphasising. Prof. Field stated clearly that American steel manufacturers would not guarantee that their steel was satisfactory for the duty, and if such was the case then Mr. Behrend had no alternative than to look for some other form of construction. The situation is quite different over here where high-grade forgings, entirely suitable for the duty, are available.

The writer cannot agree with Mr. Behrend that a failure of the unpierced-plate construction will be heralded by a change of balance that will give timely warning of the impending trouble. Failure will be by a bolt snapping at the face of the nut, and the nut flying off with a stored energy of some 20 foot-tons will produce results that cannot be forecasted with any certainty except that the engine-room staff will steer a course for the exits rather than for the emergency trip valve.

Mr. Behrend states that he adopted the construction he advocates *eleven* years ago for the reason that he had a failure with a solid forging *ten* years ago—clearly either imperfect chronology or an authentic case of occultism.—I am, &c.,

Sheffield, June 29. S. F. BARCLAY, Ph.D.

WAVE VELOCITY AND CAPACITY OF HORIZONTAL HELICES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the article on the above subject by A. Press in THE ELECTRICIAN of June 7, it may be of interest to point out that the formula employed to calculate the inductance of the equivalent straight wire, taking account of its proximity to the earth and the electrical image induced therein, is an approximate one only. The approximation used is one specially to meet the case of *long* lines composed of wire of small radius r compared with its height h above the ground.

In the present example, the radius of the "wire," r, is some 5 per cent. of the height h, while its length is but slightly over twice its height. Hence a more exact expression would be (using the notation of the Paper):—

$$L_s = 2\left(\log\frac{2h}{r} + \frac{1}{4} - \frac{2h}{l}\right) \text{ cm. per unit length.}^*$$

Substituting the dimensions of the coil in this, we get

$L_s = 7{\cdot}015$; and hence $\frac{1}{\sqrt{\mu}} = \frac{1}{147{\cdot}6}$. The velocity of wave propagation along the coil should therefore be (1/147·6) of the velocity of light. This result is considerably nearer to Dr. Fleming's value of 1/150 than the value obtained in the Paper.

Employing the same correction in the calculation of the capacity of the helix, we obtain,

$$C_s = \frac{10^9 \times 10^6}{L_s V^2} \text{ mfds. per cm.} \quad [V = \text{velocity of light} = 3 \times 10^{10}],$$

or, the total capacity of the helix

$$= lC_s = \frac{210 \times 10^6}{7{\cdot}015 \times 9 \times 10^5} = 33{\cdot}26 \text{ micro-mfds.}$$

This result is again somewhat closer to Dr. Fleming's measured value of 45 mmfds.—I am, &c.,

London, June 18. PHILIP R. COURSEY, A.M.I.E.E.

* *Cf.* "Bulletin" of the Bureau of Standards, Washington, Vol. VIII.

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Trade Parliaments and Their Work.*

By E. J. P. BENN.

(*Concluded from page* 165.)

XI.—The Position of Labour.

In concluding these articles a word or two further should be said about the position of Labour. Such opposition as exists to the Whitley Report comes from two parties who are the very last that one would expect to find associated in anything. The Whitley Report recommends that Joint Standing Industrial Councils should be composed of equal numbers of representatives of employers' associations and trade unions, and that these councils should form the basis of a complete system of self-government. The principle of the right of Labour to participate in trade questions which affect the welfare of a whole industry is accepted by moderate opinion on both sides, but the reactionary type of employer who still thinks of the world as it was in 1914 is inclined to criticise. This man still fails to see that Labour has any interests in such subjects as raw materials or markets, and he fondly imagines that he will secure the co-operation of Labour and the abolition of restriction of output while keeping Labour leaders in ignorance as to the state of trade generally. On the other hand, we get the most forward type of Socialist, the syndicalist and guildsman, who dreams of a world from which Capital is abolished and declines to have anything to do with Joint Standing Industrial Councils on the ground that they are an attempt to perpetuate and bolster up what he is pleased to call the capitalistic system. Needless to say, neither class must be allowed to prevail. I need not bother here to answer the syndicalist who wants to abolish Capital, but I may perchance catch the eye and ear of some employer who has so far failed to grasp the true inwardness of Labour's present demand for a share in the control of industry. There is no suggestion here that Labour should have any say in the control of the individual actions of an individual employer. The employer who has all the risk must be the final judge as to what he shall buy and what he shall sell and at what prices he will complete either transaction; but in our conception of industry we have got far beyond the point when it is regarded as a matter of merely buying or selling by an individual. We have reached the stage when we can see that the welfare of each industry is a matter of vital importance to the nation, also we now realise that all those engaged in that industry—capitalists, managers, workpeople, travellers, shopkeepers, clerks and others—have a right to know that the industry as a whole is sound and prosperous and is likely to provide them with a means of living in return for the study and attention that they are prepared to give to it. If, for instance, as has happened in many trades, our export business has not received the attention it deserves; if there are markets which have never been exploited and demands that have never been satisfied, then Labour is entitled to look into these questions before it will give an answer to the request that will presently be made to do its best to increase production. If, on the other hand, materials are short, machinery non-existent and capital unobtainable or credit scarce, and, in consequence, it is necessary to ask Labour to go on to half-time, Labour will not, in future, accept the mere statement of that position from an autocratic body of employers; it will demand the right to go into the circumstances for itself and satisfy itself that things are really so. But apart altogether from the right of Labour to share in the discussion of what may be called general trade politics, there is every advantage to be gained from such partnership. Every trade in the future will find itself in the position of wanting something from the Government. It may want materials, it may want a tariff, it may want something to be done, and is much more likely to want something *not* to be done. It is perfectly obvious that if these demands upon the Government are made by a joint body, composed of employers and employed they are bound to receive more attention than would be the case if they came from one section only.

Next, and last, if the new conception of industry is accepted, if we get both masters and men to look upon their calling as a branch of national service, we find for the first time the opportunity of establishing between both parties that confidence the absence of which has been the cause of most of our industrial trouble in the past. It is only the small man that fears from any of these developments some damage to his own personal position. The larger conception knows that the individual interest is, after all, only part of a wider interest, and that the promotion of the latter is the true way to benefit the former. The idea of the control of industry by Joint Standing Industrial Councils is, after all, nothing but a natural development following upon the rise within the last couple of generations of the trade associations and the trade unions.

In conclusion, let me repeat a few of the sentences which sum up the whole of this great question. The betterment and development of our trade for the benefit of all those engaged in it and for the nation as a whole; development, trade by trade, one trade at a time, the trade being the unit; each trade as a branch of national service; each trade as a vital part of the social organism; the abolition of jealousy and secrecy and all that is born of ignorance and small-mindedness; production as the source of all prosperity; waste of material, or method, or of goods, or of effort as a crime against the community. When these ideas begin to be generally understood and applied we shall all be able to afford to smile at the old days when we squabbled for the wages and profits which were insignificant beside what is thus made possible. There is far more for everybody in each of our trades than has ever yet been got out of them, and if Labour and Capital will join hands in this new voyage of discovery the prospects of the future are indeed bright.

* These articles are now published in book form by Nisbet & Co. Price 1s. net.

Legal Intelligence.

Prolongation of Dewar's Patent.

Last week Mr. Justice Sargant granted the petition of Sir Jas. Dewar for the extension of the term of his patent No. 13,638 of 1904 for "An improved method of absorbing gases, and the application thereof to the production of high vacua and the separation of gases."

In the course of his judgment Mr. Justice Sargant said he was clear no want of novelty had been made out, and the petitioner was entitled to full credit for the invention. Unfortunately for petitioner there was little opportunity at the time for the use of his invention for commercial purposes, or otherwise than for purposes of experimental research, for which he never desired to prevent its use. There was no use for liquid gas on a large scale or for commercial purposes, nor was there any production of it in any quantities in this country. It was only when, in recent years, liquid air began to be produced and used in large quantities that metal containers became necessary. The petitioner was thus deprived of any adequate return from his invention. He appeared to have taken reasonable steps to make the invention known and to get it taken up commercially. But, for the only two commercial purposes for which it appeared to be suited at first—namely, thermos flasks and electric lamps, sufficient vacua could be obtained practically by other and cheaper methods. It was not until the autumn of 1913 that the petitioner was enabled to make an agreement with manufacturers for the use of his invention on a large scale, and then the agreement was unfortunately made with a German firm, and was brought to an end by the war, after petitioner had received from them a single payment of £1,000 only. There was also great merit in the further part of petitioner's invention which was consequential on and by way of addition to the others, viz., the discovery that, after their absorption by charcoal, cooled to a very low temperature, mixed gases might be emitted by a subsequent raising of temperature in proportions different from those in which they were originally absorbed, and so a separation of mixed gases might be effected. There, too, the petitioner's failure to reap an adequate reward seemed to have been due to much the same reason as those which affected the other part of his invention. Neither the Crown nor the opponents made any case for differentiation between the several claims of the patent as regards extension. The petitioner had made out a case for the extension of his letters patent for a period which he fixed at five years from the expiration of the original patent. But, in view of all the circumstances, and particularly of the fact that neither the petitioner nor any assignee or licencee had hitherto established any manufacture in this country, and of the desirability that such manufacture should take place as speedily as possible, the grant should be on terms providing that he be bound to grant to any persons approved of by him or by the Board of Trade licences to use the invention to such extent for such purposes, with such restrictions and on such terms generally, as a duly qualified arbitrator appointed by the Board of Trade should determine.

C. J. Weld-Blundell v. Stephens.

Last week, before Mr. Justice Darling and a special jury, plaintiff sought to recover damages from Mr. J. H. Stephens, C.A., for alleged breach of contract and professional negligence; also special damages (£1,869) sustained by his alleged disclosure of a certain document.

Defendant denied negligence, and counterclaimed for £48 for fees due from plaintiff, who denied this liability.

In 1915 Mr. Weld-Blundell became interested in the Float Electrical Co. (Ltd.), which manufactured mining lamps, and financed it to the extent of £13,000. Being dissatisfied with the results, he employed Mr. Stephens to investigate the accounts and advise him, giving him a letter of instructions in which statements were made reflecting upon Mr. Low, a former manager of the company, and a Mr. Cummings, an accountant previously employed. The contents of the letter became known to Mr. Low and Mr. Cummings, who brought separate actions for libel against Mr. Weld-Blundell, resulting in verdicts and judgments for an aggregate of £1,869 damages and costs, the sum now claimed as special damages. Plaintiff contended that it was the duty of defendant to preserve the secrecy of his instructions and not to disclose a financial document.

After hearing evidence, the jury found that it was the duty of defendant

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to keep secret the letter, that defendant neglected his duty, and returned the damages at £650. His lordship postponed entering judgment pending argument on the point of law whether plaintiff could recover from defendant damages given in respect of a libel committed by himself.

A.E.G. Electric Co. (Ltd.)

On Tuesday Mr. Justice Younger had before him a petition by the Board of Trade, to wind up under the Trading with the Enemy (Amendment) Act, 1916, the A.E.G. Electric Co.

Mr. AUSTEN-CARTMELL said that was the last of the three companies formed by the parent company, of Berlin, the other two having been wound up by the Court on May 28. The business of the present company had been wound up by order of the Board of Trade. There had been a reference to an arbitrator in regard to a large claim and counterclaim between the company and the Rio Tinto Co. The arbitrator (Capt. Riall Sankey) had found some difficult questions of law, which were now before Mr. Muir Mackenzie, official referee. It was not thought that his decision would be available until after the Long Vacation, but the Board of Trade would like the matter settled before the Long Vacation, and he suggested that the petition should stand over until July 23.

His Lordship directed the petition to be put in the list for July 23.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 SPECIFICATIONS.

3,585 SCHUSTER. Galvanic cells. (12 3 17.) 115,653.
4,882 SCHOLEY. Method of and means for individual electric driving of machine tools, such as lathes, drilling or milling machines. (4 4 17.) 115,655.
6,867 MARKS. (Sparks-Withington Co.) Electrically-operated diaphragm horns. (14 5 17.) 115,679.
6,870 STONE & CO. (Walton.) Couplings or connections for electric cables, particularly intended for use on railway vehicles. (14 5 17.) 115,680.
6,871 STONE & CO. & DARKER. Brush and terminal contact mechanism of dynamo-electric machines. (14 5 17.) 115,681.
6,889 ORVILLE. Method of installing and disposition of electrical equipment for motor-road vehicles. (14 5 17.) 115,682.
6,936 BRITISH INSULATED & HELSBY CABLES (LTD.), BAIRSTO & HARRISON. Loading coils for telephone circuits. (15 5 17.) 115,685.
7,206 BROWN. Ionic electric relays, amplifiers or detectors. (18 5 17.) 115,700.
7,519 HAMILTON & HOLLAND. Means for preventing the oxidation or wasting of the electrodes in electric furnaces. (25 5 17.) 115,705.
7,627 MARKS. (United Telegraph & Cable Co.) Telegraph relays. (26 5 17.) 115,708
8,478 SAHLIN. Electric furnaces. (13 6 17.) 115,719.
8,621 STYLES. Electrical switches. (15 6 17.) 115,721.
8,622 LUCAS, BREEDEN & MOORE. Dynamo-electric apparatus for motor vehicles. (15 6 17.) 115,722.
11,990 AKT. GES. BROWN, BOVERI ET CIE. Means for the desired distribution of load and current on direct-current units connected in parallel. (21 8 16.) 109,799.
12,460 ALEXANDER. (Kleinschmidt Electric Co.) Selector systems for telegraph type-writers. (30 8 17.) 115,757.
13,332 ALLMANNA SVENSKA ELEKTRISKA AKTIEBOLAGET & LINDBLOM. Electrical limit switches. (17 9 17.) 115,761.
18,935 SWITCHGEAR & COWANS & NEEF. Magnetic blow-out fuses. (21 12 17.) 115,779.
1,048 WILSON. Control of dynamo-electric machinery. (18 1 18.) 115,786.
1,172 MARCONI'S WIRELESS TELEGRAPH CO. & SMART. Transmitting keys for use in electric telegraphy. (21 1 18.) 115,787.
4,952 CHRISTIAN. Electric relays. (20 3 18.) 115,796.

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

April 30, 1918.

7,212 ILEY. Electric terminal attachment.
7,226 BASSI. Ignition magneto for explosion engines. (30 6 17. Italy.)
7,244 CLARKE. Magnetic apparatus for indicating verticality, &c., in inclined bodies submitted to centrifugal force.
7,245 ASHCROFT. Manufacture of magnesium metal by electrolysis.
7,252 WESTERN ELECTRIC CO. High-frequency signalling. (5 9 16. U.S.)
7,261 JUNGHANS. Driving mechanism for magneto lamps, &c. (14 5 17. Germany.)

May 1, 1917.

7,281 HOLBROOK. Contact-breaking devices for magneto-electric machines, &c.
7,308 & 7,309 POLINKOWSKY. Machine switching telephone systems.
7,313 BOSCH AKT. GES. Double-current dynamos. (5 5 17. Germany.)
7,314 BOSCH AKT. GES. Double current dynamos. (1 6 17. Germany.)
7,325 FULLER ACCUMULATOR CO. & WILSON. Electrical distributors for internal combustion engines.

May 2, 1918.

7,355 HAIGH. Means of regulating and measuring magnetic fluxes and forces in testing machines, &c.
7,356 TOFIELD. Jointed arms or brackets for incandescent electric or gas lamps.
7,364 SCHATTNER & WALTON. Electric starters and controllers.
7,387 HAWKINS. Accumulator cells. (2 5 17. U.S.)

May 3, 1918.

7,406 COLSON. Locking incandescent lamps in holders.
7,426 LOVESEY & STEWART. Arc lamp lower carbon holder.
7,432 THWAITES. Electrical instrument and method for detecting immersion, passage and pressure of metallic bodies in fluids.
7,443 WELCH. Convertible electric fire.
7,443 WELCH. Convertible electric fire.
7,444 MONK. Electromagnetic trench mortar.
7,450 B.T.-H. CO. (G.E. Co.) Electric vacuum cleaners.

May 4, 1918.

7,483 GREVILLE. Electro-medical apparatus for diagnosis and treatment of partial deafness.
7,491 FIELD ENGINEERING CO., JONES & ESTCOURT. Slip-rings for magnetos.
7,513 LAXTON. Insulator carriers for overhead telephone wires.
7,514 B.T.-H. CO. (G.E. Co.) Methods of connecting electric conductors.
7,517 ELLIOTT BROS. & PHILLIPS. Magneto-generators.

May 6, 1918.

7,550 AUTOMATIC TELEPHONE MFG. CO. & TOMLINS. Apparatus for correcting electric impulses.
7,581 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Overload time limit relays for electric circuits. (7 5 17. U.S.)
7,584 LYMAN. Electric signal systems.
7,596 MARCONI'S WIRELESS TELEGRAPH CO. & SHOENBERG. High-frequency generators.

May 7, 1918.

7,616 JAMES & THOMPSON. Telephone.
7,619 FALCONBRIDGE & LEWSLEY. Electric apparatus for controlling curtains and lights in theatres, &c.
7,629 WESTERN ELECTRIC CO. Flexible conductors.
7,649 BARTON. Switch for high voltage circuits.
7,659 BROWN. Electric relays.
7,665 & 7,667 CLEVENGER. Electrolytic production of zinc. (7 5 17. U.S.)
7,668 GRACE. Control of magneto electric generators for ignition purposes.

May 8, 1918.

7,680 GARRETT. Maintenance of electric oscillations.
7,693 DIXBURY & HALL. Electric heating quilts, blankets, &c.
7,701 BARBOUR. Electric switches and starters.
7,705 ASHCROFT. Manufacture of magnesium metal or alloys by electrolysis.
7,711 WESTERN ELECTRIC CO. Telephone systems.
7,718 ALLGEMEINE ELEKTRICITATS GES. High-frequency machine with turbine drive. (24 1 17. Germany.)
7,722 B. T.-H. CO. (G.E. Co.) Protective devices for electric circuits.
7,727 ARMELIN. Dry batteries.
7,745 BRUSH ELECTRICAL ENGINEERING CO. (Aktiebologet Ljungstroms Angturbin.) Prizing devices for electrical machines.

May 9, 1918.

7,770 HOPE. Combined plug socket and switch fittings for electric circuits.

May 10, 1918.

7,824 MEACHER. Electric heating of rivets, studs, bolts, &c.
7,866 RANSFORD. (Fabbrica Italiana Automobile Torino.) Minimum current cut-out and tension and voltage regulating apparatus.
7,881 STEINBOCK. Transformer.
7,888 GHEGAN. Electromagnetic devices for use in signalling circuits.
7,905 PARKER & SMITH. Trolley heads for electric traction.

May 11, 1918.

7,920 BLANDY & WHIDDINGTON. Wireless telephony.
7,957 CAMPBELL & GOW. Control of power absorbed in electric furnaces.
7,961 COPPIN. Electromagnetic separator.

May 13, 1918.

7,964 BILL & BOWN. Electric couplings and bases combined.
7,974 HILTON. Sound magnifying device for telegraph relays.
7,978 THOMAS. Trolleys or collectors for tramways, &c.
7,988 RAVEN. Electric cut-outs.
8,002 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. & MILLER. Motor control systems.
8,029 COMPAGNIE GENERALE DE MAGNETOS. Magnetos. (1 10 17. France.)

May 14, 1918.

8,036 BLOMLEY. Flange joints for electric arc welding on thin materials.
8,038 MEYER. Electric water heaters.
8,058 B.T.-H. CO. & SIEBS. Testing prime movers.
8,065 & 8,070 HEAP. Relays.
8,066 & 8,067 HEAP. Sound detecting devices.
8,069 HEAP. Relays or switching devices.
8,081 HOLT. Electric generators.
8,082 WHEATLEY. Electromagnetic ignition apparatus.
8,094 EDISON-SWAN CO. & COFELIN. Incandescent lamps.
8,097 WARE. Fire alarms.

May 15, 1918.

8,118 MILLER & SANDERS. Brushes, &c., for electrical machinery.
8,129 PEARSON. Cells for secondary batteries.
8,133 B.T.-H. CO. (G.E. Co.) Antennæ for wireless signalling.
8,143 SELECTIVE SIGNAL CO. & LYONS. Wireless telegraphic receiving apparatus.
8,161 OLDHAM. Miners' safety, &c., electric lamps.
8,162 OLDHAM. Galvanic batteries.
8,164 HEAP. Contacting devices.
8,168 BENNETT & GARDE. Electric lamp-holders.
8,169 BENNETT & GARDE. Electric switches.
8,176 EXLEY & LEITNER. Charging boards for accumulators.

May 16, 1918.

8,182 DAVIS. Electric light stick.
8,188 TURNER. Contact-breakers on magnetos.
8,200 NOBUBARA. Rotary electric machines. (16 5 17. Japan.)
8,201 BASEBE & SMART. Electric stamping or pulverising machines.
8,207 LEVIN. Electrolytic gas generators. (22 5 17. U.S.)
8,220 NETTER. Electrotherapeutic apparatus. (16 5 17. France.)
8,224 HAVILAND & MORRIS. Electrical precipitation.
8,226 ELLISON & ANDERSON. Control of a.c. electric motors.
8,227 WALKER. Junction boxes for electric circuits.
8,242 BRITISH EVER READY CO. & SHEPPARD. Protection of terminals of batteries.

May 17, 1918.

8,273 BÖCKMAN. Electric induction furnaces. (12 8 17. Norway.)
8,287 DE FOREST. Radio signalling system. (16 6 17. U.S.)
8,288 ORLING'S TELEGRAPH INSTRUMENTS SYND. Detecting and recording situation of submerged metallic objects.
8,290 SYKES INTERLOCKING SIGNAL CO. Electromagnetic signal reverser for railways.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain of the Week.—Capt. E. G. Fleming.
Next for Duty.—Capt. W. Hynam.
Sunday, July 7.—Commandant's Parade at Waterloo Station 8.45 a.m. for work at Esher. Dress: Drill Order with Haversacks and Water-bottles. Mid-day and tea rations to be carried.
Monday, July 8, to Friday, July 12.—Drills as usual.
Saturday, July 13.—Engineering Reconnaissance Scheme for Officers.

SPECIAL NOTICES.—All drills will take place at headquarters unless otherwise stated.

The medical officer will attend for the examination of recruits on Thursday evening at 6.30.

ANNUAL CAMP.—This camp will be held at Esher from Aug. 3 to Aug. 11, both dates inclusive. Names can still be sent in.

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Commercial Topics.

Prices of Lead.

The Minister of Munitions has issued an Order increasing the maximum prices of lead fixed by the Lead Order, 1917.

Sheet lead is raised from £39. 10s. to £41 per ton; lead pipe from £40 to £41. 10s. per ton, and red lead and litharge from £42 to £45 per ton.

* * * *

Australian Imports.

The Commonwealth imports in 1917 from the United Kingdom were valued at £40,000,000 (compared with £47,600,000 in 1913); from the U.S.A. £15,500,000 (against £9,500,000); and from Japan £3,400,000 (against £900,000).

Taking into account enhanced prices, the true position in regard to the drop in volume of imports from the United Kingdom is greater than the figures show.

The Ministry of Munitions now issues ration permits for certain material to manufacturers, and the purchase of goods manufactured from such rationed material can be made without permit.

* * * *

National Health Insurance.

The important changes introduced by the National Health Insurance Act, 1918, came into operation on the 1st inst.

In cases of low wage earners, the employer has in future to pay the whole weekly contribution (7d. for a man, 6d. for a woman), including the State contribution of 1d. in cases to which it applies. He can only deduct the same amount from the worker's wages as hitherto, but he can recover the State contributions (where payable) by making application to the Commissioners on the prescribed form before the end of the half-year following that in which the contributions are payable.

Section 47 of the Act of 1911, under which an employer could pay contributions at a reduced rate in consideration of his undertaking to pay wages during certain periods of sickness is repealed. The employer is required in future to pay contributions at the full rate, and he has the right to make the ordinary deduction from wages, irrespective of any obligation he may be under to continue payment of wages during sickness.

In future, therefore, employers will *in all cases* pay contributions at the rates of 7d. a week for a man and 6d. a week for a woman.

But employers need not pay contributions for non-manual workers whose remuneration, *including* the war increase, exceeds £160 a year.

* * * *

Industrial Syndication.

We are informed that the detailed specific scheme of syndication which has been prepared and placed before the various firms in the brass industry by Mr. Howard F. Smith (a member of one of the Birmingham firms) is creating a vast amount of interest throughout the industry.

Details are being examined and the scheme is gaining adherents at such a rapid pace that it is hoped before long things will assume a definite shape. Mr. Smith believes that the combine must be formed in the daylight of public opinion and particulars of his scheme are being circulated, not only to every firm both large and small, but also to most of the recognised Trade Associations in Great Britain, who are interested in the industry. The suggested scheme describes fully the whole process of syndication from the production point of view, such as the methods of re-shuffling the manufacturing resources of the firms in the combine, so that each will specialise on certain classes of products, and also from the selling and distributing aspect, whereby a tremendous amount of wasted effort and overlapping will be eliminated. The whole question of administration of the work in each factory of the combine is also discussed and finally the financial side is referred to. The proposal is for a 51 per cent. financial merger of all the firms taking part, each firm retaining 49 per cent. only of its own capital. On this principle the profits are to be pooled and allocated and a revaluation of each firm to be made every three years in order to level up matters.

Electricity Supply.

General.

Aberdeen.—A number of firms have asked the Harbour Board to give greater facilities for the supply of electricity in connection with the repair and outfit of vessels.

Aberystwyth.—Prof. A. T. Jones is to report on the proposal to utilise the water-power in the Rheidol Valley in the generation of electricity.

Accrington.—The Electricity Committee has increased the salary of the borough electrical engineer (Mr. A. W. Clegg) from £400 to £500 per annum as from April last.

Birmingham.—Owing to the recent advance of 2s. 6d. per ton in the cost of coal, the Council decided on Tuesday to increase the charges for electricity to low-tension lighting and power consumers by 5 per cent. as from the reading of the June meters.

Derby.—A fresh agreement has been made by the Electricity Committee for the supply of energy to the British Cellulose Co.

It has now been arranged to meet a maximum demand of 3,000 kw., the company to pay for a minimum of a million units per month when the full supply is available, with a temporarily reduced minimum. The agreement is for three years, but determinable by 12 months' notice.

The Council propose to spend £20,000 for the provision of additional boiler and incidental plant.

Haslingden.—The Council will supply electricity to the local massage centre at Greenfield.

Llandudno.—The Urban Council was informed last week that the past year's income of the electric supply department was £11,463 and the expenditure £13,189, leaving a deficit of £1,725, against £1,660 in the previous year,

It is proposed to meet the deficit by obtaining £1,000 out of the rates and £726 from the reserve fund.

The chairman of the Electricity Committee (Mr. S. Chantrey) proposed that consumers of less than 87 units per quarter be charged 8d. per unit; if they exceeded 87 units but not 100 units, they would pay for 100 units at 7d. per unit. Consumers of 100 up to 428 units would be charged 7d.; if they exceeded 428 but not 500 units, they would be charged for 500 units at 6d. From 500 to 833 units the charge would be 6d. Consumers of 1,000 units or more would be charged 5d. a unit. All consumers should be required to pay a minimum of 5s. 4d. a quarter.

The proposal was referred back in order to bring up a more equitable scheme.

The Council offer to renew the agreement with the Llandudno & Colwyn Bay Electric Railway (Ltd.) for the supply of electric current, subject to sliding scale of charges based on the cost of fuel.

Manchester.—In the annual report of the electric supply department, which was presented to the Council on Tuesday, the Electricity Committee refers to the difficulty caused by the shortage of coal supplies and the calling up and taking of men for military service.

The coal supplies to the three generating stations were maintained with difficulty during the past winter, and the outlook for the future—in view of the growth in the demand for electricity supplies—gives rise to anxiety. The calling up of men for military service, especially those with special knowledge and of long service with the department, has rendered it extremely difficult at times to carry on. "It does not seem to be appreciated," the report states, "by the authorities that satisfactory substitutes are unobtainable, or that the consequences of an interruption of supply would be a most serious thing for the war industries of the city."

Sunderland.—The Corporation has decided to put in additional boiler plant and a cooling tower.

Electric Traction.

Electric Vehicle Progress.—Glasgow Corporation has decided to purchase two 2-ton electric vehicles for general carting work, at an estimated cost of £2,536.

Owing to shortage of labour the North Eastern Railway Co. is introducing an electrically-propelled luggage barrow at the Leeds and other important stations on its system. The new barrow is similar in size to the old four-wheeled luggage carrier still in general use, and is capable of carrying 25 cwt. of luggage.

Ilford.—The tramways manager (Mr. L. E. Harvey) has been authorised to use the Sandberg process for hardening rails on 50 joints at £2 per joint.

Kirkcaldy.—The ordinary tramway and transfer fares have been increased and the number of stopping places have been reduced.

L.C.C. Tramways.—London County Council has applied to the Board of Trade for an Order to extend the periods limited for the construction of certain tramways and for certain street widenings. Objections to the Board of Trade by July 10.

Increased fares came into operation on the lines north of the Thames on Sunday.

Every route will be divided into sections, any three of which may be traversed for a penny, six for twopence, nine for threepence, and so on. Workmen's penny fare stages in the London area will consist of four sections, with a return fare of twopence. The single workmen's penny fare stages will be raised to twopence, and the twopenny return fare to threepence. These fares will apply to a continuous journey from any one of the London termini to the London County boundary. Through running routes with other tramway undertakings have been divided into sections in the same way as the Council's tramways.

Metropolitan District Railway.—The Board of Trade has extended by one year the period for the purchase of lands for widening the Wimbledon and Fulham railway of the L. & S.W. Railway, and for the purchase of lands for the Wimbledon and Sutton railway.

Tramway Parcel and Goods Traffic.—The managers of tramway undertakings in Scotland have been requested by the Road Transport Board to prepare a report on a proposal that parcels and goods in larger bulk might be conveyed on tramcars. The object is to relieve the pressure on railways and also to effect economies in the use of horses and in mechanical transport on roads.

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Imperial Notes.

Hydro-Electric Power in Australia.—H.M. Trade Commissioner states that, according to the Commonwealth statician, there were in 1915 247 establishments in the Australian Commonwealth supplying electric light and power, the value of the machinery being £5,437,000 and the units produced 348,123,000 per annum.

Relatively to its size, more water-power is available in Tasmania than in any other State of the Commonwealth. At the end of 1916 the Government authorised the expenditure of a further £171,000 for extensions of the Government's Great Lake power undertaking, from which three of the largest consumers take 12,000 H.P. Experiments made by the Electrolytic Zinc Co. indicate that the production of electrolytic spelter on a commercial scale will be successful, and works for the manufacture of calcium carbide at Electra (North West Bay) are reported to be complete. The calcium carbide imported hitherto has been 13,000 tons per annum. New purposes for which the energy produced by the Government hydro-electric department is used are electric incubators, medical purposes and electric cooking and heating, and the charging of electric vehicles. Among prospective consumers is a steel works, which will require 2,000 H.P. for smelting steel scrap. An appropriation is being made in the Tasmanian estimates for the current year of £23,500 in connection with the hydro-electric department, part of which is for investigation of the King river project. The only other important hydro-electric scheme in Tasmania is that of the Mount Lyell Mining & Railway Co., which is able to supply 5,000 H.P.

In New South Wales the official estimates show that about 300,000 H.P. of water-power is continuously available. Schemes for hydro-electrical development on the Murrumbidgee, at Burrinjuck Dam, and on the Nymboida river have been inquired into by the Parliamentary Standing Committee of Public Works, and those on the Snowy, Shoalhaven, Cataract, Cordeaux and Tumut rivers and Gilmore Creek await consideration.

The only sources of water-power in Queensland as to which reliable information is obtainable are the falls in the Barron river, near Cairns. A report in 1906 on these falls as a source of power stated that 3,480 H.P. could be obtained with a head of 818 ft., and a minimum flow of 50 cubic ft. per second, or 10,440 H.P. with the normal flow of 150 cubic ft.

The officers of the State Rivers and Water Supply Commission report that total water-power developed in Victoria does not exceed 1,000 H.P. The promoters of the Kiewai river scheme estimate a total output of 30,000 kw., and offer to undertake to supply current in bulk at $\frac{5}{8}$d. per unit. The State Rivers, &c., Commission also have before them the Snowy river scheme, but their decision in regard to that is to be deferred until the Government's policy in regard to the Kiewa river scheme is known. The Minister of Mines recently stated that a Bill dealing with the whole question of public supply would be introduced in Parliament this year, and that an additional 100,000 H.P. would be required almost immediately. Before committing itself in regard to the question of deriving electrical energy from the Marwell Crown coal, the Government desire to know whether the water-powers and the State can meet all requirements.

There are no sources of water-power in South Australia, while in Western Australia the streams are generally small.

Miscellaneous.

Fuel and Lighting Order.—The new Household Fuel and Lighting Order was issued on Wednesday, but took effect on July 1.

The object of the Order is to effect a saving of not less than a quarter of the coal hitherto available for domestic use, and it applies to all coal, gas and electricity used in private dwelling houses, flats, tenements and similar buildings for lighting, heating or cooking, or for any other than industrial purposes. England and Wales are divided into two areas, A and B, with a separate allowance for each. The southern (or B) division comprises the countries of Gloucester, Oxford, Northampton, Cambridge, and Norfolk, and all counties south of them, together with the Metropolitan area. The quantity of coal, gas and electricity allowed for fuel and lighting is set out in the following table :—

Where number of rooms occupied is not more than—	Fuel. Year's allowance shall not exceed —		Lighting. Year's allowance shall not exceed—	
	A	B	Gas or electricity (both cannot be taken).	
	Tons.	Tons.	Cubic ft.	B.T. units.
2	3½	3	7,500	120
3	4	3½	7,500	120
4	4½	4	11,250	180
5	5	4½	11,250	180
6	5	5	11,250	180
7	7	6	15,000	240
8	8	7	15,000	240
9	9	8	15,000	240
10	10	9	18,750	300
11	11	10	18,750	300
12	12	11	18,750	300

An additional ton of fuel is allowed where the number of persons habitually resident in the house, flat or tenement exceeds six up to 12 rooms. An additional ton of fuel is allowed for every room over 15 until a maximum of 20 tons is reached in the scale and additional gas or electricity for lighting is allowed up to a maximum of 30,000 cubic ft., or 480 Board of Trade units.

Fuel may be taken as coal, gas or electricity at the option of the consumer. In calculating a ton of fuel—

(*a*) Anthracite shall count as fuel at the same rate as ordinary coal. (*b*) Three tons of coke shall count as 2 tons of fuel, and so in proportion for other quantities. (*c*) Briquettes (not exceeding 2½ lb. in weight) shall count as 1,600 to the ton. (*d*) 15,000 cubic ft. of gas or (*e*) 800 Board of Trade units of electricity shall count as 1 ton of fuel.

Rooms shall only count when furnished and in actual occupation. Sculleries, bathrooms, halls not used as sitting-rooms, dressing-rooms, pantries not containing fireplaces or stoves, boxrooms, &c., do not count as rooms. Rooms exceeding 4,000 cubic ft. in size, or 16 ft. by 20 ft. carpet area, count as two rooms, and rooms over 8,000 cubic ft. count as three rooms.

Additional allowances for both fuel and lighting may be granted to consumers by the Local Fuel Overseers in cases of illness, &c.

The Order come into effect on July 1. Six weeks after this date, fuel and lighting in excess of certain minimum quantities can only be supplied if the consumer has made an application upon the proper form. The necessary forms will be obtainable after July 28 at the offices of all registered coal merchants or licensed coal dealers, at gas offices and electricity offices and at the office of the Local Fuel Overseer. The minimum quantities are : Coal or coke, 2 tons 12 cwts. (or 1 cwt. per week throughout year); gas, 22,500 cubic ft. (not more than 7,500 to be burnt in any quarter); electricity, 120 B. of T. units (not more than 40 to be consumed in any quarter).

Where a consumer does not require more than these quantities, the only step necessary is to register with some coal merchant or dealer.

The allowances of gas or electricity will be for one year commencing from July 1, the allowance of coal will be for one year from the date of the requisition provided it is received and dealt with prior to Sept. 30, after that date the allowance of coal will be for such part of the year commencing from July 1 as there is still to run

Allowances of gas or electricity must not be consumed at a greater rate than one-third in any quarter. Where, however, a saving is made in one quarter it may be consumed in any succeeding quarter of that year.

Registered coal merchants and licensed coal dealers have been placed under restriction as to the quantities of coal to be delivered at one time in summer and in winter to secure an equitable distribution.

Meter readings will be taken at least once in each quarter. Where a consumer takes an excess quantity of gas or electricity he must be reported to the Local Fuel Overseer, who may cancel such consumer's supply of coal, present or future, to an extent necessary to meet such excess, or he may prosecute such consumer for an offence.

After a prosecution, a consumer still taking gas or electricity in excess may have his gas or electricity cut off.

The Coal Trade.—The report of the Departmental Committee on the Coal Trade after the war was issued last week, and among its recommendations are the following :—

That the policy of the country be directed towards maintaining and if possible increasing the export coal trade.

That all restrictions on the free export of coal imposed during the war, including the present system of export under licence, should be removed as soon as possible after the termination of hostilities.

That in order to promote the interests of foreign trade, not only in coal but in other commodities, shipping in enemy hands should be made available for the immediate use of this country and her Allies at the close of hostilities.

That on the termination of hostilities all men who prior to the war were employed in colliery work should be released from military duties at the earliest possible moment, and that every effort should be made by coalowners to reinstate these men as rapidly as it is practicable to do so.

That the attention of coalowners be directed to the desirability of introducing, wherever practicable, the most up-to-date appliances for increasing the output per person employed.

That the miners in every coalfield should be encouraged to raise the individual production of coal, and that any restrictions in operation affecting output should be withdrawn.

That a statutory tribunal be set up having powers (1) to enforce the granting of wayleaves, and (2) to consider applications for, and, if so advised, to enforce, the granting of facilities to mineral workers or lessees for the erection on land adjoining collieries of coke ovens, by-product plants, &c.

That coalowners, exporters and shippers interested in special markets should co-operate to prevent these markets from passing out of British control, and to secure satisfactory discharging, landing and transport facilities for British coal in foreign countries.

That an investigation should be made into the character of the plant in operation and the facilities afforded at all home ports used for the shipment of coal with a view to bringing them up to the highest level of capacity and efficiency.

That statistics of the trade in British coal and coal in competition therewith in foreign markets should be obtainable month by month by those interested in the export coal trade.

U.S.A. Telegraphs and Telephones.—President Wilson has asked Congress for power to take over all the telegraph and telephone lines in the United States. The President states that this is essential to prevent interruption of the telegraph service and to guard military secrets and Government communications.

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Tenders Invited and Accepted.

Wiring, &c.

MANCHESTER Education Committee require tenders by July 10 for wiring the Nanson-street Municipal Schools, Ardwick. Specifications from the Education Offices, Deansgate, Manchester.

GLASGOW.—The Corporation has placed orders with Hadfields, Ltd., and Edgar Allen & Co. for special tramway track work.

The following tenders have also been accepted: H. Bessemer & Co. and Brown Bayley's Steel Works, steel axles, tires and wheels; Carron Co., chilled-iron brake blocks (three months); Spiers, Gibb & Co. and Glenboig Union Fireclay Co., fireclay goods (six and 12 months); North British Rubber Co., Clyde Rubber Works, Ltd., G. M'Lellan & Co., Rubber Co. of Scotland, and J. T. Goudie & Co., rubber and asbestos goods; Falkirk Iron Co., Carron Co. and Lion Foundry Co., c.i. boxes, section pillars, &c.: Chamberlain & Hookham, Ferranti (*Ltd.*), British Westinghouse Co. and Aron Electricity Meters (Ltd.), meters; Callender's Cable Co., single, concentric and triple-concentric and e.h.t. cables; W. T. Glover & Co., h.t. cables; Craigpark Electric Cable Co., rubber-covered cables and flexibles.

The Tramways Committee has also accepted the following tenders:—

British Westinghouse Co., armature coils; F. Smith & Co., trolley wire; Bolckow, Vaughan & Co., 500 tons, and Walter Scott (Ltd.), 200 tons of tram rails.

IPSWICH.—The Corporation has accepted the tender of the Brush Electrical Engineering Co. for the supply of a 3,000 kw. Brush-Ljungstrom steam turbo-alternator, with condensing plant, circulating pump and motor, wet air filter, &c., at £19,150.

WOLVERHAMPTON.—The Council has accepted the following tenders:—

A. Reyrolle & Co., switchgear, £824; Mather & Platt, two pumps for cooling towers, £1,044. 4s.; Willans & Robinson, changing extractor system of part of the 5,000 kw. turbo sets from the "series" to the "shunt" system, &c., £430; Alley & McLellan, two 18 in. and two 16 in. valves for cooling tower pumps, £148; Globe Tank & Hurdle Co., erection of air shaft in boiler house, £62.

Government Contracts.—The following tenders were accepted by the British Government Departments during May:—

War Office.—Siemens Bros. & Co., rod and sheet ebonite; Day Motor Co. and West Ham Corporation Elec. Supply Dept., electric lighting sets; Austin Motor Co., British Westinghouse Elec. & Mfg. Co., Buffalo Forge Co., Electro Motors (Ltd.), Keighley Gas & Oil Engine Co., Lancashire Dynamo & Motor Co., R. A. Lister & Co., Parsons Motor Co., Rhodes Motors (Ltd.) and Siemens Bros. Dynamo Works, generating sets; Crypto Electrical Co., Electrical Apparatus Co., Electrical Construction Co., F. Parkinson & Co. and Phœnix Dynamo Mfg. Co., motors, &c.; Veritys (Ltd.), switchboards; British Thomson-Houston Co., switchgear; British Rubber Mfrs. (Ltd.) and Connolly Bros., insulating tape; Pritchett & Gold and Electrical Power Storage Co., electrical work.

Post Office.—British L.M. Ericsson Mfg. Co., telegraph apparatus; British L.M. Ericsson Mfg. Co. and Western Electric Co., telephone apparatus; Tyer & Co., boards for telegraph sets; Bullers (Ltd.), brackets; Telegraph Construction & Maintenance Co., submarine cable; British Insulated & Helsby Cables, W. Geipel & Co., General Electric Co., Henley's Telegraph Works Co., Johnson & Phillips, C. Macintosh & Co., Peel-Conner Telephone Works, Pirelli General Cable Works, Siemens Bros. & Co., Union Cable Co. and Western Electric Co., telegraph and telephone cables; Siemens Bros. & Co. and Western Electric Co., cords for telephones; J. Bourne & Son, Bullers (Ltd.), Doulton & Co., J. Macintyre & Co. and Taylor, Tunnicliff & Co., insulators; Walls (Ltd.), earthplates; P. Huntington & Co., cable suspenders; C. Macintosh & Co., flameproof wire.

India Office.—J. Stone & Co., cells.

H.M. Office of Works.—S. Reed & Sons, electric wiring Ministry of Pensions buildings, Chelsea; Mather & Platt, motor-generator for National Physical Laboratory; T. Clarke & Co., wiring at N.P.L.; Vickers (Ltd.), motors, motor-generators, &c., for N.P.L.; Fergusson, Pailin & Co., switchboards for N.P.L.; Alpha Mfg. Co., wiring Plymouth grain stores.

Appointments Vacant and Accepted.

Hammersmith (London) Borough Council require an engineer-in-charge. Salary £175, plus 20s. weekly as war bonus. Applications to the engineer and manager (Mr. G. G. Bell), 85, Fulham Palace-road, Hammersmith, W.C., by July 12. *See advertisement.*

A charge engineer is required for tramways sub-station. Wages 50s. a week, plus war bonus of 20s. and 12½ per cent. Applications to the General Manager, L.C.C. Tramways, 23, Belvedere-road, S.E.1. *See advertisement.*

A traffic superintendent is required for the West Ham Corporation Tramways. Salary £250, increasing to £300. Applications to the general manager by July 8.

A draughtsman is required by the Yorkshire Electric Tower Co., Wellington-road, Dewsbury.

A technical assistant for cable designing is required by an advertiser.

A shift engineer is required for the Accrington Corporation electricity works. Applications to the engineer and manager, Mr. A. W. Clegg.

A shift engineer is required for the Stoke-on-Trent electricity works. Applications to the borough electrical engineer, St. Peter's-chambers, Glebe-street, Stoke-on Trent.

Colwyn Bay Urban Council has appointed Mr. J. Smith, gas manager, as engineer and manager of the electricity undertaking in succession to Mr. A. R. Tudman. Mr. Smith's salary has been increased from £400 plus £17 bonus, to £600 per annum.

Mr. H. H. Sutcliffe has been appointed chief electrical engineer of the Hebden Bridge electricity works in succession to the late Mr. J. W. Garside.

Municipal Accounts.

Birmingham.—The accounts of the electric supply department for the year ended March 31 show gross capital expenditure £2,684,214 (increase £128,264), of which £1,972,132 is outstanding.

Revenue was £861,601 (compared with £726,566 in previous year), and total expenditure was £620,740 (£501,592), leaving gross profit £240,860 (£224,974). After providing for capital charges and placing to reserve £6,727 (£1,432), and to renewals and special expenditure account £39,500 (£40,000), the surplus was £25,263 (£27,794). Units sold were 160,275,400 (149,724,637). Lamp connections in 60-watt lamps are 347,103 (342,290), and motor connections 131,912 H.P. (122,153 H.P.).

Glasgow.—The total revenue of the tramways department for the year ended May 31 was £1,412,635 (including £1,404,110 traffic receipts), compared with £1,260,115 in 1916-17.

The traffic expenses were £527,152 (£395,735), general expenses £156,949 (£137,816), maintenance and repairs £179,811 (£143,757), power expenses £86,018 (£67,231), Clydebank bridges £1,131 (£879), European war £93,120 (£92,645); total expenditure £1,044,183(£838,065), leaving a balance of £368,452 (£422,049). After deducting interest on investments £8,579 (£78,637), and paying rent of Paisley lines £11,118 (£8,453), interest nil (£78,846), sinking fund nil (£114,377), income tax £64,405 (£64,622), Parliamentary expenses £60 (£97), and renewal and depreciation £123,894 (£73,304), the surplus to be handed over to the Common Good is £177,552 (£160,984).

Leeds.—At March 31 the gross capital expenditure was £1,709,772, and the net debt £1,014,463.

Revenue was £271,595 (compared with £242,589 in previous year), and after meeting working expenses, &c., the gross profit was £136,111 (£133,135), of which war allowances absorbed £1,198 (£1,752), income tax £4,506 (£2,926), interest £46,293 (£42,730) or £42,731 (£41,177) after deducting bank and investment interest, leaving £87,674 (£87,278) net profit. Redemption of debt required £68,507 (£69,992), extraordinary renewals £9,496 (nil), and contributions to capital £9,391 (£13,125), leaving surplus profit £277 (£4,161). Working expenses were 0·52d. (0·48d.) per unit sold, and total expenditure charged against revenue was 1·04d. (as in previous year). Units sold were 62,771,883 (54,992,742). Aggregate horse-power of motors in use is 15,950 (15,315).

In the report of the manager (Mr. C. Nelson Hefford) it is stated that the greater part of the increase in units sold is due to power, but there are comparatively large increases in sales for heating and residential bulk supplies, which are chiefly used for heating. Maximum load was 24,920 kw. (22,255 kw.). The 12,000 kw. turbo-alternator ordered in 1914 became available for use near the end of the period under review.

Companies' Meetings and Reports.

Globe Telegraph & Trust Co. (Ltd.)

The forty-fifth ordinary general meeting was held on Tuesday, July 2, Sir JOHN DENISON-PENDER, K.C.M.G., in the chair.

The SECRETARY (Mr. Sidney Collett) having read the notice convening the meeting, &c.,

The CHAIRMAN, who paid a tribute to the memory of the late chairman, Sir John Wolfe Barry, said: Our total receipts for the 12 months ended May 31 last, after deducting working expenses, amounted to £228,394, showing a small increase of £1,770 over those of the preceding year, and makes with the balance carried forward from last year a total of £283,570. We have paid to our preference shareholders the usual fixed quarterly interim dividends of 3s. per share, less income tax, and to our ordinary shareholders three interim dividends at the rate of 2s. per share, free of tax. These distributions have absorbed the sum of £115,468, and your Directors now recommend the payment of a final dividend of 3s. per share, less income tax, on the preference shares, making 6 per cent., less tax, for the year, and of 8s. per share, free of income tax, on the ordinary shares, making with the previous distributions above referred to a total dividend for the year on the ordinary shares of 7 per cent., free of income tax. The shareholders will have noticed that in the present accounts a reserve of £75,000 has been created to meet contingencies. The income from this fund, which, as you know, has been gradually accumulating for many years, will be available for contingencies, also equalisation of dividends, and it is quite possible that we may have to draw upon it to some

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extent in the near future to meet directly or indirectly British and American war taxes. There remains a sum of £1,179 to be carried forward to the next account. There have been only three changes in our investments during the year. You will notice that our receipts from the Central & South American Telegraph Co. are increased by £1,786. This increase represents the dividend on the new bonus shares, and we benefited to the extent of 2,096 shares; but I must tell you that the question has been raised, and negotiations are now pending, as to our liability to pay British income tax on these bonus shares, which is a rather serious matter. After explaining the returns on their various investments, &c., the chairman concluded by stating that, "taking into account the loss of capital which we sustained a great many years ago, but which has always been included in the accounts since—taking that into consideration, the appreciation in the holdings of the Trust to-day is very nearly £1,000,000."

The report and accounts for the year ended May 31, 1918, were then adopted, and the dividends as recommended were declared. Sir John Denison-Pender, K.C.M.G., was re-elected a Director, and Messrs. Deloitte, Plender, Griffiths & Co. were re-appointed auditors of the Company.

ANGLO-ARGENTINE TRAMWAYS CO. (LTD.)—The gross receipts for 1917 were £2,783,412 and working expenses were £2,051,746, leaving £731,665. Adding interest on investments, transfer fees, &c., the total is £769,987; with £50,969 brought in, the available balance is £820,956. Deducting annuity to City of Buenos Ayres Tramways Co. (£70,660), interest and sinking fund on debenture stocks (£587,821), sinking fund for redemption of preferences and ordinary shares (£6,485), interim dividend on 5½ per cent. cumulative first preference shares for half-year ended June 30, 1917 (£88,000), the balance is £67,990. Traffic receipts show an increase of £47,776. Number of passengers carried was 324,231,620, an increase of 5,811,811. The abnormal cost of fuel continued during the year and the expenses for electric traction amounted to £639,541, which, after allowing for the additional mileage run, is £273,734 in excess of what would have been incurred had the cost of fuel continued on the pre-war basis. In view of the uncertainties regarding the provision and cost of fuel, &c., the directors are unable to recommend a final dividend on the cumulative first preference shares.

At the meeting on Monday Mr. W. F. Hamilton, K.C., who presided, stated that the traffic on their subway had increased, and the line had become a favourite means of transport, and vacant houses in the neighbourhood were rapidly snapped up. The most careful attention had been paid to the upkeep of overhead lines, permanent way and rolling stock, £248,754 having been spent during the year on maintenance. Owing to the war and the shrinkage of tonnage available for carrying coal, the cost of coal had risen from 30s. a ton in pre-war days to over £8. Under their power contract the charge for electric energy increased proportionately with the price of fuel, and the price per unit had thus increased by nearly 200 per cent. Had they only to pay pre-war prices for the current consumed in 1917 they would have had an additional sum of £319,000 for distribution in dividends.

DELHI ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—The gross receipts of the tramway undertaking for the year 1917 were £13 343 and of the electric supply undertaking £25,785, representing increases of 20 per cent. and 12½ per cent. respectively over the figures for 1916. The net revenue was £15,119 against £11,593 in 1916. The profit, after charging general expenditure in London and Delhi, debenture and loan interest and Indian income tax, and after providing £5,000 for depreciation of plant and transferring £1,500 to reserve for renewals, was £4,419, and with £1,089. 5s. 6d. brought forward, the available total is £5,508. The directors recommend payment of a dividend upon the preferred share capital at rate of 4 per cent., absorbing £4,000, and leaving to be carried forward £1,508. Additions to plant during the year cost £8,964. The new 350 B.H.P. Diesel engine was put into operation in April, 1918. The increase in the demand for current during the past winter necessitated the working of the plant under unfavourable conditions.

GENERAL ELECTRIC CO. (LTD.)—The net profits for the year ended March 31, amount to £348,861, and with £89,786 brought forward the total is £438,647. After deducting debenture stock interest (£8,000), normal and special depreciation (£39,716), grants to dependants of men on active service. (£13,664), managing director's and employees' bonus (£25,915), dividend at rate of 6 per cent. per annum on preference share capital (£42,000), reserve for income tax on ordinary share dividend (£12,813), and transferring to reserve account £100,000, the available balance is £196,540. The directors recommend a dividend at the rate of 10 per cent. per annum (tax free) on the ordinary share capital for the year (£51,253), leaving to be carried forward £145,286. Electrical equipment of all kinds has played an important part in the prosecution of the war, and in consequence all the works of the Company have been fully employed throughout the year. The difficulties created by the continued process of dilution of labour have been admirably overcome by the energies and whole-hearted co-operation of the staff. Nearly 2,000 of the employees have joined the Colours and 166 have made the supreme sacrifice. The increase in the capital expenditure is mainly due to the acquisition of a freehold site for the erection of future factories near Coventry. The Conner-Magneto & Ignition (Ltd.), in which the Company holds the controlling interest, has recently erected a factory on an adjoining site. The increase in the investment acount is due to the acquisition of the whole of the ordinary share capital of Chamberlain & Hookham. The Cmpany has recently entered into an agreement for the purchase of the whole of the works of Fraser & Chalmers, at Erith. The actual purchase price will only be ascertained after the valuation of the assets has been completed. For the purpose of carrying out these, as well as other transactions, it is proposed that the capital of the Company should be increased to £3,000,000 by the creation of 100,000 preference shares of £10 each and 600,000 ordinary shares of £1 each. The directors suggest creating a fund for the superannuation, pensioning off and benefit of the employees of the Company, or their families or dependants. For this purpose they contemplate allotting to trustees shares to the value of £25,000, the unissued balance of the ordinary share capital. The reserve account stands at £700,000, and it is proposed to capitalise £300,000 of this by converting it into 300,000 ordinary shares of £1 each and distributing such shares amongst the existing ordinary shareholders in the proportion of five £1 shares for every one £10 share now held. To avoid difficulties in dealing with a fraction of a share, the directors propose that the existing ordinary shares of £10 each should be converted into ten shares of £1 each. The directors propose shortly to raise £1,000,000 further capital by an issue of preference and ordinay shares, for which the sanction of the Treasury has been obtained, and also to raise the dividend both in respect of the existing and new preference shares from 6 per cent. to 6½ per cent. Resolutions to carry the above into effect and for adopting new articles of association will be submitted to extraordinary general meetings of the Company for adoption. Major-General the Hon. Sir Newton J. Moore, K.C.M.G., and Mr. Arthur Chamberlain have joined the board.

The Treasury has refused for the present to sanction the division or issue of the ordinary share capital into shares of a lower denomination than £10, but this will not introduce any alteration in the directors' scheme, except that the denomination of the ordinary shares will remain £10, instead of £1.

City Notes.

CHILI TELEPHONE CO. (LTD.)—The directors recommend a final dividend of 5s. per share, tax free, making 8 per cent. for the year, and a distribution of 22,000 fully-paid ordinary £5 snares to existing shareholders in the proportion of one in three.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The 4 per cent. mortgage debenture stock register will be closed from 27th to 31st inst. inclusive, preparatory to payment of interest due August 1.

NATIONAL ELECTRIC SUPPLY CO. (LTD.)—An interim dividend of 5 per cent. per annum (2s. 6d. per share), less tax, has been declared on the ordinary shares for the past half-year.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—An interim dividend of 5 per cent. (12s. per share), tax free, has been declared. The transfer books are closed from the 1st to the 11th inst. inclusive.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—The transfer books are closed from the 5th to 11th inst. inclusive for the allotment of the share bonus of 1 new fully-paid ordinary share of £1 each for every fully-paid ordinary share now held.

The Round Table.

By "kVA."

EVENTS OF THE WEEK.—The Stafford Council is recommended to increase the salary of Mr. W. H. Robins, the electrical engineer, by £20 per annum.

* * * *

Colwyn Bay Urban Council has appointed Mr. J. Smith, gas manager, as engineer and manager of the electricity undertaking, in succession to Mr. Tudman. Mr. Smith's salary has been increased from £400 plus £17 bonus to £600 per annum.

* * * *

The question most discussed at the I.M.E.A. Convention was "Will the super-power station justify itself?" Obviously, the answer is "future generations will decide!"

* * *

A correspondent inquires if the O.B.E. is equal to the E.H.P. (Electrican Hot Plate). I think Edmund Hill had better answer in verse.

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, July 2, 1881.]

MESSAGES TO TURKEY.—The public are again warned by the Post Office that telegrams in code or cypher are not accepted for transmission to Turkey or Bulgaria.

IMPROVED TELEPHONIC COMMUNICATION.—The United Telephone Company have established offices in Lonsdale Chambers, Chancery-lane, and at the Metropolitan Railway Station at Westminster Bridge, so that direct communication is now available between the Law Courts and Westminster.

ERRATIC CARBONS.—At the Leicester-square Panorama the other day one of the electric lamps which illuminate the picture of Balaclava shot its livid carbon on to the straw which fills the ambulance waggon lying on the foreground between the picture and the platform. The whole blazed in an instant, and serious consequences were only averted with difficulty.

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CONTENTS.

NOTES 219
Charging Currents and Earthing Devices in Transmission Lines. By H. Behrend. Illustrated 222
The Electric Lighting of Ecclesiastical Buildings. By William Wilson, B.E., M.Sc. 223
The Fuller Companies' Electrical Works. Illustrated 224
Electric Winding Engines and Mine Hoists. By H. H. Broughton. Illustrated.—*Continued* 226
The Mechanical Design and Specification of the Turbo-Alternator Generator 228
The Operation of Railway Sub-stations Without Attendants. By W. D. Bearce 229
INDUSTRIAL ELECTRIC HEATING 230
REVIEWS 230
The Tercentenary of Common Logarithms. By William R. Bower, B.Sc. 231
All Steel Draw-Out Truck Types of Switchboards. Illustrated 232
Two and Three-Phase Induction Motors. Illustrated 233
Brush Static Transformers 233
The Erichsen Machine for Testing Metal Sheets and Strips 233
A New Light Projector. Illustrated 233
LEGAL INTELLIGENCE 233
Educational 233
Patent Record 234
Volunteer Notices 234
Commercial Topics 235
Electricity Supply 235
Tenders Invited and Accepted 237
Companies' Meetings and Reports 239

Notes.

Raising the Tramway Fares.

A BILL to enable the charges made by certain public utility undertakings to be raised has been read a second time in the House of Commons. The object in view is to remedy the unsatisfactory state in which some of these undertakings now find themselves owing to the increasingly heavy charges which they have to meet, either for the payment of materials or war bonuses and other advances in wages. The chief provisions are to the effect that, in the case of an undertaking owned by a local authority, the statutory maximum charge may be increased by not more than 50 per cent., or by such less amount as is sufficient to enable the undertaking to be carried on without a loss. On the other hand, in the case of private enterprise, an increase may be made to enable a dividend on the ordinary stocks or shares of the undertaking to be paid at half the maximum or standard rate, or at half the pre-war rate of dividend, *whichever is the lower*. The statutory maximum charges are set out in the Provisional Order or Special Act of each undertaking, and, generally speaking, the fare on tramways and light railways must not exceed 1d. per mile; also cheap fares must be provided for the labouring classes before 8 a.m. and after 5 p.m. Now, in recent years it has been a common experience that tramway undertakings have not yielded a sufficient profit to provide satisfactory dividends, and on this account considerable reductions in capital have been made. Even so, dividends on ordinary shares have often been very low, and when the pre-war rate of dividend is defined as the average of the three financial years immediately preceding the war, this means that half this low dividend will be considered by the Government to be satisfactory. Such an idea shows a ridiculous want of appreciation of the importance of paying a reasonable dividend in commercial undertakings; without such dividends it is impossible to maintain an undertaking in a proper state of prosperity, and this fact should have been realised by those responsible for the present Bill.

Earthing High-Voltage Systems.

IT is generally considered that earthing is one of our greatest safeguards against accident by shock, always provided that contact cannot be readily made with live metal near that which is earthed. The tacit assumption is also made that the flow of current in an earthed conductor does not give rise to any considerable drop of voltage. In the neighbourhood of an earth plate there may be a marked voltage gradient, though this rapidly falls off as the distance from the earth plate is increased. Some interesting diagrams bearing on this point were given by Messrs. J. G. and R. G. CUNLIFFE in a Paper read before the Institution of Electrical Engineers in 1909. If two points are selected on an equi-potential line around such a plate there is, of course, no voltage to be observed; but at right angles to these the voltage may be marked. On low-voltage systems this drop round an earth plate is unimportant; but on high-pressure systems the drop may be dangerous. This is pointed out in an article, of which we give an abstract in our present issue, by Mr. H. BEHREND. Around an earth plate there is what may be regarded as a "voltage-filter" or "funnel," which constitutes under certain conditions a kind of danger zone; within this conical zone the excess of pressure flows away, as it were, from the earth plate. It has been found in practice that curious and unexpected accidents have taken place in these zones, for it must be remembered that the capacity current (and therefore the drop) may be considerable, especially as the passage of a current tends to dry up the soil. It is therefore proposed that earthing devices should be so made that if they carry an abnormal current they automatically disconnect the high-pressure side. From Mr. BEHREND'S article it appears that further consideration should be given to the question of earthing high-tension systems if complete safety is to be secured. His dictum that "it is safe to touch nothing, especially nothing that is earthed," shows that the present position is not satisfactory.

The King and Our Industries.

A MARKED characteristic of KING GEORGE V. is his interest in our industries and his desire to obtain a true insight into their needs. Even in the days when he was Prince of Wales this inclination was evident, and it will be remembered that when he returned from his tour of the Empire he told the citizens of London that industrially the country must wake up if we were to maintain our position among the nations of the world. Since those days the war has changed many of our ideas. At the outset THE KING was quick to realise that the struggle was not merely one of arms and munitions, but one of machinery, of engineering and of science. Notwithstanding his many engagements on the important affairs of State, THE KING has not failed to spend a great deal of his time in visiting

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works and encouraging those engaged on the production of munitions. And twice during the last week he has referred to the importance of our industries. In addressing the International Parliamentary Conference last Friday, THE KING made the happy remark that "commerce is truly the life blood of civilisation." It would be well if this motto were displayed in all Government offices, not forgetting the room which sees the deliberations of the Cabinet Council. It expresses a truth which the Government seem generally to forget. Again when THE KING, on the occasion of his silver wedding, visited the Guildhall on Saturday to receive the homage of the citizens, he expressed his interest in industrial matters in the following words :—

Especially have I been struck on our visits to the industrial districts of the country by the evidence in so many quarters of a spirit of mutual concession animating both employers and workers in regard to matters affecting their individual interests, and a readiness to sink differences in order that the essential work of the country should be carried on. We may cherish, I believe, well-founded hopes that in the furnace of war new links of understanding and sympathy are being forged between man and man, between class and class; and that we are coming to recognise as never before that we are all members of one community, and that the welfare of each is dependent upon, and inseparable from, the welfare of all.

These words will be welcomed by all who are looking forward to a better social structure in this country than has existed in the past.

Industrial Health and Efficiency.

THE Committee on the Health of Munition Workers have now presented their final report (Cd. 9065), which occupies 182 pages, and contains a great deal of valuable and comprehensive information. The conclusions to which the Committee were tending have been indicated in the bulletins issued periodically since the initiation of the work, and these are now assembled and supported by additional evidence. It is satisfactory to observe that the environment and conditions of employment are now vastly better than they were at the time of the appointment of the Committee in September, 1915. The establishment of a "Health and Welfare Section" at the Ministry of Munitions has, no doubt, done much to bring this change about. Especially valuable have been the investigations into the causation of fatigue, its results of diminished output, accidents and spoiled work, staleness, ill-health and lost time. The wide-spread belief in the efficacy of unduly long hours of work, which prevailed at the outbreak of war, seems to be passing away. Originally men were employed for as much as 90 hours a week, whereas the Committee consider 65–67 hours—*i.e.*, a working day of 13–14 hours—should be the limit; while for women a maximum of 60 hours, and the avoidance of night-time as far as possible, is recommended. Experience has shown that the hours can be reduced without loss of output. The various sections of the report on such matters as accidents, food and canteens, cleanliness, ventilation, heating and lighting, &c., deserve special study. We observe that the Committee endorse the findings of the Home Office Departmental Committee on Lighting in Factories and Workshops, and mention some interesting special cases of eye trouble caused by various defects in lighting. A feature of the report is the series of photographs and sketches illustrating suitable benches, types of protective clothing, canteen and washing accommodation, &c. The ground covered is far too comprehensive to permit more than a general reference to the contents of the report, which deserves to be very widely studied. In view of its length, we think it would be helpful if the Committee would issue a short summary of its chief conclusions for general distribution, a course which we believe has been pursued with advantage in the case of other technical Government publications.

Association of Mining Electrical Engineers.—The annual meeting of the North of England branch of this Association was held at Newcastle last week. The report of the past year's work stated that there was an increase in both membership and finance. Mr. C. A. Nelson (Wallsend and Hebburn Collieries) was elected president, and Mr. Thos. H. Day was re-elected secretary and treasurer.

A New Insulating Material.—According to the "Engineer," a new Danish process by which certain by-products, valuable for electrical insulation may be made out of fish offal, is to be put to practical tests in Skagen, Denmark. The most important of the new products is called "cornimit," which is claimed to excel galalith as an electrical insulating material. It is said to have less water-absorbing ability as well as a larger insulating resistance. The price of the finished product is calculated at 5d. per lb.

The Household Fuel and Lighting Order.—Mr. T. W. Cole calls our attention to the fact that this Order takes effect from July 1st, and includes certain duties of undertakers of electricity supplies. It is advisable that all Electric Supply Undertakings should carefully peruse the section in question, viz., Part VIII., as some of the provisions affect sale of apparatus, new installations, &c., from July 1st. The Order itself is not yet distributed, but it can be read in the "London Gazette" for Tuesday, July 2, 1918, which can be obtained from the "London Gazette" Office, Imperial House, Kingsway, W.C. 2.

Influence of Hydrogen on the Resistivity of Carbon.—A contribution on the above subject by Mr. T. Peczalski, of the Nela Research Laboratory (Cleveland, U.S.A.), has appeared in the "Physical Review." It was found that at ordinary temperatures hydrogen produces no material effect on the resistances of carbon for pressures up to 33 atmospheres, but the resistance increases considerably when the filament is heated in a hydrogen atmosphere to a high temperature. Moreover, at room temperatures the resistance following such a heating shows a further increase. This effect is greater for high pressures than for low pressures. It can be counteracted by a subsequent heating in vacuum.

Cinematograph Theatres and Coal Saving.—We have referred previously to the attempts being made in the United States to substitute incandescent lamps with special filaments for arcs in cinema theatres. In a recent Paper on such lamps before the American Illuminating Engineering Society the authors point out that their substitution for arcs in the lanterns of all the picture theatres in the States would bring about an annual saving of 160,000 tons of fuel. The consumption of energy is approximately half that needed for the arc lamps. As explained previously, the possibility of using such lamps depends on the special design of filament and condenser lens with a view to increasing the percentage usefully employed.

Permanence of Photographic Prints.—During the 30 years that have elapsed since the introduction of albumenised paper in photography the problems of securing a "permanent" print has received much attention. According to modern notions a print which would remain substantially unaffected for 20 years would be considered "permanent," though it is to be desired in some cases to obtain a considerably longer period, say, 50 or even 100 years. Formerly carbon and platinum prints were considered essential for permanence and much superior to the ordinary silver prints. According to the "British Journal of Photography," however, it should now be possible to secure satisfactory permanence with a bromide paper up to 20 years, the only sign of age being a slight, and possibly avoidable, yellowing of the whites.

The Iron Resources of Canada.—Under the above title "Engineering" discusses the various sources of iron in Canada, where the proportion of mined to imported ore has been falling for some years, and the demand has exceeded the supply. Fortunately, it is believed that only the more superficial and easily accessible sources of supply have yet been tapped. For example, on the coast of Vancouver, and on the islands separating it from the main land, great mineral wealth

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is awaiting exploitation, while the vast areas round Lake Athabasca are almost unexplored. A feature of recent prospecting has been the use of magnetometric surveys, which have proved of great value in locating deposits of magnetite. In Sweden, where the conditions closely resemble those in Canada, very satisfactory deductions have been made on this basis.

A Voltage-Stabiliser to Diminish Flickering of Lamps.—In the "General Electric Review" a device was recently described which is intended to check the flickering of lamps arising through fluctuations in voltage caused when large motors are started up on the same system. The apparatus, which is described as a voltage stabiliser, consists essentially of a highly reactive transformer having a primary through which the current to the motor flows, and a secondary in series with the lamp circuit. The rush of current when the motor is started up excites the magnetising circuit of the stabiliser and induces a voltage in the lamp circuit in phase with the lamp voltage, and thus tends to maintain the P.D. across the lamps constant. The transformer magnetic circuit contains an adjustable air-gap, the intention of which is to cause the drop in the motor circuit to be in quadrature with the line voltage.

The Organisation of Railways by the State.—Mr. J. Carlier sends us a summary of two articles which he has contributed to "Le Génie Civil" on the above subject. During the war the railways in practically all belligerent countries have been taken over by the State, but doubts are expressed whether nationalisation, in its ordinary sense, will prove desirable after the war. Time is the essence of transport, and the State is not usually a "hustler." The Swiss system, which is a compromise between State and private control, has advantages, and it is suggested that the ultimate solution will be in the direction of allowing the companies to carry out their work under State supervision, the balance of profit, after meeting certain fixed interest on capital, being decided between the State and the shareholders. Such a compromise, it is suggested, would allow the State to have financial control, but would not remove the stimulus to enterprise on the part of the companies.

"The Resonance and Ionising Velocities of Electrons in Cadmium Vapour."—Scientific Paper No. 317, issued by the Bureau of Standards, Washington, contains an account of an investigation by Mr. J. T. Tate and P. D. Foote on the above subject. The types of electronic impact characteristic of mercury vapour also take place in cadmium vapour. Resonance collision of the electrons with the atom was observed at 3·88 volts, and inelastic impact resulting in ionisation was observed at 8·92 volts. The single line spectrum of cadmium is $\lambda=3260{\cdot}17A$. If we substitute the frequency corresponding to this wave-length in the relation $h\nu=eV$, where $h=6{\cdot}547\times10^{-27}$ erg.-sec., e the electronic charge, and V the resonance potential, we obtain $V=3{\cdot}78$ volts in good agreement with the above. On the basis of Bohr's theory the ionisation potential should be 8·94, in excellent agreement with the experimentally determined value. Generally speaking, the results are considered to illustrate the fundamental accuracy of conclusions based on Bohr's theory of atomic structure. Those interested may obtain a copy of this Paper by addressing a request to the Bureau.

The Heat Transmission of Building Materials.—A comprehensive series of investigations into the heat transmission of various building materials, undertaken by Messrs. A. C. Willard and L. C. Lichty, forms the subject of a bulletin issued by the University of Illinois Engineering Experiment Station. Mercury thermometers, if properly installed, will give results as good as those obtained from thermo-couples in determining the transmission coefficient (air to air), and the outside surface coefficient, the thermometer being embedded in the surface so that its centre line lies in the plane of the surface tested. The coefficient for a surface is affected by air-movements, but can be expressed as a function of the still air coefficient for the same work. Thus, with an average wind movement of 15 miles per hour a value of $K_2=3K_1$ is suggested. The effect of the humidity of the air on the heat transmission of an ordinary building is small, but if the walls are actually wet the surface coefficient may be considerably affected. It is of interest to note, according to the author's experience, that air-space construction is of value at low temperatures, but not at high temperatures, as in this case the transmission of heat across the air-space increases very rapidly.

The Effect of Artificial Light on Plants.—It has long been known that exposure to strong light had a noticeable effect on the growth of plants. Some interesting results of experiments conducted by Mr. L. L. R. Hayden and Dr. C. P. Steinmetz are described in a recent issue of the "General Electric Review." Beans were selected as a suitable subject for experiment, owing to the relatively short natural life of the plant, the extra artificial light being supplied from a series of gas-filled incandescent lamps, which were used to illuminate a piece of ground 5 ft. by 9 ft. For this area five 500-watt lamps, consuming 2·5 kw. were used. As a check-test some similar plants were placed in a box 36 in. square, in the same soil, but exposed only to natural light. It was found that under the influence of this strong artificial light the plants ripened and came to fruition in about half the time required by the ordinary natural light. It is suggested, however, that the process would not be economically justified for such cheap products as beans, but only in the case of those plants the fruit of which has a greatly enhanced value if raised and brought to market at a certain definite time.

Indirect Lighting in Textile Factories.—The lighting of textile mills has always been a somewhat awkward problem, owing to the complexity of the machinery and the large number of moving belts and machinery which interfere to some extent with the placing of overhead lamps and give moving shadows. Although modern machinery and arrangement—the elimination of belts through individual motor-drives, for example—has mitigated these difficulties it has hitherto been usual to install lamps for individual groups of machines, and to use direct lighting. Indirect lighting, though apparently possessing special advantages for this class of work, has not been used to any great extent in the past, partly no doubt on account of small overhead space and absence of suitable reflecting surfaces, and partly because the maintenance of arc lamps was considered troublesome. The introduction of gas-filled lamps of high candle-power has put a somewhat different complexion on the problem, and in a recent issue of the "Transactions" of the Illuminating Engineering Society (U.S.A.) an account is given of an apparently successful installation of this kind. In this case 500-watt units, located in rectangles of 22 ft. by 26 ft. were employed, the consumption being approximately 0·87 watt per square foot. The soft shadows given by the system appear to have been very suitable for the lighting of the complicated machinery employed and the illustrations presented suggest that the diffusion of light into every corner of the room, and the consequent diminution of moving shadows, was quite satisfactory.

Personal.

Mr. G. R. Clarke is now Director General of Indian Posts and Telegraphs, in succession to Sir Wm. Maxwell, who recently retired.

Señor Eduardo Pittaluga has been appointed Director General of Government Posts, Telegraphs and Telephones in Uruguay.

Señor F. de P. Arrillaga succeeds the Duke of Bivona as Director General of Spanish Posts and Telegraphs.

MILITARY HONOURS.—The following honours have been conferred:—

Sec.-Lieut. F. H. M. Joyce (99th Siege Battery), formerly engaged in the India Rubber Co.'s head office, has been awarded the Military Cross.

Gunner F. Yates (R.F.A.), formerly employed by Messrs. Dick, Kerr & Co., has been awarded the Military Medal.

WAR CASUALTIES.—The following casualties are reported:—

Pte. G. D. Lambert (London Regt.), formerly engaged in the India Rubber Co.'s general office, is in hospital with trench fever.

Sgt. A. Halsey (M.G.C.), formerly employed in the India Rubber Co.'s works, is a prisoner of war in Germany

A. B. Jas. Mason (R.N.D.), formerly employed by the Blackpool and Fleetwood Tramroad Co., is a prisoner of war in Germany.

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Charging Currents and Earthing Devices in Transmission Lines.*

By H. BEHREND.

The capacity of high-tension lines makes it necessary to adopt special precautions for the protection of human life; and the following remarks have reference solely to these protective devices, and not to those that may be necessary for continuity of working. Any conductive connection between tramway rails and earth is to be considered as an earthing device which has no connection with the working of the line, for a tramline works perfectly with insulated rails, even if the latter have a notably different potential from the earth. But the earthing plates of lightning conductors are quite different, as they are an essential part of the system. Ruppel has investigated the fall of potential in the neighbourhood of an earthing plate; in almost all cases, a straight line shows this fall on logarithmic paper. Without touching anything at all, a man may receive a shock if he stands with his legs wide apart on ground through which current is passing, if his two legs are not on an equi-potential surface. Many accidents of this kind have happened. Thus a pole carried a switch box, and was 10 yards from a pit containing water; the switches were properly earthed according to the regulations, but were defective owing to some cause. A man instructed his assistant to close the switch, and received a shock when this was done, as his feet were in a direct line to the pit containing the earth plates. Both energy and charging currents may cause shocks. The following is a very ordinary case. A transmission line is supported by pin insulators on iron poles, which stand in moist ground and are properly connected to earth plates. If an insulator breaks and one of the transmission lines touches the iron mast, only chance can save a man from death, even although the mast is properly earthed. Dry stockings and rubber shoes are the best protection against an accident of this kind. The same thing might happen with a transformer case, if one of the terminals were injured. In both cases a capacity current flows to earth; there is also a watt-current if the neutral point of the transformers is earthed at the central station. We may for the moment neglect the possibility of another earth on another phase. We must first consider the amount of the capacity currents, and must admit that it is impossible to calculate them with great exactness. In a former article, the author has published some fairly exact formulæ for polyphase systems, which can be used for rule-of-thumb calculations. On a three-phase system, the charging current is the ratio of the product of kilovolts and kilometres to 550; on a single-phase system, it is the ratio of the same product to 630, always assuming there is no fault on the line. If there is a fault, then on a single-phase system the charging current flows from the conductor to earth, and on a polyphase system 1·4 times this current. For low voltages between 10 and 20 kilovolt, these values are rather too low; above these values of the voltage, they are rather too high. The error may amount to 10 per cent. Let us now take the following case: The voltage of a distributing network is 15,000, and it extends over 1,000 km.; to this a three-phase transformer of 40 or 60 kw. is connected, which is housed in a brick chamber with a cement floor. Everything is mounted in the prescribed fashion according to the regulations. Suppose there is a fault in some insulating device. Then the charging current, flowing to earth, is about 38 amperes. The earthing becomes more and more defective owing to the drying of the soil by the passage of this heavy current. An earthing device is considered satisfactory if it has a resistance of 20 ohms, and thus there is a fall of 760 volts, which gradually rises as the current continues to pass. This voltage fall is a danger to human life; but it is important to know what current can pass through a man without fatal results, and this depends not only on the voltage. The coils of a normal transformer have a considerable capacity in relation to the iron core; so that even if the prescribed connections are made between the core and earth, considerable currents can flow, if the terminals are completely insulated. Let us now suppose the high-tension winding of a 60 k.v.a. single-phase transformer to be connected to two phases of a 15,000-volt polyphase network. The voltage between the iron core and earth may amount to about 4,500 volts. The current flowing through the earth connection may be 2 milli-amperes. This current is determined by the apparent capacity of the iron core which in the present case may be taken as 0·00143 microfarad. It seems to be known that a man can stand alternate currents of normal frequency up to 100 milli-amperes, and very high currents have been known to pass through the human body without fatal results. More men have been killed at pressures about 500 volts than at very high pressures such as 10,000 or 100,000 volts; but this may be due to greater caution in the latter case.

For the sake of simplicity, let us now take two electrically distinct, separately insulated, single-phase circuits. Let Fig. 1 show the high and low-tension windings of a transformer; the conductor 1 is 7,500 volts above the earth potential, and conductor 3 the same amount below; conductors 2 and 4 are each 110 volts on either side of the neutral. The points 7 and 8 can be connected together without causing capacity currents to flow, but it is not possible to inter-connect two points at random on the two circuits. Nor if the conditions are changed, as shown in Fig. 2, where conductor 1 is connected to earth. Then the point 7 has a potential 7,500 volts below that of the earth, and so on. If the points 7 and 8 are now connected, the high pressure will pass into the low-tension circuits. The condensers c_2 and c_5 are charged with a pressure of −7,390 volts, and c_4 with −7,610 volts. The conductors 2 and 4 must not be touched with the hand, if the man is standing on the ground. But this state of affairs can only arise through an unfortunate accident, *e.g.*, through a discharge between the windings, and then the point of the breakdown will determine the degree of the danger. Since the neutral point 8 in the low-tension winding is not in the present case earthed, voltages actually arise in the low-tension circuits; but these are not dangerous, if a man touches either conductor 2 or 4, because the capacities are generally too small.

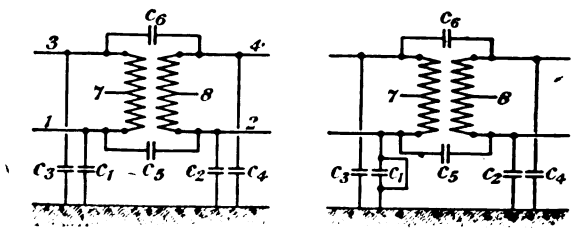

FIG. 1. FIG. 2.

DIAGRAMS OF CONNECTIONS.

Therefore the conditions that must be fulfilled for the passage of the high-tension voltage into the low-tension circuits are:—

(1) A connection between the two circuits, the resistance of which connection need not be very near the zero value.

(2) Considerable capacities between the windings, and between the windings and earth; and

(3) Such a division of the capacities that there are marked differences of potential between the points to which the connection is made in (1).

It may not be possible to reduce the value of the resistance of the earth connection to such an extent as to remove entirely the danger to human life; but it is possible to use the capacity currents, which flow to earth, as a means of cutting out the transformer, and thereby to reduce the time, during which the risk exists, to fractions of a second from the instant at which the risk is incurred. Arrangements should be made at all places, wher high tension energy is taken and transformed by a bank of transformers, to insert a device in the connection to the earth plates of such a nature that, as soon as charging currents or watt-currents pass, the connections to the high-tension side of the transformer are automatically broken, and the whole sub-station is put out of action. This proposal can only be properly carried out if the neutral conductor is insulated. For if it is earthed at a second spot or even perhaps in several places, the charging current would distribute itself in accordance with the various resistances, and the current, passing through the automatic cut-out, might be so weakened as to be ineffective. However, the insulation of the neutral conductor is quite an ordinary feature of a normal network of distribution in the country districts of Germany, where small cheap insulators are used on poles. The main danger arises on the soil around the earth connection, and is distributed over a zone which the author calls a "voltage-filter," or "voltage-funnel." The danger zone is included within a funnel, shaped as in the ordinary filter, which is symmetrical about the earth-wire as axis. This point has been previously investigated by Ruppel, Creighton and Kühn; the references to their work are given.

This automatic method cannot be applied to earthed poles, carrying the transmission wires. By connecting the poles metallically with one another, the risk may be diminished; but this is not

* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 25, 1917.

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sufficient, as many accidents have proved. It would be better to forego the earthing of these poles, as is mostly done in other countries. There remains the question as to the measurement of the resistance of an earth plate, about which there is great uncertainty

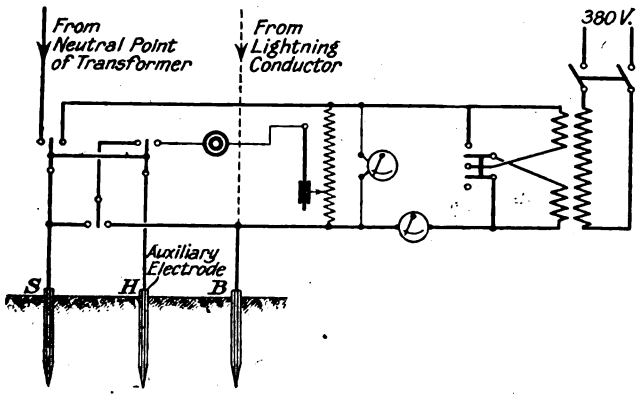

FIG. 3.—METHOD OF TESTING EARTH PLATES.

owing to many causes. It is, therefore, very necessary to test them frequently, in order to notice any unusual changes; such tests must be quickly carried out and must not depend on the skill of the observer. The connections, shown in Fig. 3, are recommended for the purpose. It is the method of the Wheatstone bridge, and has the advantage that during the test the electrodes carry an arbitrarily chosen current, while the auxiliary electrode carries no current; thus the current distribution in the soil has no effect on the results. Preliminary tests have shown that the method can be easily carried out, and that it is quite sufficiently accurate. After the bridge has once been set up, it is only necessary to read the current passing through the armature several times (the voltage remains nearly constant), in order to determine whether the resistances have altered to any marked extent. If any marked variations appear to exist, the bridge must be readjusted in order to find which of the two earth plates has changed. The bridge can consist of wire, wound on a porcelain cylinder, with a sliding contact piece; the resistance in all to be about 1,000 ohms; a telephone receiver will indicate the neutral point. The measuring transfomer might have a voltage of 110 or 220, and an output of 0·2 or 0·5 k.v.a. The cost of this outfit is small; if continually used it will explain much that is mysterious.

The outcome of the foregoing is that it is safe to touch nothing, and especially nothing that is earthed. Masts and poles ought not to be earthed. There should be high inductive resistances between the neutral point on the high-tension side and earth. The earth connections ought to be kept as free from current as possible, but such currents as flow must be used to stop the flow of power-currents as quickly as possible. The neutral conductor in a low-tension network should be insulated throughout its whole length except at the central station, where it should be earthed through a cut-out. All earth connections should be continuously kept under observation and be tested from time to time in order to note any variations.

The Electric Lighting of Ecclesiastical Buildings.*

By WILLIAM WILSON, B.E., M.Sc.

There are few tasks as difficult as that of providing suitable artificial lighting for a church or cathedral. It involves the introduction of a novelty into one of the most conservative situations in existence. It is only within about the last 50 years that the necessity for other than daylight has arisen. Thus, the requisite fittings have had to be added either to buildings in which no provision for them existed, or to others designed exactly on the lines of their predecessors, and generally resembling the latter in possessing the same deficiency.

There are also two special characteristics of a church to be borne in mind: (1) The value placed upon economy; (2) the scarcity of any form of professional attendance, and the entire absence of skilled labour.

SPECIAL ADVANTAGES OF ELECTRICITY FOR CHURCH LIGHTING.

Electricity has a number of special qualifications for church lighting. A church is a building which is used for comparatively short periods, ranging between 20 minutes and two hours, and occurring as a rule at wide intervals. With electricity, the whole of the lamps need not be put in circuit except when needed. Pilot lights do not provide a satisfactory alternative. Considerations of economy as well as convenience favour a method which can be operated by the simple turning of a switch.

One of the most valuable attributes of electricity for church work is its great suitability for concealed lighting. The maintenance cost of electric light for church purposes is extremely small. As a rule, only the lamps will need renewal, and that not until they have been actually "burning" for at least 1,000 hours. The duty required of the principal lamps will average about five hours per week, giving a life of 200 weeks, or four years. Any other method of illumination will require renewals at intervals expressible in months, or even weeks. Nearly all church services occur at other than times of peak load, and consequently electricity supply authorities often grant specially favourable rates to churches. A final advantage is provided by the wide range of candle-power obtainable.

The chief problem before the designer lies in satisfying both æsthetic and practical requirements, which are often mutually conflicting. For example, many churches are fitted with a double row of excellent chandeliers pendent from the roof, placed sufficiently high above the floor to avoid contact with the heads of the congregation. With their long stems extending from nearly top to bottom, they will harmonise to a nicety with the dominant vertical lines of a Gothic building. Thus the artistic requirements are fully met, but from the point of view of satisfactory illumination the case is quite otherwise. The lamps intrude themselves most unpleasantly between the observers and the objects of vision.

* Abstract of a Paper in the "Journal" of the Institution of Electrical Engineers.

FITTINGS FOR ELECTRIC LAMPS.

Prior to the introduction of electric lighting, the following types were in use: (1) The floor-standard, (2) the pendant, (3) plain lamps round the capitals of the pillars, (4) a continuous row of lights round the top of the walls.

In any of these positions electricity is at least as effective as any other illuminant; but the second class is much superior to any of the others. As renewals of electric lamps are only required at intervals of at least four years, their bare accessibility is all that need be secured. Consequently, they may be placed, if desired, at the very apex of the interior, 100 ft. or more above the floor. This position is actually adopted at Southwark Cathedral.

The designer may also locate the lamps deep in angles, close to or immediately below woodwork or other inflammable material, or in narrow spaces where an air circulation is impossible. It is through this that concealed lighting, so valuable when dealing with the chancel, is made possible. The author, however, is not inclined to recommend the use of indirect, cove, and semi-indirect methods.

SELECTION OF FITTINGS.

To decide what fittings shall actually be adopted, first, and chiefly, the characteristics of the interior under consideration must be studied. It will suffice for a preliminary survey if the whole be divided into two portions—the chancel and the body of the church

(*a*) *The Chancel.*—It will very often happen that the chancel, by virtue of being more richly furnished than the body of the church, will not require ornamental fittings, and the lighting can then be entirely carried out by the concealed method. Lamps should be so placed and inclined that the light is mainly directed on the books and the surroundings of the adjacent part of the choir. These lamps will, then, illuminate the westward end of the chancel.

The easternmost portion can be served by lamps behind convenient pillars or other projections, at a height of not less than 15 ft. or 20 ft. if possible. It may be considered necessary for ornamental reasons to install a few electroliers, and these can then be used for the further portions of the area. Roof lights may be resorted to in this part of the building, and can usually be concealed.

(*b*) *The Body of the Church.*—The body of the building presents a large space requiring uniform treatment. Chief attention must be devoted to keeping the points of light out of the direct line of vision. Yet the question is worth considering, whether it is not a positive advantage that some of the light sources, suitably shaded, should be visible, provided the light is no brighter than the ordinary candle-flame.

Assuming that pendants are permissible, and the question now arises from whence they shall be suspended. Many circumstances will affect this question, of which the chief is the relative width of

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nave and side aisles. If the latter are absent there is a good deal to be said for the use of a central row of electroliers, comparatively large, few in number, and hung high. If side aisles are present, central fittings might still be employed, augmented by smaller pendants in the aisles themselves, but it is more usual to adopt a double row of pendants, corresponding in number to the pillars, bays or roof trusses.

With regard to the ornamental design of the electroliers, the observance of two golden rules will be sufficient. One of these is to give due weight to the quiet dignity that should characterise everything connected with a church. The second rule is that ornament without utility is an abomination.

There are a few special positions that will require individual lights, of which the pulpit and lectern are alone likely to give trouble. In both cases it should be remembered that the reader or speaker himself needs to be illuminated; this and other conditions can be simply and effectively met by plain cord pendants from the roof. The opaque, or nearly opaque reflectors should be located a foot or two in advance of the vertical line of the book-rests. Purely local lighting of the latter is neither easy nor satisfactory.

INTENSITY OF ILLUMINATION.

There is only one consideration that requires noting in connection with the determination of the candle-power of the various lamps; otherwise the treatment of a church is the same as of other buildings. This is the great height of the roof.

The actual intensity appropriate to the situation lies between 1·5 and 3 ft.-candles. Special care must be taken in providing for the choir, who are in many cases reading nearly the whole time. The congregation, on the other hand, use their books but little except when actually singing.

With regard to consumption, 1 c.p. for every 1¼ sq. ft. to 2½ sq. ft. of floor area will fulfil the conditions mentioned, under average circumstances. If there is any doubt as to the requisite candle-power the installation should if possible be so designed as to permit after-adjustment by changing the lamps for others of slightly lower or higher candle-power.

SWITCHING ARRANGEMENTS AND WIRING.

There should not be any great difficulty in arranging for the convenient operation of the installation in spite of the large number of individual lights. The different combinations required are briefly as follows:—

1. Complete lighting during service.
2. Partial lighting before service.
3. Partial lighting during portion of evening service.
4. Partial lighting on dull days.
5. Choir only (for choir practice).
6. Parts of building only (for week-day services).

The above does not include the control of the vestries and other supplementary parts of the building, which are dealt with upon ordinary residence or office lines. These and any other likely combinations must be put into circuit with the least possible trouble and without attracting attention.

The wiring of a church should be of the very best description, not only on account of the necessity of reliability and long life, but also for reasons of safety. Thus, heavy-gauge welded steel conduit only should be permitted, united by screwed joints. Sharp bends should be forbidden, and all joints should be of the inspection type.

With such long runs of conduit as will be found necessary, the question of providing sufficient earth connections becomes important.

It is not always possible to conceal all the wiring, but by careful designing the conduit actually exposed may usually be reduced to such an extent as to escape the notice of an ordinary observer.

The Fuller Companies' Electrical Works.

A rapidly extending business, and the unsuitability of the old premises and conditions at Bow, has, during the last few years led to the formation of various companies grouped under the heading of the Fuller Companies, and the erection and subsequent extension of new workshops and offices covering a large site of over 12 acres. These Companies are concerned with the manufacture of the "Block" accumulator, "Sparta" batteries and dry cells, electric wires and cables, electric light carbons and other products.

THE "BLOCK" ACCUMULATOR.

In addition to the ordinary grid type, the Company produces upon a large scale their unique "Block" accumulator. We understand that this type of cell, after exhaustive tests extending over two years has been adopted by the Admiralty to replace thousands of dry and other primary cells. The War Office, Post Office, and numerous railway companies, both at home and abroad have, after considerable tests, largely adopted them for telegraphy, railway signalling and similar work. Although the advantages possessed by accumulators for such classes of work had been recognised by the authorities for a long time, the difficulty of obtaining a really reliable type of cell, which would retain its charge without attention in isolated districts for a long period, and possessing the requirements necessary for such work, has restricted their use very considerably.

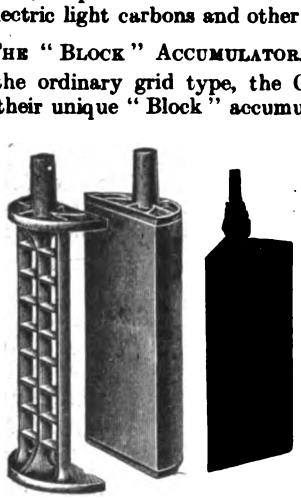

FIG. 1.—ELECTRODES OF BLOCK ACCUMULATOR.

The construction of the "Block" cell is shown in Fig. 1. The material is substantially the same as that used in the plate type of accumulator, but the cell differs in having electrodes which, when pasted, are of such a shape that two or more assembled with insulation between them form oblong or round elements. Thus the section of each plate is triangular or a sector of a circle as the case may be. In Fig. 1 an electrode is seen on the left hand side and the pasted electrode on the right, and in this case the section is in the form of a semi-circle so that when two such plates are placed face to face with insulation between them they form a block of circular section.

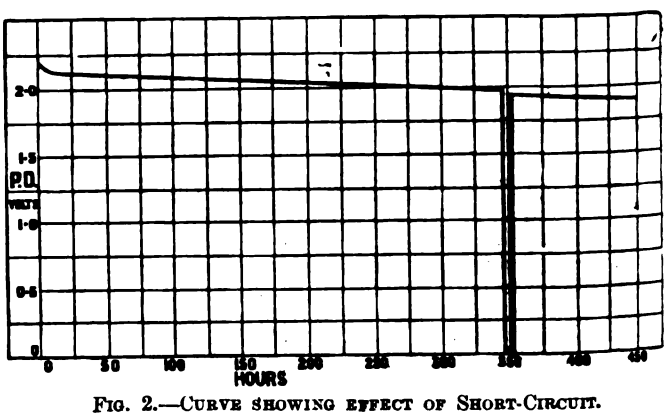

FIG. 2.—CURVE SHOWING EFFECT OF SHORT-CIRCUIT.

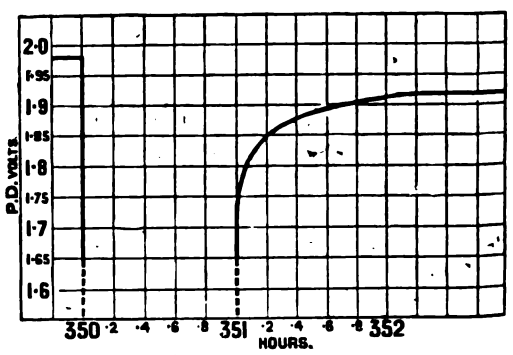

FIG. 3.—ENLARGEMENT OF PART OF FIG. 3, SHOWING RECOVERY.

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The makers find that this method of construction presents considerable advantages for certain purposes and that the electrodes are free from injury by vibration, or short-circuiting. The grid, being buried in the block, is free from growth. Buckling does not occur and accidental short-circuiting has but little effect owing to the large mass of active material. The charge can be retained for many months and risks of sulphation due to cells standing out of use for long periods is reduced to a minimum; consequently such cells are more adapted to rough usage and to neglect than the ordinary plate type.

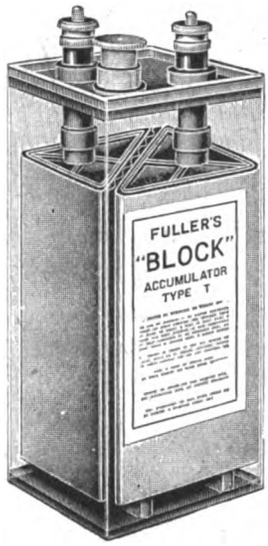

FIG. 4.—COMPLETE BLOCK CELL.

Figs. 2 and 3 are interesting curves, showing the effect of short circuiting on a "Block" telegraph cell. The discharge rate was such as to complete the discharge in 700 hours. After discharging for 350 hours the cell was dead short-circuited for 60 minutes, after which the discharge was continued through the original external resistance. Fig. 2 shows the effect of the short-circuit and Fig. 3 shows the recovery on a larger scale. Fig. 4 shows a complete "block" cell. Apart from telegraph work such cells are being used largely by the Admiralty and also for private house lighting in cases where the supervision that can be given is not such as is demanded by the more usual types of lead battery.

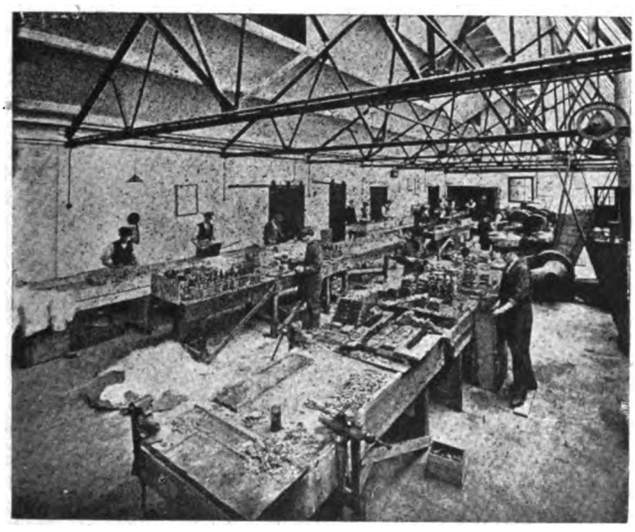

FIG. 5.—ACCUMULATOR ASSEMBLING SHOP.

The Sparta battery, which is of the more usual plate construction, is used on a considerable scale for starting and lighting purposes on automobiles. The electric starter having come into far more general use in the United States of America than in this country, it is only natural that the majority of motor vehicles with such starters in the United Kingdom should be provided with American made storage batteries. Now, however, the importation of starting batteries for use on private vehicles is entirely prohibited. Messrs. Fuller were among the first to realise the possibilities of producing English made accumulators, which could be substituted without alteration of the car on the many American motor vehicles so equipped, as well as for use on British built cars in which electric engine starting and lighting equipments were used. Although the "Block" type of cell has many advantages for lighting and ignition purposes it is not suitable for this class of work, which demands a very heavy rate of discharge without excessive drop in voltage, together with special recuperative powers, so that the battery will start the engine time after time without failure. Such a battery must be as light and compact as possible,

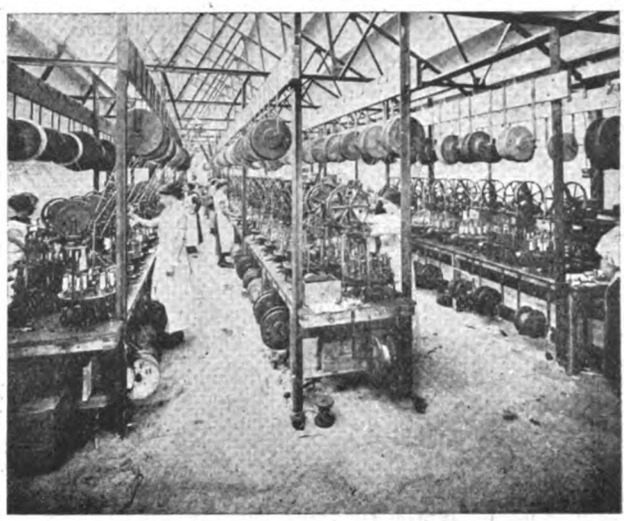

FIG. 6.—CABLE PLAITING AND BRAIDING SHOP.

yet of such robust construction that it will withstand the disintegrating effect of heavy discharges and the strenuous life that such units have to lead. The containers are of ebonite, permitting the use of a high gravity acid. The outer cases are of teak and are generally intended to be carried on the running board of the vehicle.

ARC LIGHTING AND BATTERY CARBONS.

It is well known that previous to the war most carbons used in this country came from Germany and Austria. When these supplies were stopped, makers of batteries and users of arc lamps had

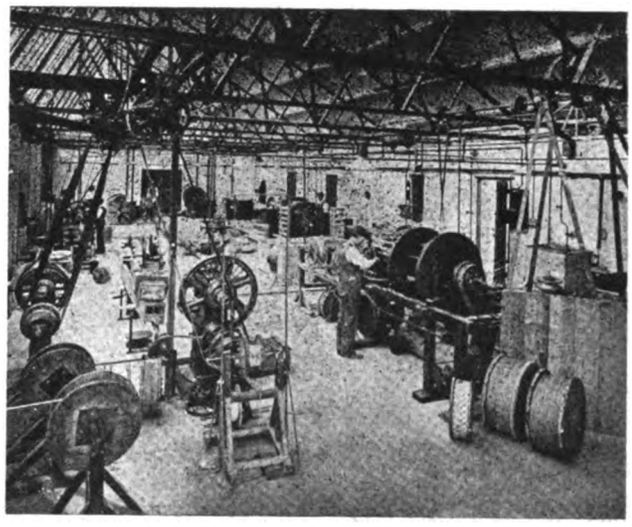

FIG. 7.—COATING AND VULCANISING SHOP FOR RUBBER-TREATED CABLE.

to turn to home manufacturers for their supplies. These were very few in number and consequently Messrs. Fuller decided to make their own carbons in order to fulfil their own battery contracts. A large plant was established for this purpose, and shortly afterwards new works were erected, the most modern of their kind, equipped with specially designed machinery for the manufacture of high grade carbons and carbon products. A separate plant for the production of pure carbons, which forms the basis of the carbon mixtures has also been erected.

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For use in flame arcs various brands are produced. The "Solar" brand is stated to have an efficiency of 0·3 watt for M.S.C.P., and is specially suitable for magazine type flame lamps. It possesses no metal core, and is consequently considerably cheaper than the metal cored type, which has a metal wire running through the carbon for its entire length in order to lower its resistance. Copper plated carbons can be supplied in place of the metal cored carbons, but they are not recommended.

Cinema carbons are now manufactured as the result of experiments specially made to determine what particular combinations were necessary in order to ensure steady burning of the arc, coupled with even consumption of the electrodes. The positive carbon has a special chamfered point and a soft core. The negative carbon is coppered externally, and is provided with a hard coppered core.

Carbon rods for flash lamp batteries, impregnated with wax or unwaxed, are included among the principal carbon products of the firm. The impregnated rods are found to give excellent results in practice.

Other carbon products include welding carbons, specially prepared to carry the heavy currents used in welding operations; and also carbon plates for rheostats, which will stand a high current density without disintegrating.

The highest grade English carbon black for the rubber and paint trades is now manufactured by the most modern process by this firm, a special plant having been erected for the purpose.

Wires and Cables.

The wire and cable business is now installed in a separate factory, which is fitted up on the most modern lines, and equipped with the latest machinery, for dealing with the indiarubber from the earliest stages of washing, mixing and calendering, to the final braiding or lead covering. Every description of electric light wire and cable is being manufactured. Special machines are installed for covering wires with rubber on the longitudinal lapping system for the highest class of insulation. Lead presses for covering cables with an outer casing of that metal, and special modern machines for covering wires with rubber by extrusion, a process well adapted to the production of thick coatings of rubber for cables, such as are used for motor car wiring, and insulated flexible are among the modern machines recently installed. Figs. 5, 6 and 7 illustrate portions of the new works devoted to the electric wire and cable industry.

Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

(*Continued from page* 209.)

Summary.—The Author deals with the technology of the electric winding engine or mine hoist. In this article, which is the first of the series, the scope of the work is defined, and notes of general interest are given on the question of power supply.

Kinds of Mine Shafts.

Mine shafts may be classified under the following three headings:—

(i.) Vertical;
(ii.) Incline;
(iii.) Compound;

and examples of these are given in Fig. 3 (*a*) to (*h*).

Most of the coal mines in this country have vertical shafts, but in many cases abroad, particularly in metalliferous mines, the shaft follows the dip of the reef or seam. This may result in a shaft of varying inclination, as shown in Fig. 3 (*c*) and (*d*).

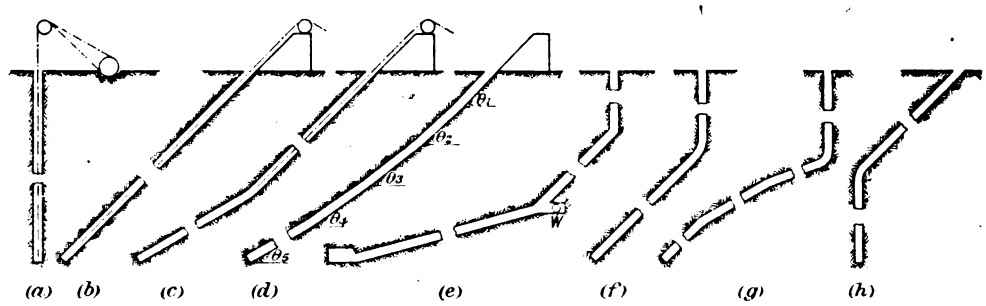

Fig. 3.—Typical Mine Shafts.

Compound shafts either descend vertically until the reef is struck and then follow on the incline, Fig. 3 (*e*) and (*g*), or they follow the dip of the reef from the surface and then descend vertically to a lower level. A shaft of this kind is depicted in Fig. 3 (*h*). If the angle between the two sections of a compound shaft is less than about 150 deg., the corner should be rounded off so as to form a curve of large radius in order to prevent shocks when the skip passes from one section to the other. When the maximum speed exceeds 15 to 20 ft. per second, it is customary to slow down as each skip approaches the bend, so that the speed of the skip as it passes the bend will not exceed 15 to 20 ft. per second. Since the sections are not, as a rule, of equal length it follows that there will be retardation and acceleration twice during each wind—not counting the starting and stopping periods—so as to enable the ascending and descending skips safely to pass the bend. It should be noted that practically all compound shafts are old-fashioned, and they are seldom met with in modern mining practice.

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Operations to be Performed.

The operations which a winding engine is required to perform fall naturally into two groups, *viz.*, those normally carried out in balance, and those which usually necessitate out-of-balance running.

Examples of balanced operation are shaft-sinking, winding from one level; winding from several levels; raising and lowering men, materials and supplies; dead-slow running for shaft and rope inspection, and for repairs.

Taking-off, turning, and renewal of ropes; adjustments for stretch of ropes; and alterations of rope lengths for winding from different levels, are examples of operations which necessitate out-of-balance running.

Electric Winding Systems.

The system to be adopted in a given case depends on the load and depth of shaft, and upon the intensity of the winding. It also depends upon local conditions, and it is impossible to lay down hard and fast rules of general application. Although at least a dozen systems have been suggested, not more than three have met with wide adoption. These are the direct alternating-current system, or three-phase system, as it is called; the Ward Leonard system; and the equalised Ward Leonard system, or Ilgner system, as it is called.

Reference will be made to each of the systems in the section devoted to electrical equipment, and the three systems named will be considered in some detail. For the present it may be stated that the three-phase system is used in those cases where the power supply is drawn from a generating station of considerable size and where low initial cost is of primary importance. To some extent the success and safety of the

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system depend on the skill of the operator, and satisfactory braking arrangements are not readily obtained.

Although more complicated and more costly than the three-phase system, the Ward Leonard system is easier to control and handle. In many cases it is more economical of current, and the current consumption is independent of the skill of the operator. It possesses the advantage over the three-phase system of not making a sudden heavy demand on the generating station; the demand steadily increasing from practically zero at the beginning of the wind to a maximum just before the end of the accelerating period, or, say, in from 10 to 30 seconds. This gives the automatic voltage regulators at the generating station sufficient time to act, and, at the same time, enables a relatively small supply system to cope with the demand. The Ward Leonard system has the further important advantages over the three-phase system of lending itself to mechanically-automatic operation, and to safe and economical braking. Moreover, for running at reduced, or dead-slow, speeds, and for moving the skips or cages a few inches, the Ward Leonard system is markedly superior to the three-phase system. Except in those cases where there is an appreciable saving in current consumption by using the Ward Leonard system, it is for the user to determine whether the several advantages are worth the increased cost.

As regards ease of control there is nothing to choose between the plain Ward Leonard system and the equalised Ward Leonard system. At considerable cost and at the expense of efficiency arrangements are made in the equalised system for preventing, or for limiting, fluctuations of the power drawn from the supply. Although many of the large electric winders owe their existence to the equalised Ward Leonard system, it is now generally agreed that the system should be avoided if possible. The following figures taken from records made by Mr. H. Bramwell * for the Maritime winder, serve to give some idea as to the cost of equalising the demand in this case.

	Equalised.	Not Equalised
Fortnight ending	26/6/09	1/10/10
Total number of winds	5,260	5,370
Board of Trade units used	29,800	17,800
Tons of coal raised	5,986	6,043
Board of Trade units per ton of coal	**4·26**	**2·94**
Board of Trade units per wind	**5·66**	**3·31**

It will be noted that with the equalised system in use, the kW.-hours per ton of coal raised are 45 per cent. greater than with the unequalised three-phase system.

At 0·5d. per unit, the costs per ton of coal are 2·13d. and 1·47d., and reckoning on an output of 200,000 tons per annum, the saving in favour of the unequalised system works out at £554 on current consumption alone.

KINDS OF DRUMS.

The kind of drum used affords a convenient method of classifying winders. Drums are of seven kinds, namely :—

(*a*) Cylindrical.
(*b*) Conical.
(*c*) Reel.
(*d*) Cylindro-conical.
(*e*) Spiro-cylindrical.
(*f*) Koepe pulley.
(*g*) Whiting sheave.

These are shown diagrammatically in Fig. 4. Winders having reels and Whiting sheaves, besides being practically obsolete, are relatively unimportant and need not be considered at any length. The principal kinds of drums are the cylindrical and conical, and their derivatives the cylindro-conical and the spiro-cylindrical; the latter, of which there are several notable examples, being of comparatively recent origin. Although used to a considerable extent on the Continent, the Koepe pulley has met with little support in this country.

In the case of (*a*) to (*e*) either one or two drums may be used. Two drums are required when it is necessary to run the winder out-of-balance, or when the winder has to operate from different levels. When two drums are used one of them may be clutched and the other keyed to the shaft of the winder; or both drums may be clutched to the shaft.

To set a double-drum winding engine when the levels are being changed, one drum has to be turned relatively to the other till the skips are in the required positions. This is done at the end of the trip when one skip is at the surface. The drum to which this skip is attached is held fast by the brake and disconnected by means of the clutch; the other drum is next rotated until the skip in the shaft comes to the desired level. Finally, when the loose or uncoupled drum is clutched-in, winding may be continued from the new level.

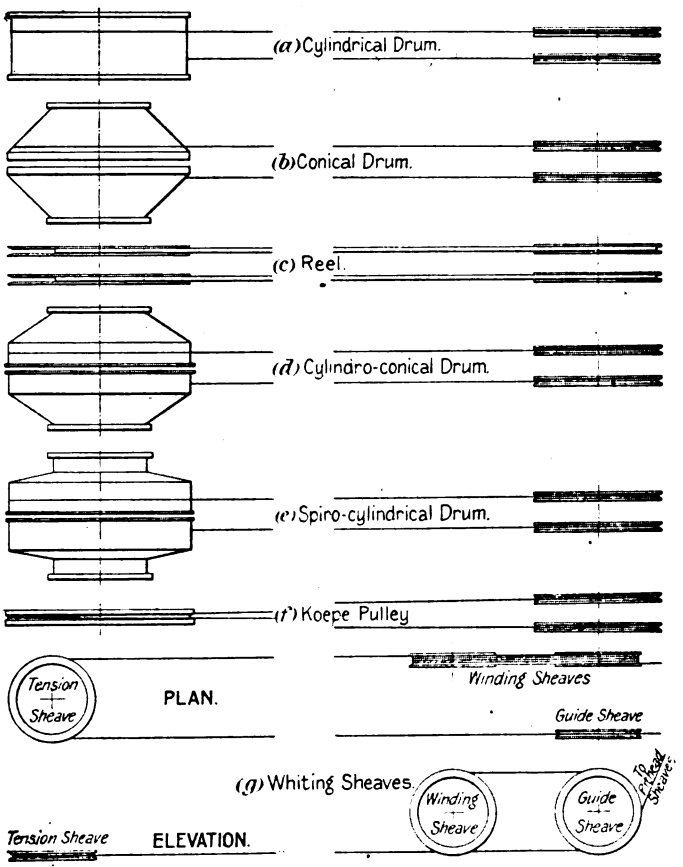

FIG. 4.—TYPICAL WINDER DRUMS.

Frequent change of levels necessitates two loose drums; but if the levels are changed, say, only once or twice per shift, one drum may be fixed rigidly to the shaft of the winder. When adjustments are seldom necessary the winder may have two fixed drums so arranged that the levels may be changed by unwinding rope from small drums or reels housed inside the main drums.

(To be continued.)

* "Proceedings," South Wales Inst. of Engineers, Vol. XXVII.

Books Received.

[Copy of the undermentioned work can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"Telegraphy, Aeronautics and the War," by Mr. Charles Bright, F.R.S.E. (London: Constable & Co., Ltd.) Pp. xvii.+407. 16s. net.

"From War to Work," by S. Turner. (London: Nisbet & Co.) Pp. xiii.+109. 1s. 6d. net.

"Decimal Money Tables," by A. M. Pooley, B.A. (London: "Syren & Shipping," Ltd.) Pp. 46. 2s. 6d. net.

"Electric Motor and Control Systems," by A. T. Dover. (London: Sir Isaac Pitman & Sons, Ltd.) Pp. xvi.+372. 16s. net.

"General Lectures on Electrical Engineering," by C. P. Steinmetz. (London: Hill Publishing Co., Ltd.) Pp. ix.—242. 5th edition. Price 12s. 6d.

"Workmen's Time and Balance Book." (London: W. F. Chalker. 1s.

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The Mechanical Design and Specification of the Turbo-Alternator Generator.

The following is an account of a discussion on Dr. S. F. Barclay's Paper at the Manchester Section of the Institution of Electrical Engineers. An abstract of the Paper appeared in our issue of March 22

DISCUSSION.

Mr. J. S. PECK said that the author had referred to various sources of weakness in the construction of turbo-generators. His own firm had made many such machines during the past 15 years, and had standardised the solid forged type of rotor. During the whole period no serious mechanical breakdown had occurred. In only one or two cases was there minor trouble, due to balancing, but nothing in the nature of an explosion or burst. Laminated and plate types had, however, advantages. A large solid forging might not be entirely homogeneous, and first-class material was essential. In a laminated rotor every plate could be inspected, and if one or two were defective there was little chance of accident. So far excellent results with the solid forging had been obtained. The ductility was not quite as good at the centre of the core, the tensile strength was practically uniform. He would never put in a laminated rotor for use with an unbalanced load, unless a very heavy damper winding was provided: with the solid rotor the steel core in the top of the slots and the wedges both had a damping effect. The detail designing of electrical machinery should be done by specialists, and consultants should merely satisfy themselves as to the safety and soundness of the general design.

Mr. SLOAN referred to the suggestion that excessive heating in the neighbourhood of the stator end plates occurred chiefly on zero power factor, *i.e.*, on short circuit. In one machine he knew, working on service conditions (about 70 per cent. power factor), the steel end bell was excessively hot, though the load was practically balanced. The type of end-bell shown by the author would be apt to increase in diameter at full speed. If it tended to become eccentric, holding it central at one end only was no guarantee that the other end would remain true. There might also be high local concentration of stress at the point where the cylindrical portion was joined into the radial flange.

Mr. J. R. BEARD remarked that the delivery of a laminated rotor was likely to be more speedy and certain than a solid forging and the latter more difficult to replace. He then described a rotor with a double winding which had certain mechanical advantages. Steel wire might not be a suitable material for retaining the end windings, owing to difficulties of balancing, if wound direct on to the windings. The difficulty could be removed by winding the wire on a rigid former, preferably of non magnetic material, protected if necessary by an outside shell. Neither the reported tendency of managnese bronze to disintegrate nor the effect of alternating stresses was mentioned in the specification at the end of the Paper. The author's views of the value of the impact test would be welcomed, as opinions varied on this point. Did the author consider the yield point as good an indication of the quality of material as the ultimate stress?

Dr. WM. CRAMP said the Paper would help the engineer who has to draw up specifications. He agreed with the warning concerning the neglect of small matters, such as might cause disasters. One single turbo generator giving serious trouble might set the industry back for years. Specifications should prescribe conditions necessary for safety, but leave each maker free to develop on his own lines. His firm inserted clauses limiting the peripheral speed and requiring a test at 30 per cent. above normal speed: they also reserved the right to call for test pieces taken from any portion of the machine. Mr. Cramp proceeded to compare Dr. Barclay's remarks with those of Mr. Brearley, of Sheffield, a year ago. Dr. Barclay laid stress upon the tensile properties of steel, whereas Mr. Brearley thought that the tensile properties alone were of no use, and insisted upon the use of the impact test in conjunction with the yield point and the maximum stress as the only safe guides. He thought that the impact test should be included. In reply to a remark by Dr. Barclay Mr. Cramp added that some steel makers would guarantee an impact figure if the impact machine to be used was specified. Dr. Barclay had laid stress on work being finished smooth. Tramway axles, which were rough machined, were apt eventually to break along the very fine thread left by the tool. A punched hole was likely to have distorted edges and weaken the whole plate. But a plate that was drilled rapidly or bored rapidly was as weak as a punched plate. Boilers often now had their rivet-holes punched abroad. Drilling was best if done slowly. Dr. Barclay had shown a curve connecting the diameter of the rotor in inches with the revolutions per minute. Was this simply the result of a series of practical designs or founded on theoretical considerations?

Mr. W. KIDD agreed with the author in preferring a solid rotor. A built-up rotor had always appeared a make-shift and was undesirable for machines of high peripheral speed. Owing to reversal of strain in each revolution there was bound to be some relative movement between the parts of a built-up rotor. In some cases machines had worked loose, although instances of rotors bursting were comparatively rare. The speaker did not agree that the purchaser should draft his specification in greater detail. The design of a turbo-rotor was the work of a specialist and the designer should be given as free a hand as possible. The purchaser was entitled to state in his specification that full details of the machine and particulars of the material and stresses should be supplied with the tender, also working drawings submitted, before any work was put in hand.

Mr. ROBERTS referred to the question of uniformity in the steel. Could this uniformity be tested in any way in the piece without taking a piece from it? Inequality of loading upon wire bands was the main reason why they had been given up. How were the stresses in the cap-rings or "end-bells" discussed by the author computed? Ventilation and windage on high speed rotors deserved attention. The fan loss mentioned by the author was 20 per cent. of the total windage, which might be equivalent to 50 kw. on a 5,000-kw. machine.

Prof. GERALD STONEY mentioned a case of an impulse turbine which started to vibrate. The spindle had been calculated as if the discs were fixed solidly on to the shaft giving a critical speed of 3,000, but if the discs were loose the critical speed was only 2,900, and therefore it vibrated badly at 3,000. Solid rotors in small sizes were all right, but the forging must not be reduced too quickly down to the diameter of the spindle end. It should be forged in a taper and the extra metal cut away. He was doubtful whether in large sizes sufficient work could be put on the forging to make it really and absolutely reliable. The alternative method of thick plates bolted together with bolts had advantages, but the bolts must be made of high grade steel, and they should have equal elasticity all along. There must always be sufficient tension on the bolts to keep the plates solid under all conditions. Thick plates forged under the press were most reliable.

Mr. JUHLIN said that it was general practice to shrink the laminations on to the shaft with an allowance which would ensure the laminations remaining tight at the over-speed. The author had stated that the bursting stress in the solid rotor was always lower than the toothed, but the toothed stress and could be made whatever desirable. With large diameters the bursting stress would be the governing feature. The laminated rotor certainly was cheaper, and when the stresses could be kept down so as to leave a sufficient factor of safety, there was no case for condemning it. The question of insulation in high-speed turbo rotors deserved more attention. With carefully made coils by efficient bracing one could obviate side-slipping. The suggestion that the stability of coils could be improved by dividing them into two portions by means of a wedge about the middle of the slot had not been confirmed in practice. The number of slots was a question of great importance. Rotors having 16 slots per pole and running at 3,000 revs. per min. had been in satisfactory operation about 2½ years. The stiffness and stability on the coils was quite satisfactory. The output was reduced when the number of slots was reduced. He did not agree that 32 in. was the maximum diameter; 35 in. rotors might have to be adopted if very large outputs were to be obtained at 3,000 revs. per min. It had been the practice of his company to specify tangential and radial test pieces in addition to the usual longitudinal ones. He agreed that a hole should be bored through the rotor when alloy steel was used, and for all large and medium sized rotors, whether of carbon or alloy steel, as flaws were not unknown in carbon steel forgings. There were no difficulties in obtaining rotors up to 57 in. diameter from British steel makers, and this might not be the limit. It was of great importance to avoid abrupt changes of diameter in the shaft, and it was general practice to taper the shafts wherever possible, in order to avoid abrupt changes. Ventilation by radial ducts for the stator and separate axial ventilation for the rotor was satisfactory for short machines, but not for long ones, especially if small air-gaps were adopted. As regards fans on the rotor it was difficult to understand why the blades could be curved in a forward direction, when a radial discharge was required. The power required to drive the fans would be increased. The specification seemed to be far too detailed. It was more important to specify that the insulation should be as far as possible non-combustible than non-hygroscopic. Merely specifying the thickness would not ensure satisfactory results. Pressing of coils in the slot had for several years been the standard practice of one company, and had also been applied to the end windings. The greatest difficulty with wire-wound rotors had been the damage caused to the band through arcs, due to failures of stator windings.

Mr. J. A. KUYSER agreed that a diameter of 32 in. at 3,000 revs. per min. was, for the present time, a desirable maximum. It might, however, be necessary to build larger 3,000 revs. per min. generators in future. 20,000 kw. turbines were being built at 2,400 revs. per min. in this country, and in Germany 15,000 kw. 3,000 revs. per min. had been built. In order to increase the present limits it was necessary to obtain stronger material for the end rings. The author mentioned 50 tons per square inch ultimate, 40 tons yield point, 18 per cent. elongation, 50 per cent. reduction, as physical properties for chrome nickel steel. Supplies from U.S.A. of 31-in. rings had the following guaranteed properties:—

Ultimate strength	73 tons per square inch.
Yield point	67 tons.
Elongation	15 per cent. in 2-in. reduction 45 per cent.

These rings were made of chrome vanadium steel of the cylindrical type and shrunk on to a separate end disc. These rings would allow a diameter of at least 40 in., or 32,000 ft. per minute at 3,000 revs. per min. British steel makers supplied a large number of chrome nickel steel rings of the following properties:—

Ultimate strength	60 tons per square inch.
Yield point	51 tons per square inch.
Elongation	15 per cent. in 2 in.
Reduction	45 per cent.

These rings could be used up to at least 35 in. diameter, depending upon the amount of copper which was used. The main point in obtaining a large output from the rotor at high peripheral speeds was to get as much copper in the rotor as possible without exceeding toothed stress, bursting stress and a stress in wedge. Tooth saturation had only a small influence on total flux and had no influence on the operation of the

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machine. The speaker here presented curves showing the amount of copper which could be accommodated for different sizes of slots and the total field ampere-turns, for which a formula was given. The curves referred to a rotor of 35 in. diameter, and of this diameter 90,000 ampere-turns could be obtained. A diameter of 45 in. corresponding to 36,000 ft. was the maximum for a solid steel cylinder without exceeding a safe bursting stress. The mechanical and electrical design for a machine with a diameter of 35 in., giving 25,000 k.v.a. per 100 in. core length, or 31,250 k.v.a. for 132 in., had been worked out in detail. The stresses in the rotor were all below the figure corresponding to the safety factor recommended in the Paper. Ventilating of the rotor was of little advantage in machines of a large core-length and a high peripheral speed. For long machines air was delivered to the gaps at the centre of the stator yoke from a separately driven fan at a fairly high pressure and carried down to the air gap through the radial ducts, and travelled axially over the rotor and escaped through the radial ducts of an adjacent section. Many single-phase machines had been built in the States and in this country with solid rotors. Several 3,000 revs. per min. single-phase machines of moderate capacity had been built in this country with solid rotors. He would recommend the elastic limit as a basis for the safety factor if this be more easily determined, but the ultimate strength should also receive consideration. With reference to the bolted-plate type construction no trouble had been experienced with any of the rotors built by the Westinghouse Co., and a machine of the size mentioned by the author had not been built by them. This construction would have a field for large machines running at 1,800 revs. per min. and very large machines for 1,500 revs. per min.

The author reserved his reply.

The Operation of Railway Sub-stations Without Attendants.*

By W. D. BEARCE.

The automatic railway sub-station was first put into commercial operation about three years ago in the stations of the Elgin & Belvidere Electric Co., near Chicago. The operation of sub-stations without attendants by the Detroit Edison Co. in 1912 was a forerunner of the present automatic station. This installation consisted of a 500 kw. synchronous converter connected to the lighting system for the purpose of maintaining the proper voltage in outlying districts. A new station was installed instead of additional feeder copper and was controlled by the operator of the main alternating-current supply station over the 4,400-volt three-phase alternating-current line. A similar installation was made in 1914 by the New South Wales Government Tramways at Sydney, but the scheme of control was quite different, the starting, shutting down, &c., being effected by the use of pilot wires. This station was connected to a railway load and was subject to the fluctuating peaks common to railway service.

The stations installed at Detroit and in Sydney, however, were of the remote control type, while that put in operation on the Elgin & Belvidere system was strictly automatic, so that the machines are started up connected to the line and shut down without the assistance of an operator either in the station or in any remote station These functions are performed in accordance with the requirements of the load on the system, whereas with the manually-operated or remote controlled station, the starting, loading and shutting down of the converting apparatus is either left to the judgment of the sub-station attendant or performed in accordance with a set schedule. With automatic control, sensitive relays are relied upon to observe the conditions of load on the trolley feeders and the control equipment acts automatically in response to the movement of these relays.

In order to eliminate the possibility of the circuit being opened by overload circuit-breakers, a current-limiting resistance is installed, and adjusted to be connected into circuit when the current drawn from the sub-station machinery reaches certain predetermined overload values. While the remote control sub-station makes some savings in the cost of attendants' services, the automatic station also makes appreciable savings in the cost of power. Moreover, the current-limiting prevents injury to the sub-station machinery, and thus assists in keeping the converter machinery always ready for service.

Elgin & Belvidere Electric Co.

The Elgin & Belvidere Electric Co. operates a single-track road 36 miles in length handling a 600-volt interurban service. Power is purchased at 26,000 volts three-phase 25 cycles and delivered to three sub-stations located at Gilberts, Union and Garden Prairie. Each of these stations contains a 300 kw. three-phase synchronous converter with the necessary transforming and switchboard equipment.

The essential features of the installation are a motor-operated drum controller arranged to make the necessary connections for starting and connecting the synchronous converter to the line; the direct-current exciter forming a part of the same set so connected that it gives the proper polarity to the synchronous converter fields before connecting the converter to the line; the necessary controlling and protective relays; and the load limiting resistance. The converter is started up when the potential on the trolley falls to 450 volts or below. This low voltage causes a contact-making voltmeter to start up the drum controller which, in turn, energises the actuating coils of the starting and running alternating-current switches, the field switch and the direct-current line switch. As soon as the converter reaches full speed and full voltage, the drum controller comes to rest and the station thus operates until the current which it is supplying to the trolley circuit falls below some predetermined value, at which time a current relay operates and shuts down the station.

The series current-limiting resistors are placed between the positive terminal of the converter and the station 'bus, and they are automatically cut into circuit at predetermined overloads.

Similar automatic equipments are now in operation on half a dozen other systems in the United States. There are also under construction in the Schenectady plant of the General Electric Co. about 30 equipments ranging in capacity from 200 kw. to 1,500 kw.

Des Moines Railway Properties.

The Des Moines City Railway Co. operates 85 miles of city trackage and the Interurban Railway Co. operates 74 miles of interurban line, both of which have installed a number of automatic equipments. In general, the scheme of operation of these sub-stations is the same as that employed by the Elgin & Belvidere Electric Co. One of the novel features is a portable automatic station containing a 500 kw. synchronous converter, which is at present in use on a spur of track reaching out to a gravel pit. This portable sub-station is completely equipped for operation either on the 23,000-volt interurban transmission lines or the 4,400-volt city supply.

One of the remarkable features of the Des Moines installation was the saving effected in feeder copper by the use of automatic equipment. A detailed estimate furnished by the railway company shows a saving of more than $140,000 in favour of the automatic plan.

Although no operators have been displaced owing to the fact that all automatic sub-stations are new, the Des Moines lines are making a large saving on operators' wages since the several automatic stations dispense with attendance which would have been required for manually-operated stations. Considerable savings are also being made from the elimination of light-load losses as well as the reduced maintenance on the equipment and the lighter duty secured by the load-limiting resistance.

Milwaukee Electric Railway & Light Co

The first 1,200-volt automatic sub-station was put in operation during 1917 on the Interurban division of the Milwaukee Electric Railway & Light Co.'s lines at East Troy. This sub-station contains four 300 kw. 25-cycle 600-volt synchronous converters arranged to be operated two in series for 1,200 volts. One set of these machines has been equipped with automatic control, and is now handling the load without assistance. The equipment is arranged to cut in the two machines when the trolley voltage drops to 950, and the current relay operates to shut down the station when the current falls to 25 amperes. Estimates on the approximate saving effected by the elimination of two operators and the reduction in the no-load and light-load losses give an annual saving of more than $1,700 per year for the single station.

Grand Rapids, Grand Haven & Muskegon Railway.

Another station put in operation in 1917 is the Spring Lake Station of the Grand Rapids, Grand Haven & Muskegon Railway Co. containing a 500 kw. six-phase 600-volt synchronous converter. The line is equipped for the most part with an over-running third-rail, and handles freight and express service in addition to the regular passenger and summer resort traffic. The automatic equipment is similar in general to the other 600-volt stations now in operation; and it is expected that considerable savings will be effected from the elimination of operators' wages and light-load losses on the machine.

Other automatic equipments are in operation in different parts of the country, and among the several stations now under construction is one automatically controlling two units in the same station, the second unit being put in service to take care of load peaks during rush hours at morning and night, while the first unit handles normal loads.

* Abstract of an article in the "General Electric Review" (U.S.A.).

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Industrial Electric Heating.

We doubt if it is fully appreciated that electric heating for industrial purposes is fast becoming a subject of considerable importance. Possibly this importance is more evident in America than in this country at the moment; but there is no reason why electrical energy, at the low prices at which it is now available in our larger cities, should not be used industrially to a large extent in Great Britain also. In making these remarks we do not refer to the electric furnace, which is another branch of the subject and which requires high temperature heating; what we have in mind is heating for low temperatures, such as are required in a variety of ovens. In America thousands of kilowatts are being used for this purpose.

It must be remembered that in chemical operations there are two general classes of low temperature heating. The first is by means of steam. This may be either at atmospheric pressure, or under some higher pressure, depending upon the temperature which is required. Within limits, variation of temperature is thus obtained, and once the pressure is set and maintained, the temperature is constant. If, however, higher temperatures are required, steam heating becomes inconvenient; in that case oil heating may be utilised, but this is not very desirable, and consequently resort must be had to some kind of fuel, which may, for example, be coke, but would more generally be gas, owing to its greater adaptability; in this case, however, there is always the difficulty of obtaining constant temperature conditions. Regulation is not easy and the thermal capacity of the installation may be considerable, so that quick regulation of temperature is not possible.

Attention is drawn to this subject in a Paper on "Low Temperature Electric Thermal Processes," by Mr. C. F. HIRSHFELD, which is published in the last volume of the "Proceedings" of the American Electro-Chemical Society. The author takes as an example the use of electric heating in japanning. The material used in this case is typical of many others. For instance, japan is capable of considerable variation by being thinned to various degrees. Before the article is actually put into the oven it may be allowed to stand for a time, which may vary widely, and when it is put into the oven the temperature may rise at a rate which may, or may not, be the best for the ultimate result. Assuming that some definitely thinned japan is taken, there must be some temperature at which the best results will be given. If there is unequal heating the article will have a number of different temperatures, some of which will be more suitable than others to give a good coating. Again, there may be some best rate at which the temperature should vary after the operation is complete; and, lastly, the condition of the atmosphere in the oven may have a marked effect. It will be seen that the number of variables is very considerable, and if some of these can be removed or be maintained constant by having a perfectly definite schedule of heating, the final result is likely to be improved.

That this is so is shown by a remarkable series of microphotographs, which are reproduced by Mr. HIRSHFELD. It appears that if baking is carried out by means of hot gases, the japanned surface becomes covered with a number of small craters; this is probably due to the formation of a film on the surface of the japan when the heat is first applied, and through this film the volatile solvent is forced as the lower layers become heated. On the other hand, if the work is heated in an electric oven the flow of gas is avoided and this effect is not nearly so marked. Microphotographs of a surface after the third coat, dried in an electric oven, show that there are practically no imperfections.

Undoubtedly the ideal method would be to apply the heat from the inside outwards, that is, for the metal to be heated and for the temperature gradient to be outwards instead of inwards. Experiments were made in which a metal article was placed in an alternating magnetic field, so that this condition was secured, and the results were found to be very much improved. It would be difficult, however, to apply internal heating on any considerable scale.

It is sometimes stated that the cost of electric heating is too great. This we very much doubt. As is pointed out by Mr. HIRSHFELD, gas was adopted in place of coke notwithstanding the fact that the cost of gas heating was about 18 times that of coke heating. It must be remembered that generally the cost of heating in such cases is only a small part of the cost of the whole article, and it pays to spend more upon heating if the results so obtained are better. Electric heating has the great advantage in all such industrial operations that it can be regulated to a nicety, and, what is more important, the regulation can be rendered automatic without difficulty, so that the best results can be obtained consistently.

Reviews.

Applied Electricity for Practical Men. By A. J. ROWLAND. (London: The Hill Publishing Co.) Pp. xiv.+375. 8s. 4d. net.

There is no end to books, good, bad and indifferent, on applied electricity. It is a little difficult to understand for whom they are written and to what class of reader they appeal. In his time the reviewer must have had the handling of a score of such books, and this must serve as a reason for submitting a review close on 12 months after receiving the book.

We have read this book not without interest. Although it is little, if any, better than other books of which we have knowledge, the book nevertheless bears traces in many places of careful thought and orderly arrangement. As a teacher of 20 years experience the author is a firm believer in examples, and his examples appear to have been carefully chosen.

For those just entering the electrical business we would prescribe in the first year 10 hours' home-work for every 4 hours spent at a technical school. Many students imagine they can learn electrical engineering merely by attending evening classes or by joining a "get-rich-quick" correspondence course. The only way is to do a good deal of hard thinking in the works, in one's employer's time, and even more at home in one's own time. It is well to have a friend at least as anxious to get on and a little less dull than oneself and to have a teacher to appeal to at frequent intervals.

Of the 18 chapters into which the book is divided, seven deal with the fundamental principles of direct and alternating currents; five deal with the generation and utilisation of direct currents and five are devoted to alternating-current machinery and apparatus. In addition there is a chapter on "Electric Lights" and one on "Wire and Wiring."

When one remembers the influence of good diagrams at the beginning of a student's career it is difficult to understand the indifference of many authors and publishers to this side of their work. The book under notice is an exception, and the author

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is to be complimented on the obvious care he has taken with the diagrams, of which there are well over 300 in the book. We look forward to the time when the pages of engineering text-books will be brightened by the use of colours in the printing of diagrams. Every teacher uses coloured chalks on the blackboard to enable his students to follow the more readily. If it be necessary for a teacher to use colours it surely stands to reason that it is even more necessary for an author to do so.

We note that, *even in America*, the use of the finger-and-thumb rule for determining the direction of the generated E.M.F. still persists. It would be well to get rid of such rules of thumb before they make it impossible for the student to do a little original thinking on his own account.

Reference was made above to the large number of books on applied electricity. Such books may be divided broadly into three groups :—(*a*) Those of no depth whatsoever, written expressly for, and of no particular use to, the general public ; (*b*) those, written by men steeped in the theory of the subject, which afford innocent amusement to the men who are conversant with a few of the principal facts of applied electricity and which do no harm to those who are not ; and (*c*) those in which an endeavour is made to avoid *p re the ry* excepting that which has a direct bearing upon the machinery under description.

Being of no particular use, books coming under the first group as a rule have a ready sale ; books in the second group can be picked up second-hand from barrowmen ; those of the third group are passed on from one generation to another and do little good in consequence.

In books coming under the third group it may be noted that authors oftentimes pride themselves on their skill in having produced a book without the aid of mathematics. The reviewer takes it that it is the desire of every sane individual, and of all engineers, to get at bed-rock truths without recourse to difficult mathematical operations. With a few brilliant exceptions none of our engineers use more mathematics than are necessary for determining how to invest money to advantage. Those without mathematical knowledge may be able to derive consolation from the fact that with many of the brilliant exceptions the question of investing money to advantage has not arisen. H. H. B.

From War to Work. By S. TURNER. (London : James Nisbet & Co.) Pp. 128. 1s. 6d. net.

Mr. Samuel Turner, joint author of "Eclipse or Empire," has now published a little volume under the above title, which will be welcomed as an extremely useful addition to reconstruction literature. As in the case of Mr. Ramsay's "Terms of Industrial Peace," this volume is also free from the exaggerated nonsense of the Socialist. Mr. Turner gives quite a deal of information on the question of reconstruction of output, consumption and distribution ; but he stands out as one of the few authors of industrial problems who has the courage to state the case for profits. In these days it is the fashion to decry profits, and, by means of taxation and otherwise, to endeavour to get rid of them ; but the author claims that profits are essential to the process of production for the same reason that sunshine is essential to the life of the garden. Profits and sunshine must be accepted for the present, if not for ever, because without them under existing conditions there would be neither industry nor flowers. He thinks that possibly when our civilisation has evolved the necessary character and stamina we may dispense with profits, but in all probability by that time our scientists will have discovered a substitute for sunshine. In the world as it is, it is profits generally first and foremost which tempt men to strive and to begin to build that great social high road to progress, well-being, happiness, health and prosperity, which the author calls Production, with a capital P. No society, he says, ever travelled far except along that road. Then why discourage the builders ?

After showing in the most conclusive way the enormous possibilities that are before the nation in the matter of output, Mr. Turner asks why Labour and Capital should not even go the length of agreeing to increase by mutual co-operation the productive powers of industry. The only result would be that, until we have found the means of composing our differences, we should be wrangling over a barrel of apples instead of a pailful. The first essential, then, is that the nation as a whole should accept the policy of high and scientific production, and work whole-heartedly for it, and a recognition of the fact that there is not the least chance of attaining that end except by creating opportunity for the individual. The first elements of good organisation are lacking in the modern democratic Government office. A sound organisation implies the existence of a single head of high directing ability, exercising sole control and assuming sole responsibility ; but there can be no such real authority as this in Government work.

We are not able to follow the author to some of his conclusions. For instance, he quotes the Prime Minister as saying that democracy is a bad war maker, and he argues from that that democracy is also a bad peace maker. We should be sorry to think that the industrial development, which is a first necessity for the future of the Empire, meant the abandonment of the democratic ideal.

The Tercentenary of Common Logarithms.

By WILLIAM R. BOWER, B.Sc.

Logarithms form one of the most valuable of the mathematical tools that are available for the use of engineers. Both of the well-known types of logarithms—viz., the natural, hyperbolic or Napierian logarithms and the common, decimal or Briggian logarithms—enter largely into professional work, and the simplifications effected by them in what would otherwise be difficult and cumbersome mathematical operations are highly appreciated. Three hundred years ago, towards the end of the year 1617, Henry Briggs published "Logarithmorum Chilias Prima," a small pamphlet of 16 pages, containing the first table of common logarithms.

John Napier was the originator of logarithms. He published his "Descriptio" in 1614. In this work, "Mirifici Logarithmorum Canonis Descriptio," he set out the "symptomes" and uses of his invention, and gave a considerable table showing logarithms and the numbers to which they correspond. There seems no doubt that this work, which was launched unexpectedly upon the world, contains the first published table and account of logarithms. The year 1614 must be regarded as that of the birth of logarithms, an event which proved to be one of the few of very highest importance in the domain of the exact sciences. John Napier, Baron of Merchiston, was born near Edinburgh in 1550, and died there in 1617.

The publication by Briggs of the "Chilias Prima" of common logarithms was the second important event in logarithmic development. Henry Briggs (1560-1630) was born near Halifax. He was the first Gresham Professor of Geometry, London, and the second Savilian Professor of Geometry, Oxford. He died at Merton College. An epitaph, in Greek, states that "his soul still astronomises and his body geometrises."

The one rival of Napier who can claim to be an inventor of logarithms, is Jobst Buergi (1552-1632), a Swiss watch and instrument maker, who published, in 1620, a pamphlet entitled, "Arithmetische und Geometrische Progress Tabulen." In this he tabulated, without explanation, a series of red numbers or logarithms in arithmetical progression, and of black numbers in geometrical sequence.

Napier gave no account of his method of calculating logarithms in the "Descriptio." He wished to get the opinions of contemporary mathematicians on the merits of his invention before revealing the internal mechanism. But he had prepared a work in which his methods of obtaining logarithms were displayed. This work, the "Constructio," or "Mirifici Logarithmorum Canonis Constructio," was published in 1619, two years after the death of Napier. In it logarithms are called artificial numbers. Napier coined the word "logarithm," signifying a measure of ratio, for use in the "Descriptio."

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Napier gained instant approbation for his invention from the two contemporary English mathematicians, Briggs and Wright. Kepler (1571-1630), the Danish astronomer, also highly praised its value. Edward Wright (1558-1615) was born in Norfolk. He is said to have been the originator of the New River scheme for the water supply of London. He wrote specially on navigation, and quickly perceived the importance of logarithms to mariners. This led him to undertake the translation into English of the "Descriptio," which had been written in Latin. His version was highly commended by Napier, it was "most exact and conformable to my minde and the originall." Wright suggested the method of proportional parts for the calculation of logarithms of numbers between those given in the tables.

Immediately after the publication of the "Descriptio" Briggs became "wholly taken up and employed about the noble invention. I never saw a book which pleased me better and made me more wonder." He visited Napier at Edinburgh in the summers of 1615 and 1616, and suggested some improvements. There is doubt whether the idea of common logarithms was originally due to Napier or Briggs; apparently the system was called into existence by a real co-operation of the two men. The association of Napier and Briggs was that of master and disciple, and their friendship was most sincere. Napier regarded Briggs as a mathematician of the highest eminence. Briggs appreciated to the utmost not only the value of Napier's achievement, but also the importance of modifying Napier's canon in order to adapt it to work outside the domain of trigonometry, to which it had been restricted. It is related that when the two mathematicians first met they were so overcome that each beheld the other in admiration for a quarter of an hour before a word was spoken.

The table in the "Descriptio" gives the logarithms of the sines of angles for every minute of the degree, and also the natural value of the sine. The logarithms are not those calculated to the base e (=2·71828 . . .), which are now frequently called Napierian. In the original system the logarithm of 10,000,000 was zero; the logarithms increased in value as the numbers diminished; the logarithm of 1 would have been given by Napier as 161, 180, 896—more accurately, 161, 180 960. The logarithms may be considered to have the reciprocal of e, or 1/2.71828 . . . as their base. Because log 1 was not 0 the rules for the use of these logarithms were not so simple as those employed to-day.

The first extensive table of natural logarithms, or logarithms to the base e, having the logarithm of 1 equal to 0, and the logarithms increasing as the numbers rise from unity, was published in 1622 by John Speidell, a "mathematical practitioner," who lived in London. Buergi's table of red and black numbers mentioned above may be considered as one of approximate natural antilogarithms.

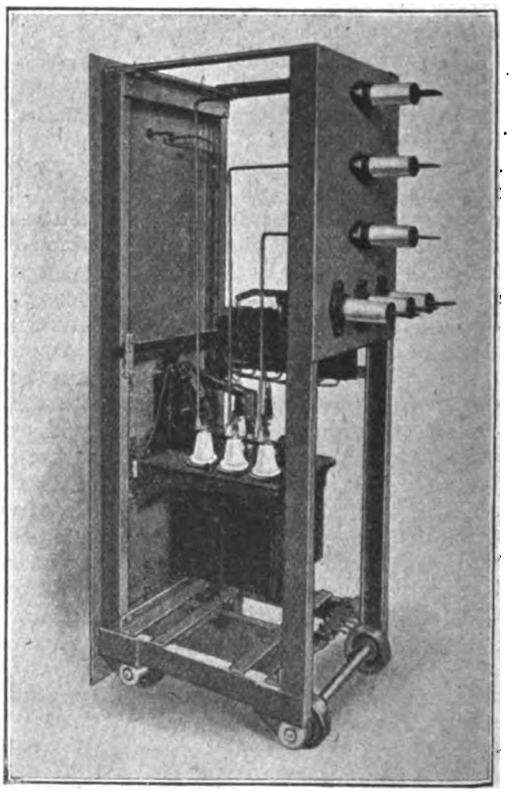
Napier seems to have been dissatisfied with his first logarithms. After having accommodated them to the immediate requirements of his contemporaries, he took advantage of the opportunity offered by the publication of Wright's translation of the "Descriptio" (1615) to introduce an admonition concerning "Logarithmes . . . to fall upon decimal numbers." An account and discussion of the "better kind of logarithms, . . . in which the logarithm of unity is 0," was given as an appendix to the "Constructio."

The importance of a modification of the original logarithms had also occurred to Briggs, and he showed some calculations to Napier on his first visit to Edinburgh in 1615. In Napier's first system log 10,000,000 was 0, and log 1,000,000 was 23,025,842·34. Hence each time a number was multiplied or divided by 10, the logarithm diminished or increased by 23,025,842·34. Briggs suggested the advantage of planning the table so that multiplication by 10 should diminish the logarithm by 10,000,000. Napier agreed with the advantage of this, but said it would be best of all to have 0 the logarithm of unity, and to make the logarithms increase as the numbers rise in value. Finally, 10,000,000 was adopted as the logarithm of 10. Thus, our system of common logarithms was produced by the collaboration of the two men. Briggs undertook the calculation of the new logarithms. His tract, "Logarithmorum Chilias Prima," gives the logarithms to the base 10 of numbers from 1 to 1,000, expressed to 15 figures. Assisted by several computers and with the co-operation of the Gresham Professor, Edmund Gunter (1580-1626), the exacting labour of logarithmic computation was carried on with great rapidity. Gunter, in 1620, published the common logarithms of the trigonometrical functions in the "Canon Triangulorum." In 1624 Briggs published his "Arithmetica Logarithmica." In this he gave the common logarithms, to 15 figures, of the numbers from 1 to 20,000 and 90,000 to 100,000. He also included a considerable treatise on the use of logarithms. Finally, in 1633, "Trigonometria Britannica" appeared, a work, mainly due to Briggs, giving the common logarithms of trigonometrical functions. In this the degree was not divided into minutes, but into a hundred parts. The book was edited by the Gresham professor, Henry Gellibrand (1597-1636), and published three years after the death of Briggs.

The remarkable value of Common Logarithms was quickly appreciated, so much so that for nearly half a century there was no further effective development of logarithms. The work of this group of British mathematicians, which should also include William Oughtred (1574-1660), the inventor of the slide rule, is a very early and brilliantly successful example of collaboration in Research.

All Steel Draw-Out Truck Types of Switchboards.

A list issued by Messrs. Johnson & Phillips illustrates a variety of truck-type switchboards, the essential characteristic of which is that the switches and other apparatus are mounted on a movable truck. With the truck in the working position all live metal is enclosed behind its sheet steel front; when the truck is drawn out for inspection of the gear all parts are automatically rendered dead and safe of access, the live fixed contacts being meanwhile effectually screened.



VIEW OF TRUCK ROLLED AWAY FROM SWITCHBOARD.

Other advantages include strong construction and minimum occupation of space. Each cubicle is made in two parts, stationary and movable, and forms a rigid self-contained, cellular structure. The operations of insertion and withdrawal of trucks are facilitated by ball bearings. Special arrangements for earthing are provided.

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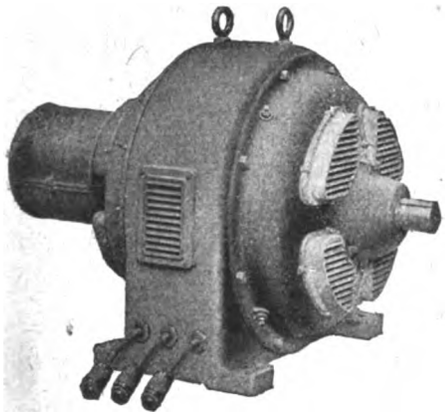
Two and Three-Phase Induction Motors.

A descriptive list issued by the British-Thomson Houston Co. (Ltd.) illustrates some of the firm's typical two and three-phase induction motors. The distinction between "squirrel-cage" and "slip-ring" motors is explained, and a variety of types of the protected and enclosed ventilated types are shown. The figure refers to a drip-proof induction motor with slip-ring rotor. This type has the great advantage over squirrel-type motors that it will exert full-load (or more) at starting, while taking approximately full-load current, and control can be effected by the insertion of resistances in the rotor-circuit, which are short-circuited when the motor has run up to speed. Protected and enclosed ventilated machines will operate at full-load for six hours, with a temperature rise not exceeding 40°C., the temperature for drip-proof machines in the same circumstances being 47°C. An account of the chief features of such motors, under the headings of power-factor, reversibility, speed variation, &c., is given, and the constructional details are explained. The list is concluded by a complete series of ratings for protected and enclosed ventilated machines.



B.T.-H. DRIP-PROOF SLIP-RING INDUCTION MOTOR.

Brush Static Transformers.

We have before us some particulars of transformers constructed by the Brush Electrical Engineering Co., Ltd. Among the features of interest we note the interleaving of steel laminations at the joints, which is considered a stronger construction than butt joints, and the adoption of three alternative types of high-tension winding. In transformers of small capacity there are several sections per phase, each consisting of several layers, former wound, with a special fabric inserted between each layer in winding. With medium capacity transformers the winding is of the spiral type, each section having one turn per layer, while with large transformers the winding consists of single layers. The windings are arranged concentrically and the low-tension winding is invariably next the core. Transformers of small capacity are provided with tanks of cast iron; corrugated steel is used for the medium size; for large types welded sheet steel tanks are employed. Importance is attached to the use only of the best mineral oil, which should be purchased to specification if not supplied with the transformer. A temperature rise after continuous operation at full load of 45°C.-50°C. is permitted, and data regarding the percentage overload which should be provided for a specified length of time are presented.

The Erichsen Machine for Testing Metal Sheets and Strips.

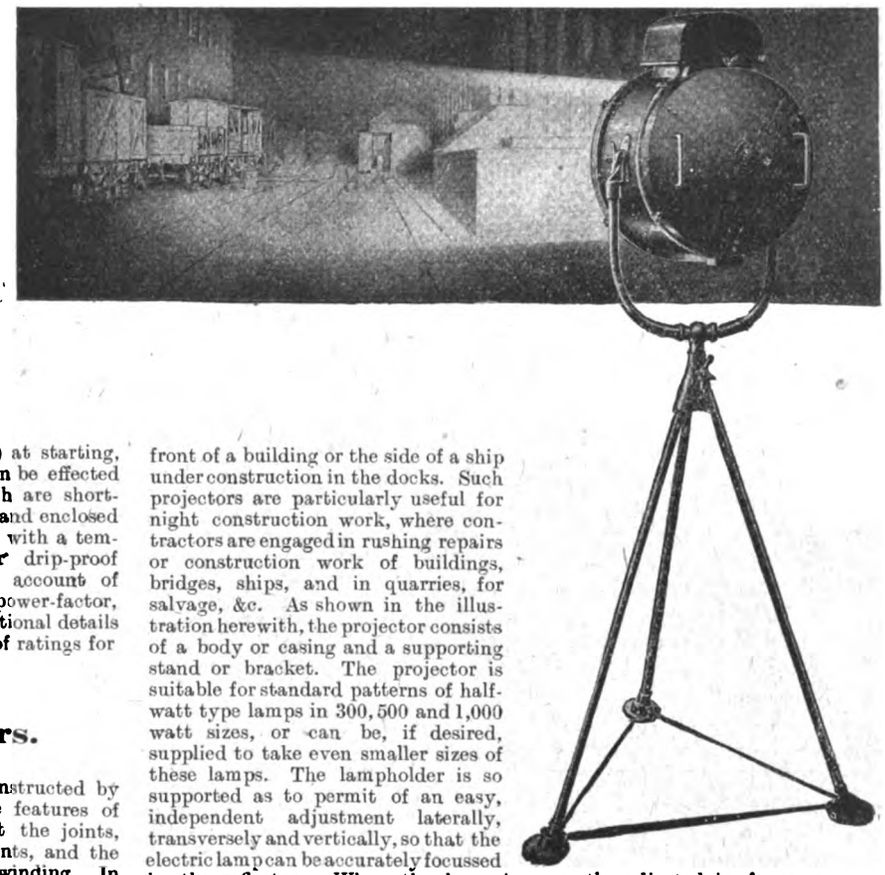
This machine is the invention of Mr. A. M. Erichsen, a Norwegian metallurgical engineer, and is stated to enable the qualities of a material for drawing, stamping and compressive purposes to be readily tested.

The specimen is clamped between two dies, and a tool with a rounded end is moved gradually forward under the influence of a ram, actuated by a micrometer screw, until fracture occurs. The point of fracture can be obtained with great accuracy (0·01 mm.). All results obtained with homogeneous material are strictly comparable, and standard specifications regarding the quality of metal sheets can be readily obtained. Tests can be executed in a few minutes without precious preparation of the test-piece and it is therefore possible to test in a few minutes a large number of different qualities of metal sheets or strips. The "dome" produced by the indentation permits ready observation of the macro-structure of the drawn metal, furnishing valuable information regarding the treatment it has undergone. In the descriptive pamphlet, curves are presented showing the relation between the thickness and the "Erichsen values" of good metal sheets. As an example, a brass stamping of 1 mm. thickness should not crack in the machine below 14·25 mm. depth of indentation.

A New Light Projector.

The British Thomson-Houston Co.'s illuminating engineering department is to be congratulated on designing for the English market an improved form of light projector employing standard half-watt or gas-filled lamps for "flood-lighting" work. This new flood-light projector is described in the B.T.-H. price list No. 10,482, which has just reached us, and which gives a description of the apparatus and its applications.

With such a projector a flood of light can be readily thrown over any area—such as a works yard, shipyard, or upon any surface such as the front of a building or the side of a ship under construction in the docks. Such projectors are particularly useful for night construction work, where contractors are engaged in rushing repairs or construction work of buildings, bridges, ships, and in quarries, for salvage, &c. As shown in the illustration herewith, the projector consists of a body or casing and a supporting stand or bracket. The projector is suitable for standard patterns of half-watt type lamps in 300, 500 and 1,000 watt sizes, or can be, if desired, supplied to take even smaller sizes of these lamps. The lampholder is so supported as to permit of an easy, independent adjustment laterally, transversely and vertically, so that the electric lamp can be accurately focussed in the reflector. When the lamp is correctly adjusted in focus, a powerful beam, giving a divergence of from 5 deg. to 15 deg. on each side of the centre is obtained with a maximum candle-power of 50 to 100 times that of the lamp employed.



Copies of this new list may be obtained on application to the Publication Department of the Company at Mazda House, 77, Upper Thames-street, London, E.C.

Legal Intelligence.

Weld-Blundell v. Stevens.

On Saturday Mr. Justice Darling delivered his considered judgment in this action for damages for breach of duty by or negligence of defendant in permitting the contents of a letter written by plaintiff to defendant to become known, and thus enabling two servants of the Float Electrical Co., Ltd. (in which plaintiff was interested) to bring successful actions for libel against plaintiff.

The jury found that it was the duty of defendant to keep secret the letter, and that he had neglected his duty in permitting its contents to become known. After reviewing the facts of the case, Mr. Justice Darling held that plaintiff could not recover damages for a wrongful act committed by himself, and gave judgment for defendant on the claim, and also on defendant's counterclaim for £48 for professional services.

Educational.

Manchester College of Technology.—The 1918-1919 session begins on Oct. 3. The matriculation and entrance examinations will be held in July and September, and matriculated students may enrol from Aug. 1.

There are complete courses in mechanical, electrical and sanitary engineering, the chemical and textile industries, mining, architecture, &c. The college possesses well equipped laboratories and workshops for demonstration and original research. Particulars of university course or of part-time courses may be obtained from the Principal.

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Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 SPECIFICATIONS.

1,540 RUTHERFORD. Electric lamp holders. (26 1 18.) 116,239
1,697 AKT. GES. BROWN, BOVERI ET CIE. Electrical ignition apparatus for internal-combustion engines. (13 2 17.) 113,784.
2,592 BOSCH. Interruptor for electric circuits. (13 2 18.) 116,242.
4,366 CHAILLIEY. Magnetos. (29 12 17.) 116,064.
4,885 WADE. (Flanders, L. H.) Manufacture of plates for electric storage batteries. (4 4/17.) 115,866.
5,072 GREAVES & ETCHELLS. Electrically-heated resistance furnaces. (11/4 17.) 115,866.
7,034 AKT.-GES. BROWN, BOVERI ET CIE. Magneto-ignition apparatus for internal combustion engines. (16 5 16.) 107,000.
7,197 TOWNSEND. Variable electric inductances. (18 5 17.) 115,876.
7,230 CLAUS. Systems for telegraphic and telephonic communications. (20 5 16.) 116,107.
7,337 BRITISH INSULATED & HELSBY CABLES, LTD., BAIRSTO & HARRISON. Loading coils for telephone circuits. (21 5 17.) 115,895.
7,368 SOPWITH AVIATION CO. & CATO. Electric couplings. (22 5 17.) 115,898.
7,461 BARR. Electrical water-heating apparatus. (24 5 17.) 115,904.
7,487 PAXTON. Electric cables. (24 5 17.) 116,122.
7,510 PALMER & PALMER. Electric flat irons. (24 5 17.) 115,908.
7,558 DUBILIER ELECTRICAL SYNDICATE. Device for forming electric arcs. (15 8, 16.) 108,851.
7,563 RELAY AUTOMATIC TELEPHONE CO. & BYGRAVE. Time-element electric circuit controlling devices. (25 5 17.) 116,126.
7,680 OSRAM-ROBERTSON LAMP WORKS & DRIVER. Means for supporting electrodes in ionic tubes, for use more particularly in wireless telegraphy. (29 5 17.) 116,133
7,681 OSRAM-ROBERTSON LAMP WORKS & HARVEY. Means for supporting electrodes, in ionic tubes, for use more particularly in wireless telegraphy. (29, 5, 17.) 116,134.
7,682 OSRAM-ROBERTSON LAMP WORKS & DURDLE. Means for supporting electrodes in ionic tubes, for use more particularly in wireless telegraphy. (29, 5, 17.) 116,135.
9,134 COX & COLWELL. Electrical switches. (26 6 17.) 115,943.
9,153 KERMAN & MATHIAS. Devices for the speedy fixing of fuse wires to electrical installations. (26 6 17.) 115,944.
9,309 WOODY. Watches. (28 6 17.) 116,176.
9,579 WHITE & BURGE. Electric lanterns for hand signalling. (3 7 17.) 116,179.
9,816 JACKSON. (Bosch Magneto Co.) Multipolar magnetos for electric-ignition systems. (6 7 17.) 115,949.
10,335 FLETCHER. Electric hot plates. (17 7 17.) 116,183.
11,064 OATES. Conductive clamps for electrodes of electric furnace. (1/8/17.) 115,973.
12,041 MURRAY. Transposing-machines for telegraph alphabets. (22/8/17.) 116,195.
12,158 NEVILLE & KAVANAGH. Cord grip for electric lamp holders. (11/11/16.) 111,283
13,167 CONNER. Telephone receivers. (14 9 17.) 116,201.
14,759 MOOR & CALLENDER'S CABLE & CONSTRUCTION CO. Electric junction boxes. (12 10/17.) 116,016.
18,731 MARKS. Means for cooling the commutators of electrical machines. (17/12/17.) 116,226.
18,796 AUTOMATIC TELEPHONE MFG. CO. (Automatic Electric Co.) Automatic telephone systems. (18 12 17.) 116,039.
107,002 DUBILIER ELECTRICAL SYND. Electrical condensers. A high-tension condenser apparatus consisting of a metallic body with insulating closure compressing plates within the body. The metallic body constitutes one terminal, the other comprising an element for compressing the plates. The compressing body extends through the closure in the form of a terminal for the purpose of conducting away heat. The plates contain high and low potential elements. The condenser elements are built up in sections. (2 5 16.)
115,045 KESSELRING. Continuous-current dynamos, characterised by constant voltage and variable speed. Means are also provided for producing an approximate constant component $\phi 3$ of the same direction as $\phi 1$. The dynamos are characterised by ϕ or —additional number of ampere-turns in the main, and additional magnetic circuit proportionate (*a*) to *I* (current), (*b*) to *N* (revolution). An iron resistance is inserted in series in the main exciting coils. (8/6/16.)
115,050 MARKS. (Suddeutsche Telefon-Apparate Kabel-und DrahtwerteAkt.-Ges.) Apparatus for operating door bolts and the like by electrical means. (7/12/16.)
115,099 B.T.-H. CO. (G.E. Co.) Systems of electric motor control, comprising manually controlled electromagnetic switches, with means for preventing their opening and closing for the purpose of reversing the motor until the said motor is substantially or actually at rest. (30 4 17.)
115,105 JACKSON. (Murray.) Electric welding apparatus, consisting of a switch actuated by a wattmeter relay, by a cam and a projecting arm in the switch. (2 /17.)
115,107 [illegible]DS. Means for automatically recording calls in telephonesystems. (4 5/17.)
115,112 [illegible].-H. Co. (G.E. Co.) Phase conversion of alternating electric currents. (2 5/17.)
115,129 GOLDSTON & WOOD. Electrical switch apparatus, comprising switch plates, contact plates, vibrating bar and resistances. (11 6 17.)
115,147 JACKSON. (Bosch Magneto Co.) Multipolar magnetos for electric ignition systems. (6/7/17.)
115,173 GRAHAM. Electric bells, wherein the solenoid is held by a removable core or striker tube within a watertight casing. (30, 8, 17.)

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

May 17, 1918.

8,293 COPE. (Soc. Anon. Hecla.) Electric heating stoves.
8,300 SUCHOSTAWER. Dynamos.
8,318 LATOUR. Audion or lamp relay or amplifying apparatus. (23/10/16, France.)
8,324 R.I. ELECTRICAL INSTRUMENT CO. & ROBINSON. Electric engraving pencils.
8,331 BASTIAN. Conductors for electric current.
8,334 PORTABLE ELECTRIC MOTORS (LTD.) & FRYER. Dynamo-electric machines.
8,348 DAVIDSON. X-ray localisation.

May 21, 1918.

8,372 PATTERSON. Electric ignition tube or plug.
8,382 MAJOR. Ventilation and cooling of dynamo-electric machines.
8,397 MACARTAIR. Apparatus for military telegraphy to avoid overheating by listening apparatus.
8,447 FORD. Support for telephone receivers.

May 22, 1918.

8,538 NICOLETIS. Apparatus for regulating strength of electric currents for medical purposes.
8,476 MCKAY & POLLOCK. Electric arc welding systems.
8,492 LANGDON-DAVIES & SOAMES. Electro magnetic clutches.
8,505 SHORT. Electric lamp holders.
8,509 B.T.-H. CO. (G.E. Co.) Electric furnaces.
8,529 SOC. GALLOT ET CIE. Apparatus for electrical separation of substances in suspension in gaseous or fluid media.

May 23, 1918.

8,573 B.T.-H. Co. (G.E. Co.) Protective devices for electric circuits.
8,574 B.T.-H. Co. (G.E. Co.) Electric motor control.
8,581 WATKIN, MILLS & CO., SMALL & THATCHER. Trolley heads for electric tramways, &c.

May 24. 1918.

8,607 BEIN. Electric hand lamps.
8,621 WALLWORK & CO. & SHILLITO. Direct current dynamo-electric machines.
8,623 LESTER. Apparatus for measuring and indicating electricity supply.
8,639 B.T.-H. CO. (G.E. Co.) Electric induction apparatus.
8,640 B.T.-H. CO. (G.E. Co.) Electric conductors.
8,644 GOSSWEILER. Dynamo-electric couplings. (29 5 17, Germany.)
8,664 MACKENZIE. Multiple telegraphy.
8,669 WITHERS. (Cox.) Telegraphy.

May 25. 1918.

8,699 VANDERVELL & MIDGLEY. Condensers for magnetos.
8,707 WILLIAMS. Gas and electricity economiser.

May 27, 1918.

8,727 JUDGE. Operating electromagnetic release gears for use on aircraft.
8,749 MARAZZI. Terminal for attaching magneto wires to sparking plugs. (21/3/17, Italy.)
8,755 YOUNG. Apparatus for conversion of energy of motion of a dielectric into electric energy, and conversion of electric energy into motion of mass.
8,761 SARRON & SIMON. Electro-converter furnaces and manufacture of steels thereby

May 28, 1918.

8,779 ROBINSON. Variable circuit electric motor.
8,789 FRANKLING. Semi-automatic electric welding device.
8,792 COLLINS. Speed limit apparatus for electrical machinery.
8,793 COLLINS. Trolley heads.
8,811 VAN WIJK. Overload switches. (7 3/18, Holland.)
8,819 KAPP. Alternating-current protective devices.

May 29. 1918.

8,867 CAMPBELL. Electrically heated perforator.
8,870 B.T.-H. Co. (G.E. Co.) Transformers.
8,883 EVERSHED & VIGNOLES. Magneto-electric machines.
8,884 PLAISANT. Electromagnetic devices.

May 30. 1918.

8,933 SUCHOSTAWER. Electric milk steriliser.
8,936 OSRAM-ROBERTSON LAMP WORKS & SACK. Incandescent lamps.
8,941 BURLEIGH. Dynamo-electric machinery.
8,953 VANDERVELL & CO. & MIDGLEY. Self-regulating continuous-current dynamos.

May 31, 1918.

8,978 CHICKETTS & ROBINSON. Electric fuse carriers.
8,998 WILSON. Regulating arrangements for electric circuits.
9,003 B.T.-H. Co. & YOUNG. Magneto-electric machines.
9,016 M.-L. MAGNETO SYND. & WATSON. Spark gaps.
9,018 WORDINGHAM. System of distributing electric energy.
9,021 STHOLEFIELD. Windings in electrical apparatus.
9,023 EFANDEM CO. & GIBBONS. Electric torches.
9,025 WALLACE. Primary batteries.
9,028 EDISON-SWAN ELECTRIC CO. Treatment of refractory metals.

June 1, 1918.

9,055 JOUBERT. Electrical installations. (4/6/17, France.)
9,056 JOUBERT. Electrical installations. (4/6/17, France.)
9,068 COMPARRI WIRELESS CONTROL SYND. & COMPARE. Detector for wireless telegraphy.
9,074 B.T.-H. Co. (G.E.Co.) Means for controlling electric circuits.
9,075 B.T.-H. Co, TAYLOR & WHITCHER. Alternating current dynamo-electric machines.

June 3, 1918.

9,115 LYON & WRENCH & BENNETT. Conversion of electric currents.
9,104 WHITESIDE. Electric motors.
9,149 IGRANIC ELECTRIC CO. (Cutler Hammer Mfg. Co.) Battery charging apparatus.

June 4. 1918.

9,223 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Ejector or injector apparatus. (20 3 18, U.S.)
9,226 HAZARD & MORRIS. Electrodes for smelting, &c.

June 5, 1918.

9,249 PITT. Electric furnaces.
9,267 B.T.-H. Co. (G.E. Co.) Production of steel alloys and constituents thereof.
9,268 B.T.-H. Co.. (G.E. Co.) Manufacture of steel.
9,285 KILBURN. (Norske Aktieselskab for Elektrokemisk Industri, &c.) Carbon electrodes.

June 6, 1918.

9,322 BENNETT & GARDE. Electrical connectors.
9,323 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Electrical insulating bushings. (8/6/17, U.S.)
9,328 MARR. Lock for carbon electrodes.
9,330 FULLER ACCUMULATOR CO & WELCH. Electric relays.
9,331 FULLER ACCUMULATOR CO. & WELCH. Booster relays.
9,345 B.T.-H. Co. & MARTIN. Dynamo electric machines.
9,346 B.T.-H. Co., EDMUNDSON & MUNRO. Vacuum electric discharge devices.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain of the Week.—Capt. W. Hynam.
Next for Duty.—Capt. W. Darley Bentley.
Monday, July 15, and Friday, July 19.—Adjutant's Technical Lecture (Earthworks) 6.30-7.
Monday, July 15—Friday, July 19.—Drills as usual.
Sunday, July 21.—Commandant's Parade at Waterloo Station, 8.45 a.m., for work at Esher. Dress, drill order, with haversacks and water-bottles. Midday and tea rations to be carried.
Special Notices.—All drills will take place at Headquarters, unless otherwise stated.
The M.O. will attend for the examination of recruits on Thursday evening, at 6.30.
Annual Camp.—This camp will be held at Esher from Aug. 3 to Aug. 11, both dates inclusive. Names can still be sent in.

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Commercial Topics.

Decimal Coinage.

The Government propose to appoint a Royal Commission, consisting of members of both Houses of Parliament with some expert members, to consider the question of the desirability or otherwise of making a change in our coinage system. The Coinage (Decimal System) Bill, recently introduced in the House of Lords by Lord Southwark, will also be considered by the Commission.

* * * *

Rosin Supply.

The Ministry of Munitions (Non-Ferrous Materials Supply Department) have appointed the United Kingdom Rosin Distributors' Association for the distribution of Government rosin.

The Ministry have fixed the following prices :—

AMERICAN.—B.G., £55 ; H/M., £56 ; N/WW., £57. 10s. per ton net cash, ex warehouse or store. FRENCH OR SPANISH.—B/G., £54 ; H./M., £55 ; N/Upwards, £56. 10s. per ton ; tare allowance, 20 per cent. American ; 7 per cent. French or Spanish. The rosin is sold in the specified groups or grades (no one particular grade guaranteed). Prices are ex store, U.K. ports, where stock exists.

At present the only Government rosin available is French (various grades). A supply of American Government rosin, of all grades, is expected about the end of July. The offices of the Association are :—

London—28, St. Mary-axe, E.C. ; Liverpool—23-24, Imperial-buildings, Exchange-street, E. ; and Glasgow—142, Queen-street. Buyers must send inquiries through their usual sources of supply.

* * * *

Increased Tramway and Lighting Charges.

By the Statutory Undertakings (Temporary Increase of Charges) Bill, which was introduced into the House of Commons last week, tramway, electricity supply, gas and water undertakings are authorised to increase their charges for the period of the war, and two years thereafter. The principal clause is as follows :—

(1) Where it appears to the appropriate Government Department that the financial position of any undertaking to which this Act applies has been adversely affected by circumstances arising out of the present war, the Department may, if they think fit, by order provide for the modification of any statutory provisions regulating the charges to be made by the undertakers, and of any statutory provisions consequential on or supplemental to any such provisions for such period during the continuance of this Act, in such manner, and subject to such conditions, as appear to the Department to be just and reasonable :—

Provided that—

(*a*) where the undertakers are a local authority no modification shall be authorised which will increase the statutory maximum charge by more than 50 per cent., or which is more than sufficient, so far as can be estimated, to enable the undertaking to be carried on without loss ; and

(*b*) in any other case no modification shall be authorised which is more than sufficient to enable a dividend on the ordinary stock, or shares of the undertaking to be paid at half the standard or maximum rate of dividend, if any, prescribed for the undertaking, or at half the pre-war rate of dividend, whichever is lower.

(2) An application to a Department for the purposes of this Act shall be accompanied by such information, certified in such manner, as the Department may require with respect to the financial position of the undertaking.

* * * *

s s in the Formation of Whitley Councils.

e formation of Joint Industrial Councils is making steady rogress.

Councils in the pottery and building industries are already at work, and during the present month the following newly-formed Councils will hold their first meetings : The heavy chemical trade, gold, silver and allied trades, the rubber industry, match manufacture and the silk industry.

In the following industries provisional Committees have drafted constitutions of proposed Industrial Councils which have been sent out to the various associations concerned for their approval : baking, cable making, commercial road transport, electrical contracting, furniture making, leather goods and belting and vehicle building.

A constitution for the printing industry will shortly be sent out for approval to the associations concerned, and in the following industries preliminary conferences have taken place and proposals to proceed with the drafting of constitutions have been approved : Bobbin manufacture, boot and shoe manufacture, electricity, power and supply, roller engraving and the woollen and worsted industry.

In some 20 other industries the question of the formation of Joint Industrial Councils is under consideration, and in a number of cases proposals to summon joint conferences of employers' association representatives and trade union representatives have been approved.

* * * *

Meaning of "Period of the War."

The final report of the Committee on the interpretation of the term "Period of the War" has just been issued.

Three interim reports have already been made. The first dealt with the meaning of the phrase "termination of the present war," and other similar phrases used in Emergency Acts, and the rules, regulations and Orders made thereunder, and also in Government and private contracts, awards and similar instruments. The second dealt with the effect of the termination of the war upon the Defence of the Realm Acts and the regulations thereunder. The third related to the effect of the war upon contracts of apprenticeship, &c. The final report deals with the rest of the emergency legislation which has taken place, and recommends special legislation in two classes of cases, viz. : (1) Where statutes have been passed to relieve persons from disabilities which would have been caused by their absence on military service during the war, but may also be caused by absence during demobilisation ; and (2) where temporary Acts, which expire with the termination of the war, or at a fixed period thereafter, create offences and impose penalties as punishment for such offences.

* * * *

International Parliamentary Conference.

At its sittings last week the International Parliamentary Commercial Conference adopted resolutions on the unification of legislation relating to intellectual and industrial property.

The resolutions proposed that the Allied countries should allow the same duration to copyrights ; the mutual protection of drawings and patterns whatever may be their worth or destination ; the adoption of one rule for the duration of patents ; the establishment as soon as possible of an international office for patents ; and to assure in all the Allied countries the same conditions as in the original country for the patents which concerned war materials.

The Conference, which endorsed the recent declaration of Mr. Bonar Law in the House of Commons relative to the control of raw materials, also expressed the hope that the Allied Governments would organise the control of raw materials and would work to promote by reciprocal concessions the exchange of manufactured goods and merchandise of all kinds.

* * * *

Brisbane Tramways Purchase.

The Government have decided to reintroduce the two bills for the purchase and working of the undertaking of the Brisbane Electric Tramways Co.

The bills provide for compulsory reduction in fares so that the profits of the company shall be restricted to not more than 5 per cent. on the value of the tramways. The undertaking is subject to purchase by the Government after Sept. 20, 1920 (under the Act of 1882), and according to legal opinion the purchase terms must be arrived at on the basis of the commercial value of the undertaking as a going concern, the profits being the basis of the valuation. If the fares, and consequently the profits, are reduced meanwhile, the value of the property will be so much the less when the time arrives for the Government to purchase the undertaking.

Electricity Supply.

Extensions.

Elland.—The Council has been authorised to borrow £2,000 for extensions of the electric supply undertaking.

Lincoln.—Last week the City Council adopted the recommendation of the Electricity Committee to purchase the power station of Messrs. Clayton & Shuttleworth and to carry out extensions of the electric supply undertaking.

The chairman (Ald. White) explained that the proposed scheme would involve a total expenditure of about £240,000. The Government insisted on the abolition of small power stations, and on the establishment of large stations.

Councillor Ashley gave notice to move that the L.G. Board be requested before sanctioning the borrowing of money for the scheme to order a public inquiry to be held.

Walsall.—Application is to be made to the L.G. Board for sanction to borrow £6,304 for the electricity undertaking.

General.

Clayton.—Bradford Corporation will apply for a provisional order with the assent of the Urban Council.

Coventry.—The annual report of the Electricity Committee was adopted by the Council on the 25th ult.

The past year's revenue was £197,987 (compared with £169,787 in 1916-17), and working expenses, &c., were £136,603 (£104,179). After providing for capital charges, the net profit was £16,321 (£27,766). A sum of £6,000 has been devoted to relief of rates, and £21,500 placed to reserve. Revenue was equal to ·866d. per unit, and total costs were ·794d., leaving net profit ·072d. Units generated were 54,931,450, purchased 4,071,000 and sold 54,854 340. The capital expenditure is £571,776.

Dr. Orton, who submitted the report, said the total increase in charges to power consumers was 15·3 per cent., and there had been no increase to ordinary consumers for lighting or domestic purposes.

East Ham.—The salary of the borough electrical engineer and tramway manager (Mr. W. C. Ullman) has been increased from £700 to £800 per annum.

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Greenock.—During the year ended June 30 the units generated at the electricity works amounted to 29,500,000, or about 4,000,000 more than in the preceding year.

Hackney (London).—The Council is recommended to increase the salary of the borough electrical engineer (Mr. L. L. Robinson) from £750 to £850 a year.

The Electricity Committee has refused to accede to the request of Sir John Hunter (Administrator of Works and Buildings, Air Ministry) for the release of Mr. Robinson to take up an appointment under the Ministry, as it is of opinion that the national service would not benefit by the exchange of duties.

National Kitchens.—The Ministry of Food has taken over three canteens in the Southampton Dockyards, and will convert them into national kitchens.

It is intended to re-equip the buildings with up-to-date steam and electrical cooking arrangements, and they will be in full working order in about three months' time.

Sheffield.—On Wednesday the Electric Supply and Parliamentary Committees presented reports to the Corporation on the recommendations of the Board of Trade Electric Power Committee.

The Parliamentary Committee recommended the Council to place on record their dissent from the principles underlying the report, and to affirm in particular that the proposed terms and conditions of taking over electricity undertakings belonging to local authorities are unjust, and in many districts, including Sheffield, must result in increased charges being made to consumers of electrical power. They also recommended that the Consultative sub-committee be authorised to take such steps in the matter, in connection with representatives of the Electric Supply Committee, as they deem necessary.

Stoke-on-Trent.—The past year's accounts of the electricity supply department were criticised at the last meeting of the Council and their adoption was postponed until a report has been obtained from Sir John Snell, who is also to report upon a scheme of extensions at the central power house estimated to cost about £100,000.

Ald. H. LEESE, chairman of the Electric Supply Committee, said the extension scheme would save 5,000 tons of coal a year. They had sold eight million units of electricity during the year, an increase of half a million. Revenue was £65,663 (increase of £6,000), but expenditure increased by £9,000. Gross profit was £19,664, and after providing for redemption of loans and payment of interest the net loss was £3,769, increased to £3,993 after paying for new meters out of revenue. The increase in cost of coal was £4,292, and increase in wages £1,640. They were paying over double pre-war prices for coal, and it was 15 to 20 per cent. inferior.

The Deputy Mayor (Ald. J. S. GODDARD) said the committee had failed in their duty in not increasing the price of electricity so as to prevent a deficit.

Salford.—The Council has accepted a contract for the supply of cable for linking up the Salford electricity supply with that of Manchester.

The contractors (Callender's Cable & Construction Co.) will supply and lay 2,700 yards e.h.t. 33,000-volt cable and 2,700 yards of telephone cable from the boundary of the borough at Regent Bridge to Frederick-road station, at a schedule of prices amounting to about £6,950.

Stratford.—The Council has referred to a committee a request by the Stratford-on-Avon Electricity Co. for permission to increase the price of current from 6½d. to 7d. as from the 30th inst.

Wolverhampton.—On Monday the Council was recommended by the Electricity Committee to increase the charges for electricity to all consumers not under contract by a further 15 per cent., but since that was suggested a further 1s. 6d. had been added to the 2s. 6d. per ton on the price of coal, making the advance 4s. in all, and the matter was referred back for a report to be presented.

Electric Traction.

Electric Vehicle Progress.—Ilford Urban Council has decided to obtain two 3½ ton electric vehicles from the General Vehicle Co.

Leyton Urban Council recently ordered two electric motor vans from Edison Accumulators (Ltd.), and the company now offers to supply a British-built chassis (to overcome the objection to importing their chassis from America) at 5 per cent. over the original quotation.

Worthing Corporation has decided to purchase four two-ton electric motor vehicles from Messrs. Ransomes, Sims & Jefferies, at £1,033. 10s. each. The present cost of collecting house refuse by horse-drawn vans is 6s. 6d. per ton, and the estimated cost by electric vehicles is 5s. 6d. per ton. One vehicle is to be purchased at once out of revenue.

Glasgow.—The following increases of salary have been granted:—Mr. J. Dalrymple, tramways manager, from £1,300 to £1,500 per annum; Mr. L. M'Kinnon, traffic superintendent, £700 to £750; Mr. J. Ferguson, chief engineer, £700 to £750.

Liverpool.—A strike of tramway employees which commenced at midnight on Monday has disorganised the tramcar service.

The strike is the outcome of friction between rival unions of tramway employees. On nearly all the routes there were fewer cars on Monday and Tuesday. The Municipal Employees Association claim that of over 2,000 tramway workers, 1,200 are out on strike. The demands of the Association were submitted by their general secretary to the Chief Industrial Commissioner with a view to arbitration this week.

Scarborough.—The local Electric Tramway Co. proposes to carry fish on its tramcars from the piers to the goods station.

Tramcar Kitchens.—Halifax Corporation recently introduced a tramcar kitchen, and now the Food Committee has made arrangements with the Tramways Committee to equip a railless car as a travelling kitchen, at a cost of £252.

Walsall.—The net profit on the tramways for the past year is £16,515, of which £5,000 is to be appropriated to relief of rates, £4,895 placed to reserve for motor omnibuses and £6,620 carried forward.

Imperial Notes.

Australasia.—At the recent annual general meeting of the Victorian Institute of Engineers, the retiring president (Mr. M. E. Kernot) said there had been during the war a slowing down of engineering works in Victoria, such as railway and tramway construction.

The establishment of the steel making industry in Australia was developing rapidly and another great work to which they should devote themselves was the supply of electricity. The first stage of the electrification of their suburban railways was likely soon to start working, and they expected to have the largest electric traction undertaking in the world.

Mr. J. S. Dethridge was elected president for the ensuing year.

Sydney City Council recently decided not to connect any new consumers to the electric supply mains. When the Railway Commissioners' supply is available, it may be practicable to resume the connecting of installations. Additional generating plant is on order in England but it is not expected in Sydney until after the war. Arrangements have been made with the Railway Commissioners for a limited supply from the tramway power-house, but converting plant must be installed. This plant (which has been ordered from America) will be ready by September.

The Australian Thermit Co. (Sydney) is to be wound up by order of the Minister for Trade and Customs.

Ararat (Victoria) Municipal Council is applying for an order in Council authorising it to supply electricity.

The Junee (N.S.W.) Municipal Council propose to raise a local loan for an electric supply scheme.

Electrical Trade in India.—Commencing early in October next, the "Times of India" will publish fortnightly a page dealing with the progress of electrical science and industry.

It is believed that these special pages will lay a strong foundation for a considerable extension of British electrical trade throughout the Indian Peninsula, as the exclusive right to use the advertising spaces that will be available has been secured to British firms. Messrs. S. Davis & Co., 30 and 31, St. Swithin's-lane, London, E.C. 4, are the sole agents for advertising on these pages.

Jamaica.—According to the U.S.A. consul at Kingston there is a good opening for small electric lighting and power plants for isolated country houses and farm work.

Owing to the lack of development of water-power here, electric current is available only in the larger centres, and there is a good demand throughout the island for individual plants at a moderate price. The plant should consist of an oil or petroleum engine and a dynamo mounted on the same shaft, preferably, and a bank of storage batteries. Only oil-burning engines should be considered, as petrol is altogether too expensive at present.

Foreign Notes.

Buenos Ayres.—The Argentine Government has accepted the tender of the Compañia Alemana Transatlantica de Electricidad for the supply of electrical energy to the National Penitentiary for five years, at $0·045 gold per unit for lighting and 3 cents. gold for power and heating up to 100,000 units per annum, and $0·027 gold per unit after consumed.

Electric Fires in New York.—According to reports in the American press, 14,053 fires occurred in New York in 1917, but only 152 were attributable to defective electrical installations, and the loss (about $50,000) is only 50 per cent. of that of the previous year. The investigations of the Board of Fire Underwriters show that $33,000 of the loss was due to electrical equipment made without the knowledge and approval of the board.

Industrial Congress at Batavia.—An Industrial Congress in the interests of the Netherlands East Indies is to be held at Batavia (Java) in 1919.

The Congress will probably be divided into six sections, including sections for communication (railways, tramways, telegraphy and telephony) and production of energy, electricity and industries. Each section is to be represented by a sub-committee, and the committee of management will be composed of the presidents of the sub-committees. The participants in the Congress will comprise experts from the surrounding colonies and also from the neighbouring countries, such as Western America, Japan, Australia and South Africa.

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Porcelain Trust in Germany.—The Bank for Thuringia (formerly M. Strupp) recently acquired the greater part of the 3,000,000 marks share capital of the Weiden Porcelain Mfg. Co. (formerly Bauscher Bros.).

To the same concern belong also the porcelain manufacturing firms Kahla, Hermsdorf & Konigszelt and the Lorenz Hutschenreuther Co. (Selb), which towards the end of 1917 bought the firm of Paul Müller, and has now increased its share capital from 2,000,000 to 3,000,000 marks. Another group of porcelain firms controlled by the banking firm of Arnhold Bros. (Dresden) includes the C. M. Hutchenreuther Co. (Hohenberg) and the Tielsch Company (Altwasser). A third group controlled by the Dresden Bank includes the Ph. Rosenthal Co. (Selb and Kronach) and the firm of J. Zeidler & Co. (Selb).

Research in Sweden.—The Kungle Kommerskollegium (the Swedish Board of Trade) is considering a scheme for establishing a Scientific Academy of Engineering composed of prominent technicians and industrial men interested in the promotion of scientific research.

The Academy would grant subsidies to teachers and pupils at laboratories and high schools and support individual technicians and inventors in cases where private capital would not be expected to come forward.

Spain.—Efforts are being made to make the country independent of Germany in regard to the supply of electric motors, &c., and an Institute of Electrical Industries has been established at Barcelona, with a department specially equipped for electrical research work.

Miscellaneous.

Alien Enemies' Patents.—In reply to a question in the House of Commons on Monday, Sir A. Stanley stated that 1,310 patent applications had been received from enemy subjects since the outbreak of war, of which 944 had been accepted.

Calorific Power of Gas.—In the regulations set out in the new Order made by the Minister of Munitions it is provided that

Gas works which have coal gas plants only shall produce gas of a calorific power of as nearly as possible 500 B.Th.U. gross, but not in any event less than that calorific value, before scrubbing.

If it is impossible for any gas works to supply its consumers' ful demands and it has a water-gas plant, the balance of its consumer's requirements shall be met by an admixture of uncarburetted water-gas, but the minimum calorific value of the mixed gas must be 450 B.Th.U.

Coal Prices.—The Board of Trade have authorised an increase of 1s. 6d. per ton in the price of coal despatched from the colliery for consumption in the United Kingdom to meet cost of increased wages recently granted to the miners.

The prices of coal for shipment for export and as bunkers are increased by 2s. per ton in the case of all vessels, the loading of which is commenced on and after July 8. The Board of Trade have assumed responsibility for the payment of the war wage as from June 30, and, to provide funds for so doing, are to be credited by the collieries with 4s. per ton on all coal disposed of on and after that date.

Electrical Work for the Blind.—In the current issue of "St. Dunstan's Review," Sir Arthur Pearson, who is doing very valuable work in the interest of our blinded soldiers, has a report on what is a promising new occupation for blind people, namely, the winding of coils for the armatures of electric machines.

Having read an account of the work in an American journal, Sir Arthur got into touch with Mr. Hugo Hirst, chairman-director of the General Electric Co. Mr. Hirst took the matter up, and cabled to Dr. S. S. Wheeler for full particulars, and as the result, Dr. Wheeler came over from America to supervise the starting of this new industry for blind people. Dr. Wheeler paid a visit to St. Dunstan's, then Mr. Hirst called a meeting of the heads of the largest electrical firms in the United Kingdom, when the matter was discussed, and Sir Arthur was able to demonstrate to the experts present the ability of a blind person to accomplish the desired results. It was arranged that Sir Arthur should place himself in communication with Mr. W. H. Thurman, superintendent of the Birmingham Royal Institution for the Blind, in order that the latter should install the industry on an experimental basis in his workshops, obtaining the necessary material from the Birmingham works of the General Electric Co. It is anticipated that the experiment will prove a complete success, and that it will open up a valuable channel of employment for the blind worker.

Government Establishments and the Whitley Report.—Mr. Bonar Law announced in the House of Commons last week that the War Cabinet had decided to adopt in principle the application of the recommendation of the Whitley Report with any necessary adaptations to Government establishments where the conditions were sufficiently analogous to those existing in outside industries. An Inter-Departmental Committee of representatives of the Departments concerned would consider what modifications were necessary.

Royal Assent.—On June 27 the Royal Assent was read to the following Acts of Parliament: Brixham Gas and Electricity Act, Yorkshire Electric Power Act.

The Channel Tunnel.—Sir A. Fell recently read a Paper on "London and the Channel Tunnel" before the Society of Arts.

Sir ARTHUR FELL said London had not yet appreciated what the Channel Tunnel would mean for it, nor how much upon the completion of the work would depend its future as the greatest city of the old world. After the war there would be great and friendly rivalries between the nations of Europe. London could not stand still and hope to reap its share by simply erecting new theatres, bigger hotels and great drapery stores. The isolation of the country from the Continent was practically complete, and if the isolation continued after the war some other capital would have to be found for the new era to which we looked forward. It might be Paris or Vienna, or even Berlin or Brussels; but it must be a railway centre, to and from which would run the great world expresses. To reach such a railway centre passengers from the United States, Brazil, the Argentine and other wealthy South American States would go direct to Cherbourg, Rotterdam or Hamburg. London would thus be sidetracked because of its insular position. The tunnel would not only help our island and its capital, but be vital to the continued pre-eminence and prosperity of our steamship lines as carriers of the passenger traffic to Europe. The construction of the Franco-British Submarine Railway would be the earliest and greatest of all the works of peace which would be begun immediately the war ended.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during May, 1918, and (*b*) the aggregate figures from Jan. 1 to May 31, with increase or decrease compared with corresponding periods of 1917 :—

Electrical machinery, (*a*) £21,187 (decrease £115,838), (*b*) £367,723 (decrease £459,818); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £9,736 (decrease £27,811), (*b*) £60,848 (decrease £52,924); and electrical machinery unenumerated, (*a*) £11,451 (decrease £88,027) (*b*) £306,875 (decrease £206,894); telegraph and telephone cables other than submarine, (*a*) nil (decrease £2,001), (*b*) £1,846 (decrease £44,007); telegraph and telephone apparatus, (*a*) £1,459 (decrease £1,740), (*b*) £14,695 (decrease £76); other electrical wires and cables, rubber insulated, (*a*) nil (decrease £1,223, (*b*) £602 (decrease £23,454); with other insulations, nil (decrease £1,603), (*b*) £455 (decrease £4,820); carbons, (*a*) £3,391 (decrease £8,593), (*b*) £19,084 (decrease £24,704); glow lamps, (*a*) £4,545 (increase £4,101), (*b*) £51,971 (decrease £8,063); parts of arc lamps and searchlights (other than carbons), (*a*) £5,902 (decrease £4,169), (*b*) £39,404 (decrease £8,149); primary and secondary batteries, (*a*) £9,955 (decrease £8,301), (*b*) £88,268 (decrease £59,362); meters and measuring instruments, (*a*) £1,360 (decrease £2,389), (*b*) £5,507 (decrease £7,349); electrical goods and apparatus unenumerated, (*a*) £54,517 (increase £7,273), (*b*) £176,847 (decrease £46,036). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £81,129 (decrease £18,645), (*b*) £398,945 (decrease £225,792).

Exports.—The exports of electrical machinery, material, &c., (*a*) during May, 1918, and (*b*) from Jan. 1 to May 31, with increase or decrease compared with corresponding periods of 1917, were as follows :—

Electrical machinery, (*a*) £71,447 (decrease £39,772), (*b*) £433,869 (decrease £165,386); including railway and tramway motors, (*a*) £4,498 (increase £3,991), (*b*) £15,080 (increase £3,930); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £42,930 (decrease £37,770), (*b*) £253,904 (decrease £98,348); and electrical machinery unenumerated, (*a*) £24,019 (decrease £3,993), (*b*) £164,885 (decrease £70,968); telegraph and telephone cables, submarine, (*a*) £247,150 (increase £243,828) (*b*) £325,031 (increase £225,730); other than submarine, (*a*) £29,776 (decrease £44,636), (*b*) £99,190 (decrease £274,091); telegraph and telephone apparatus, (*a*) £13,593 (decrease £3,194), (*b*) £86,313 (increase £5,698); other electrical wires and cables, rubber insulated, (*a*) £2,804 (decrease £6,354), (*b*) £26,861 (decrease £92,074); with other insulation, (*a*) £3,007 (decrease £22,956), (*b*) £32,200 (decrease £129,265), carbons (*a*) £608 (decrease £5,356), (*b*) £2,520 (decrease £11,930); glow lamps, (*a*) £5,300 (decrease £6,773), (*b*) £35,903 (decrease £25,671); arc lamps and searchlights, (*a*) £2,852 (increase £3,752), (*b*) £10,177 (decrease £471); parts of arc lamps and searchlights (other than carbons), (*a*) £2,425 (increase £1,083), (*b*) £8,915 (decrease £8,346); primary and secondary batteries, (*a*) £12,793 (decrease £444), (*b*) £43,109 (increase £33,468); meters and measuring instruments, (*a*) £16,816 (increase £11,844), (*b*) £49,173 (decrease £992); transformers, (*a*) £2,406 (decrease £4,043), (*b*) £10,523 (decrease £18,673); switchboards, (*a*) £1,141 (decrease £5,461), (*b*) £14,644 (decrease £2,224); electrical goods and apparatus unenumerated, (*a*) £34,330 (decrease £28,387), (*b*) £178,922 (decrease £16,340). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £375,001 (increase £137,903) (*b*) £923,481 (decrease £480,117).

Tenders Invited and Accepted.

Turbo-Alternators, Water-tube Boilers, Economisers, &c.

BELFAST Corporation invite tenders for the manufacture and erection of two 6,000 kw. Turbo-alternators and one 30 kw. Balancer Booster; four Water-tube Boilers, Fuel Economiser, &c.; two steel Chimneys with Fans; two electrically-driven boiler-feed Pumps, Accumulators; three 500 kw. and five 1,000 kw. Rotary Converters, with Transformers, &c.; and two 250 k.v.a, two 350 k.v.a. and six 1,250 k.v.a. Static Transformers. Specifications, &c., from the consulting engineers (Messrs. Preece, Cardew, Snell & Rider), 8, Queen Anne's-gate, Westminster, S.W. 1; or, Mr. T. W. Bloxam, M.I.E.E., city electrical engineer, Belfast. Tenders must be lodged at the Town Clerk's office, City Hall, Belfast, by Aug. 16.

See an advertisement.

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BRADFORD.—The following tenders are recommended for acceptance :—

C. A. Parsons & Co., 12,000 kw. turbo-generator; Hick, Hargreaves & Co., surface condensing plant; Thwaites Bros., air exhauster for suction gas plant.

LEEDS.—The Electricity Committee has placed an order with Ferguson, Pailin & Co. for the supply of switchgear, at £1,041.

MANCHESTER.—The following tenders have been accepted by the Corporation :—

Callender's Cable & Construction Co., supply and laying of cable; C. Macintosh & Co., supply of cable; Richardsons, Westgarth & Co., platforms and staircases for turbo-alternator at Stuart-street; Ferguson, Pailin & Co., and B. Thomas, d.c. machine panels for Dickinson-street; Callender's Co., Macintosh Cable Co., and British Insulated & Helsby Cables (Ltd.), supplies of cable.

SALFORD.—The Tramways Committee has placed an order with Hadfields, Ltd., for the supply of four pairs of manganese points and 12 managnese steel crossings at £696.

SHEFFIELD.—The City Council has accepted the following tenders: W. T. Glover & Co., supply and laying of two feeder cables between the Blackburn Meadows and the Rotherham power houses; also for cables at revised schedule of prices; A. Reyrolle & Co., e.h.t. feeder panel at Neepsend; Davidson & Co., centrifugal fan, casing, &c.

The Council has also accepted the following tenders :—

Dewhurst's Engineering Co., Ltd., 250 steel boiler tubes; Cole, Marchent & Morley, eight new valves and spindles; Edison Accumulators (Ltd.), two British built chassis.

WALSALL.—The Council has accepted the following tenders :—

Brush Electrical Engineering Co., two 350 k.v.a. and one 100 k.v.a. transformers, £929; British Westinghouse Co., three switch cubicles, £345; Cross & Cross, steel carrier for conveying main across canal, £168; Vacuum Oil Co., 700 gallons transformer oil.

Appointments Vacant and Filled.

A charge engineer is required for tramways sub-station. Wages 50s. a week, plus war bonus of 20s. and 12½ per cent. Applications to the General Manager, L.C.C. Tramways, 23, Belvedere-road, S.E.1. *See advertisement.*

A technical assistant, with knowledge of switchgear, &c., is required. *See advertisement.*

A designing engineer is wanted by a large electrical firm in Lancashire. *See advertisement.*

Draughtsmen, with experience of switchgear and motor-control gear, &c., are required by an electrical engineering firm in Lancashire.

A draughtsman is required by the Yorkshire Electric Power Co., Wellington-road, Dewsbury.

A technical assistant for cable designing is required by an advertiser.

Mr. W. Jessop, of Eastbourne, has been appointed engineer in charge at Hammersmith (London) electricity works.

Mr. S. C. Midwinter, of Sunderland, has been appointed station superintendent at Eastbourne.

Business Items.

The works and offices of the Benjamin Electric (Ltd.) have been removed to Brantwood Works, Tariff-road, Northumberland Park, Tottenham, London, N. 17. Telegrams: Benjalect Tottlane London; Telephone: 2114 (three lines).

In future the business of A. J. Greenly & Co. will be carried on as Greenly's Limited, 37/38, Strand, London, W.C. 2. There will be no change in the management or staff.

E. J. Chapman and F. A. S. Wormull (trading as Chapman & Co., electrical engineers, 41, Lewis-grove, Lewisham, London, S.E. 13, have dissolved partnership

Plant, &c., for Sale.—The Midland Railway Co. has some open and enclosed type arc lamps for sale Offers to the Stores Superintendent, Derby.

Aberdeen electricity department have for sale three 420 kw. d.c. 440-550-volt direct-coupled sets; also Alley & Maclellan surface condenser, and Edwards three-throw air pump. Offers to city electrical engineer (Mr. J. Alex. Bell), 1, Millburn-street, Aberdeen, by noon July 23.

Meldrum Specialities.—Messrs. Meldrums (Ltd.), Timperley, Manchester, have recently issued pamphlets giving particulars of the "Meldrum" combustion appliances and of the castings and apparatus supplied by them for chemical works.

Municipal Accounts.

Blackburn.—At March 25 the total capital expenditure of the electricity department was £327,986, of which £173,645 is outstanding.

Revenue was £68,378 (compared with £58,639 in previous year), and total expenditure £44,765 (£34,474), leaving gross profit £23,613 (£24,165), to which was added £571 for interest. After providing for interest, repayment of loans and sinking fund, the net profit was £4,472 (£2,199), which has been transferred to depreciation and renewals fund. Units generated were 10,318,417 (8,837,213), and sold 9,819,986 (8,053,530). Total maximum supply demanded was 4,354 kw. (4,057 kw.)

In his report the engineer (Mr. P. P. Wheelwright) says the difficulties of maintaining supply have been greatly increased owing to the restrictions of supply and cost of materials, labour, &c. He advises the Corporation to urge upon the Government the importance of the erection of a new generating station. The department has been supplying electrical energy for battery vehicles, and there is every indication that this class of demand will rapidly increase.

The tramway accounts show gross capital expenditure £336,258, of which £127,823 has been provided for repayment. Revenue was £80,361 (£67,434), and working expenses were £53,231 (£50,156). After provision for capital charges and income tax, the net profit was £6,970 (against a deficit of £2,439). Average total revenue per car-mile was 18·27d. (14·62d.), and working expenses, including power, were 12·10d. (9·74d.). Passengers carried were 12,458,787 (11,862,343), and car-miles run 1,055,876 (1,052,078).

The manager (Mr. J. H. Cowell) states in his report that the Committee's action in increasing the fares resulted in the traffic receipts being £14,340. 2s. 7d. higher than in the previous year. The car-mileage will probably be reduced 10 per cent., which means heavily decreased receipts. The wages account will be increased by £7,000 owing to the latest award of the Committee on Production, and further increases are asked for. After deducting £3,000 which is owing to Permanent way renewals fund, the actual profit was £3,970.

Halifax.—The gross profit on the past year's working of the electricity department was £12,033.

After providing for interest and capital charges, £3,791 for the new site at Copley, £610 for military allowances, £773 for new meters and rheostats, £996 for electric vehicle, &c., and £1,504 overspent on sanction for a 6,000 kw. turbo-alternator, there was a deficit of £1,182, compared with a surplus of £2,206 for the previous year The units sold were 19,863,121 (16,704,487).

Manchester.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £3,325,530 (increase £160,386), of which £1,761,232 is outstanding.

Revenue was £861,078 (£742,072), working expenditure was £539,941 (£447,398), and after providing for interest £77,678 (£72,079), sinking fund £128,658 (£123,573), instalment of loan £7,712 (£7,504) and renewals suspense account £28,805 (£28,630), the net surplus was £58,284 (£62,889). Kelvins generated were 236,463,749 (213,273,499) and sold 195,582,784 (172,267,789). Total maximum supply demanded was 65,600 (61,700) kw. The Electricity Committee's report states that of the surplus of £58,284, income tax required £34,619, and £16,570 has been handed over in aid of rates, while £1,590 was contributed for capital expenditure for which borrowing powers were not obtained, and £5,505 has been placed to reserve. At the Stuart-street works, Messrs. Richardsons, Westgarth & Co. have completed the contract for a 15,000 kw. turbo-alternator and condensing plant; Messrs. Babcock & Wilcox have installed two water-tube boilers of 65,000 lb. capacity each; additional cooling towers have been installed during the past year by the Davenport Engineering Co.; and several contracts for e.h.t. switchgear have been completed by the British Thomson-Houston Co. At the Bloom-street station the British Westinghouse Electric & Mfg. Co. have completed the contract for a 10,000 kw. turbo-alternator and condensing plant. The average price paid for coal has risen 1s. 9d. per ton during the year. The average weight of coal consumed has fallen 0·08 lb. per kelvin sold. The efficiency of the distributing system as a whole equalled 89·27 per cent., the quantity lost or absorbed in the mains and distributing stations being 10·73 per cent., a decrease of 2·06 per cent. on the previous year.

Tynemouth.—The accounts of the electricity department for the year ended March 31, 1917, show a net deficit on the year of £126 (compared with £513 on the previous year).

Gross capital expenditure amounts to £98,064 (increase £369), of which £46,665 has been repaid or provided for repayment. The year's revenue was £22,435 (compared with £21,652 in previous year). Working expenses, rates, taxes, management, &c., amounted to £8,069 (£8,163), cost of three-phase current, public lighting, contracts, &c., £7,973 (£7,490), and interest, sinking fund, loan instalments and capital expenditure out of revenue £6,519 (£6,512), the net result being the deficit of £126 above mentioned. Total costs were 1·009d. (1·055d.) exclusive and 1·824d. (1·897d.) inclusive of financial charges. Kelvins generated were 2,068,460 (2,090,551), and sold 1,919,039 (1,857,306). The net deficit is more than accounted for by a sum of £279 paid out of revenue for the purchase of meters, &c., and £126 has been paid as allowances to men at the front. In spite of war conditions charges have not been increased. A local firm is negotiating for a pair of electric vehicles, and as it is anticipated that others will follow, these will provide an increased demand for current at present times of light load.

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Companies' Meetings and Reports.

BRITISH THOMSON-HOUSTON CO. (LTD.)—The directors' report for the year 1917 states that the works at Coventry which have been held on lease have now been purchased by the Company under the terms of an option contained in the lease. The large canteen at the Rugby works has been completed. The profits for the year, after deducting all expenses other than interest on debentures and loans, and after making provision for year's estimated war taxation, are £329,664. The amount brought forward was £163,923, less estimated provision to end of 1916 for munitions levy and excess profits duty £150,000, leaving £13,923, and making a total available sum of £343,587. Interest on debentures and loans was £95,745, and of the balance of £247,842, the directors recommend there be appropriated for depreciations and reserves £194,098, carrying forward £53,744. In the balance sheet for 1916 the remainder of the cost of "goodwill, patents and licences," after taking into consideration the amounts previously written off, was £100,636. There was written off in that balance sheet £40,636, leaving a net amount of £60,000. It has now been decided to restore the items comprising this account to their original cost (£219,844. 3s. 8d.) and "office furniture, &c" has been reinstated at £20,000. On the other side of the balance sheet the directors have created a capital reserve account, to which has been added from this year's profits £80,000, the total capital reserve account now standing at £237,959. The total par value of debentures redeemed to date is £43,805, and leaves a net amount outstanding of £168,195. Lord Carmichael, G.C.S.I., G.C.I.E., K.C.M.G., has joined the board. The year has imposed the most exacting demands upon the employees in all departments and their loyal and efficient co-operation has been of the most gratifying nature: 201 of the employees who joined H.M. Forces have fallen, 163 have been wounded and 13 are prisoners in Germany; 121 received commissions, 39 have been awarded special honours, 16 mentioned in despatches and 11 specially commended for service in the field.

CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—The accounts for the year 1917 show a balance at credit of profit and loss of £121,784. Deducting interest on debenture stock (£13,500), preference dividend (£10,000) and appropriating £17,000 for depreciation of buildings, plant and machinery, and £232 for depreciation of office furniture, the balance is £81,052. Adding amount brought in from 1916 (less £150,000 transferred to reserve), the available balance is £180,259. It is proposed to pay a dividend on the ordinary shares at rate of 20 per cent. per annum (less tax), being 20s. per share (whereof 5s. was paid in November last), and a bonus of 5s. per share (less tax), making together a total return for the year of 25 per cent.; to carry £25,000 to reserve account, and to carry forward £111,509 (subject to excess profits duty). The Company's operations have been confined exclusively to war production, and a large amount of work of national importance has been completed for Naval construction, for use by the Army in France, and otherwise. The ever rising cost of raw materials and labour have rendered the carrying out of the Company's operations difficult and expensive. Transport restrictions have been considerable and in other ways the course of manufacture has been rendered difficult; but in spite of all the Company has produced an increased amount of cables and warlike stores, and is continuing to do so. All plant and appliances have been maintained as usual in thorough order, the expense of so doing having again increased, due not only to the high cost of labour and materials, but to the greater difficulty in keeping the machinery in running order when working under existing conditions. The operations of the Anchor Cable Co. have again been closely bound up with those of the parent Company, and the workshops at Leigh have been continuously employed, day and night. The directors have had under consideration for some time past the advisability of reorganising the capital and they propose to increase the capital by the issue to existing ordinary shareholders, as a bonus, one new fully paid-up share of the nominal value of £5 for each £5 ordinary share now held. The necessary authorisation from the Treasury has been obtained to this issue. They have transferred to the reserve £150,000 from the amount carried over from previous years, and this, with the £100,000 previously in reserve, gives an available sum of £250,000, out of which it is proposed that £175,000 shall be capitalised against the new issue of ordinary shares. They also recommend the transfer to reserve from the profits of the present year the sum of £25,000, so as to restore the reserve to £100,000. It is intended that the £5 ordinary shares shall be sub-divided into £1 shares.

CHILI TELEPHONE CO. (LTD.)—The aggregate number of subscribers at all centres at March 31 was 15,420, an increase of 1,177 for the year. The total length of lines in operation was over 24,676 miles, an increase of over 1,977 miles. The gross revenue was £213,140, an increase of £60,958, and the total expenditure (exclusive of income tax) was £129,187, an increase of £36,590. the net revenue being £83,953, an increase of £24,368. The balance to credit of revenue account, after deducting income tax and including £5,202 from previous year, is £77,689. An interim dividend of 3s. per share, tax free, was paid in January, and after carrying £7,000 to general reserve, and placing £20,000 to reserve for renewal of plant, the directors recommend a final dividend of 5s. per share, tax free, leaving £24,289 to be carried forward. In order that the nominal capital may approximate more closely to the actual capital expended the directors propose to transfer £110,000 from general reserve to capital account, and to distribute the equivalent to the shareholders in 22,000 fully-paid £5 ordinary shares in the proportion of one share to every three shares held by them. The Treasury has sanctioned this issue.

CROMPTON & CO. (LTD.)—In their report for the year ended March 31 the directors express regret for being still unable to present the accounts for the year ended March 31, 1917, and as a consequence, the accounts for the year ended March 31, 1918, must also be postponed. The output has again shown a considerable increase, and profitable business continues to be secured to the full capacity of the works. A dividend at rate of 3½ per cent., making with the interim dividend paid in January last, 7 per cent. for the year, is recommended on the preference shares, and a dividend at rate of 7 per cent. per annum for year ended March 31, 1918, on the ordinary shares.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.)—Mr. J. B. Braithwaite, who presided over the annual general meeting on Monday, said that, owing to the continuance of the war and the action of the Treasury in practically prohibiting all electrical commercial issues of the class which the company was formed to assist in financing and issuing, their ordinary business had been at a standstill during the year, and they had devoted themselves to nursing existing holdings and strengthening the company's position. During the year they had paid off and cancelled £3,692 of debenture stock (leaving only £12,988), and they had reduced their loans from bankers and others by £10,000. They had increased the carry forward by £4,225, and the net result was an improvement of £11,046 on the year. They had slightly reduced expenses, and actual profit for the year was higher by £1,256, with the result that they carried to the balance-sheet a credit of £17,224. The net improvement in the valuation of the investments was £2,596. There had been considerable depreciation in their investments owing to harassing legislation. Tramway companies had been very hardly treated in many cases and handicapped in a very unfair way with regard to their rates and the maintenance of roadways, &c. Electrical supply companies had also been harassed by legislation in various forms, but he thought a better day was dawning for them. The public generally had noticed since we had been at war what the directors and shareholders had long known—namely, that electrical supply was a matter of almost vital importance to the industries of the country. That great truth had at last dawned on the Government. They seem to realise now that electrical supply was a matter of very great importance, with the result that quite recently we have had four important reports issued by the Board of Trade Committees, and they saw the Cinderella of industries—electricity—at last coming into its own, and he thought it could not but be to the advantage of their investments in electric power supply and tramway companies. The attention dawn to the matter would result in some of those handicaps at present imposed on the lighting and tramway companies being removed. He did not want anybody to go away with the idea that they would ever get electricity cheaper than it was before the war, or that they would even get it again as cheap. There was an enormous rise in the price of coal; the Government has advanced it 9s. per ton in a comparatively short period. As to the advances in the cost of labour, many of them were likely to remain after the war; and all the raw materials—copper and other things of that kind—had all advanced considerably in price, so that they should not be led away by the optimistic figures given in the Board of Trade reports. What they could do was to afford facilities for giving an increased supply of electricity, to make it available over larger areas, and for a larger number of industries. It seemed to have been brought home to the Government at last that electricity was the cheapest of all forms of energy. It was economical of coal and labour, and it had the great advantage of enabling manufacturing to be carried on without the accompaniment of a pall of poisonous smoke which they saw overhanging manufacturing towns.

The report and accounts were adopted; Mr. Emile Garcke, the retiring director, was re-elected; and Mr. H. Leigh Williams was also elected auditor.

GENERAL ELECTRIC CO. (LTD.)—Mr. H. Hirst presided over the meeting on Monday, and said the results of the past year's working were not in the main due to any special war work outside their own industry. With very few exceptions they manufactured in all their shops the same products that went through in pre-war times, with the addition of those that necessity, invention or experience had created during the war. In addition to the dividend of 6 per cent. on the preference shares and of 10 per cent. on the ordinary shares, the directors suggested a bonus to the ordinary shareholders of one ordinary share of £10 for each two ordinary shares held. That operation would be carried out by transferring £287,500 from the undivided profits to capital account. £1,600,000 of new capital would be created, and the present shareholders were entitled to some of the pre-war profits accumulated at their expense. Owing to the action of the Treasury in refusing to sanction the division of the ordinary shares into denominations of £1, they were making arrangements to enable them to buy and sell fractional shares. Their relations with their employees throughout their history had been excellent, and they had come to the conclusion that this was the time to show their gratitude to those who had loyally worked in their service. They proposed that £37,500, provided from reserve, should be vested in trustees and invested in new ordinary shares. The fund was for the superannuation, pensioning off and benefit of employees or their dependents. He had spent 37 years in the electrical industry, and 32 years ago they laid the foundation of what was now the G.E.C. He had always cherished the hope that he might some day be the instrument of building up an electrical concern of such magnitude that it would be respected not only in this country, but in all the countries of the world. He hoped they might succeed. He saw no reason why there should not be two, three or four great electrical concerns in this country, grouping themselves into big units out of the mass of electrical material

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at their disposal in order to play a better and more important part in the world's work. They had an unrivalled selling organisation throughout the United Kingdom; they had established affiliated companies in all the principal parts of the British Empire, and in many neutral and allied countries as well. They had established modern works covering nearly every branch of electrical engineering. One of their engineering works produced every kind of dynamo and motor for power or lighting, from a 20,000 H.P. turbo-generator down to the smallest electric fan. Their carbon works were unique; their telephone works were the first of their kind in the country that produced a complete telephone exchange equipment by British labour and materials; their lamp works were the first metal filament lamp works, and their switchgear, tube, fixtures and brass works were among the most important of their kind in the country. The cable works in which they were interested were now in full swing and exclusively employed on Government work. Their magneto works had just commenced a useful and much-wanted output.

After referring to the developments in their carbon and lamp works, Mr. Hirst said that if the electrical industry was to rise to the level expected of it and make itself independent of foreign importation it must develop all its requirements from raw materials and resources which the Empire placed at its disposal. In that direction great opportunities would be afforded for science, research and invention. The electrical industry would not be content to be a mere adjunct to other industries; it would have to be a "key" industry by itself. Industrial penetration had been carried out by Germany, who had used the electrical industry as a "key." If electrical concerns were to open the door for British enterprise abroad they must be enabled to carry out complete contracts. It was little realised that average electrical contracts brought as a rule only 10 per cent. or 15 per cent. of work into purely electrical shops. The work connected with it automatically brought 85 per cent. or 90 per cent. of work into engineering and other industries. He wished some attention to that necessity had been visible in the recent report on the organisation of the super-stations contemplated. Firmly convinced that these changes would take place, they had had to change their policy somewhat. What was denied to them both by time and restrictions, to build for themselves they must acquire by purchase. In accordance with that policy they had acquired the ordinary shares in Messrs. Chamberlain & Hookham, and they had also acquired the works of Messrs. Fraser & Chalmers.

The report and accounts were adopted, and at subsequent extraordinary general meetings resolutions were passed authorising the directors to carry out the proposals outlined in the chairman's speech.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—Mr. G. C. Isaacs, who presided over the meeting last week, gave an analysis of the report and accounts (abstracted in our issue of the 28th ult.). The receipts from ships' telegrams, subsidies, &c., had increased from £270,000 to £470,000, and the profit was £192,000, compared with £96,000. The company was paying a further dividend of 10 per cent. (making 15 per cent. for year), placing £50,000 to reserve for obsolescence of plant, and carrying forward £105,417. 19s., subject to excess profits duty for 1916 and 1917. In order to meet the obligations undertaken with the Board of Trade to provide for installations on board a large number of additional vessels, it became necessary to increase the capital to £600,000. By the end of the year the total number of public telegraph stations owned and worked by the company on the high seas had increased to 2,265, compared with 1,472 in December, 1916; and at the end of June, after deducting ships lost during the year, the total was 2,446. At the end of 1917 their rentals had increased to £570,000 from £352,000 per annum, and at June 30 they amounted to £703,374. After conferring with representatives of the Association of Wireless Telegraphists, an agreement had been made on all matters touching the conditions of employment by the company. A new scale of pay was also considered, and he was glad to say that the Shipping Federation had recognised the recommendations as reasonable, and, subject to agreement with the Ministry of Shipping, the new terms would be put into operation. They were pleased to recommend the improved terms of employment of operators, for their conduct as a body had been magnificent during these very perilous times. No praise of them could be too high. Rewards for bravery in the field had been given, no doubt most deservedly, to a large number of men, and he trusted that due recognition would be given by the authorities to the brave acts of wireless operators as well as to those who had served their country on other fields of battle. The original shareholders must be gratified to see, not only the great and successful development of the business, but also the immense service which the company had been able to render in these anxious years to the Empire, the Allies and the peoples of every neutral nation. It was impossible to estimate how many thousands of lives had been saved or safeguarded and it was difficult to say, even approximately, how many millions in pounds sterling of invaluable material and food supplies had been saved.

WAYGOOD OTIS (LTD.)—At the recent meeting the chairman (Mr. H. C. Walker) stated that they continued to be solely occupied on work for Government Departments. Much of it was of a special character, requiring the use of their machine shops to the exclusion of other departments. The work in hand, coupled with the necessity for increased dilution of labour, compelled them to purchase additional new and modern machine tools. The profits earned during the year exceeded those of the previous year by rather more than £10,000. They were distributing a full year's arrears of preference dividend (instead of the usual 6 months), leaving £8,403, which would be retained in the business for the present.

New Companies.

HIGHTENSITE (LTD.) (150,736.)—Private company. Reg. June 15, capital £50,000 in £1 shares, to acquire business of manufacturing "Hightensite" (a substitute for the German material "Stabilit") which is now carried on as a branch business by the Park Royal Engineering Works at Streatham. First directors are Sir Lindsey B. Peters, K.B.E., A. Spurrier, A. G. Morrish, V. E. Joyce and H. G. Morrish. Reg. office, 34-6, Gresham-street, E.C.

METALLIC ELECTRODES (LTD.) (150,675.)—Private company. Reg. June 7, capital £10,000 in 9,500 ordinary shares of £1 each and 20,000 deferred shares of 6d. each, to carry on the business of reconstructing by agglomerating, restoring and otherwise utilising metal trimmings, turnings and scale of metal and scrap, and any other waste of metal, china, glass, &c. Permanent directors: T. Rouse and W. S. Leefe (23, Coleman-street, E.C.).

WM. McBRIDE & SONS (LTD.) (4,569.)—Private company. Reg. in Dublin on May 30, capital £7,500 in £1 shares (1,500 preference), to take over the business of sanitary and electrical engineers, &c., carried on as style of Wm. McBride & Sons. First directors are W. McBride, G. McBride and J. McBride. Reg. office: 5, Merchant's Quay, Cork.

City Notes.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—An interim quarterly dividend of 15s. per cent. has been declared on the ordinary stock.

DIRECT UNITED STATES CABLE CO. (LTD.)—An interim dividend of 2s. per share (less tax), being at rate of 4 per cent. per annum, has been declared for the quarter ended June 30.

DUBLIN UNITED TRAMWAYS (1898) (LTD.)—An interim dividend of 4 per cent. per annum has been declared.

SIEMENS BROS. & CO. (LTD.)—At an extraordinary general meeting on Tuesday resolutions were passed to subdivide each of the existing shares of £5 each into five fully-paid up shares of £1 each, and increasing the share capital to £1,500,000 by the creation of 900,000 shares of £1 each.

The Round Table.

By "kVA."

To those of us who are working all hours the war sends at the office munition and other volunteering, special constabuleering and allotmenteering, a week in bed with the "flu" is a relief, I won't say a pleasant one, but a relief—and a change!

* * * *

The "Daily Express" recently had an interesting column on crazy war inventions, from which I take the following:—

"Electricity and magnetism would soon end the war if some inventors' hopes came true. It has been proposed to electrocute the enemy, to interfere with magnetos or compasses of aircraft, and to explode ammunition dumps. Magnetism is to be used to attract and bring down enemy aircraft, or to repel them, and to divert falling bombs. The truth is that even the large magnets in power stations do not attract spanners laid on tables in the room, a fact that defeats the scheme to trail from balloons monster magnets that would snatch rifles from men's hands."

There is still the inventor who would give the enemy airman an iron tonic to upset his compass.

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, July 9, 1881.]

ELECTRIC LIGHT AND YACHT CLUBS.—These clubs are taking up the idea of lighting their rooms by electricity. We believe that the committee of the Royal Thames Yacht Club has made arrangements for giving the light an immediate trial

REASSURING.—Among the items of intelligence forwarded to this country in the American language during the present week we noticed the following: "Jay Gould, who is regarded by men who do not know him intimately, as a mere speculator, is a pleasant, sympathetic man. He wept like a child when told that the President was likely to die."

THE FAURE BATTERY.—Premises have been taken in London for the manufacture and sale of this battery, and we believe that it is intended shortly to have a number of batteries on view at rooms in the Strand, opposite Charing Cross Hotel. Anyone who chooses can then form his own opinion as to the merits of the battery, as it will be shown at work.

ELECTRIC LIGHT IN THE HOUSE OF COMMONS.—We understand that the lamps used in the late experiments in the House of Commons are to be removed, in spite of the intimation of Mr. Shaw-Lefevre that further experiments were to be undertaken during the recess. It would appear that the opinion of the hon. members of the House was not favourable enough towards the new light to encourage further experiments

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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CONTENTS.

NOTES 241
Arrangements for the Week 243
A Study of Electric Range Efficiency. By R. G. Kloeffler. Illus. 244
Theory of the Static Frequency-Doubler. By M. Osnos. Illus. .. 246
Calculation of Performance of Induction Motors Working in Conjunction with Flywheels and Slip Regulators. By Herbert Vickers, M.Eng. Illustrated 248
Higher Harmonics in Polyphase Electric Systems. By V. Karapetoff 250
THE SAVING OF INDUSTRIAL FUEL IN DETAIL 252
REVIEWS 252
A New Method of Measuring Alternating Currents and Electric Oscillations. By I. Williams, M.Sc. Illustrated 253
CORRESPONDENCE 255
The Shanghai Electricity Works 255
PARLIAMENTARY INTELLIGENCE 256
LEGAL INTELLIGENCE 256
Patent Record 256
Volunteer Notices 257
Commercial Topics 257
Electricity Supply 258
Educational 259
Tenders Invited and Accepted 259
Companies' Meetings and Reports 260

Notes.

Electric Range Efficiency.

FROM time to time experimental contributions are made to our knowledge of the efficiency of hot-plates and electric ranges. The latest is due to Mr. R. G. KLOEFFLER, and is the result of a series of investigations carried out at the Kansas State Agricultural College in the United States. An abstract of this Paper will be found in another column. A point of interest is that results are given for both enclosed and open types of hot-plate. It has generally been assumed that the efficiency would be higher in the case of the open type. This, however, is not necessarily the case, since the results depend very much upon the character of the utensil that is used. If a black vessel is employed, then the conditions are suitable for the absorption of radiant heat, which is the kind of heat emitted by the open hot-plate. On the other hand, the closed type of hot-plate transmits the heat by conduction, and is therefore more satisfactorily in the case of a utensil which is clean and makes good contact, such as new aluminium. If such vessels are used with the open type of element, then the heat is reflected downwards, and is not so readily transmitted. The net result is that the enclosed hot-plate generally shows a greater efficiency. It is difficult, however, to draw any very general conclusions, as the results vary not merely with the type of utensil, but also with the quantity of water and other contents in the vessel, and whether it is open or closed. Further, the results are affected by the input to the hot-plate. It is obvious that if the input is small the rise in temperature will also be slow and a point may be reached where most of the energy is employed in merely keeping the utensil and its contents at a certain temperature. For a high efficiency it is desirable that the operations should be carried out quickly. In the second part of the investigation several electric ovens are compared. The rise in temperature naturally varies with the type of thermal insulation, but it also varies with the extent of the insulation. If this is very heavy then the rate of rise of temperature may be reduced owing to the thermal capacity. On the other hand, the rate of cooling will be smaller. Thus it follows that the efficiency varies somewhat, according to the operation which is to be carried out. If it is desired to use the oven for quite a short period it is preferable that the thermal capacity should be small; on the other hand, if the oven is to be used for long periods it is desirable that the thermal insulation should be good, and the thermal capacity becomes of secondary importance.

Business Training for Engineers.

WHILE so much is being said and written on the place of science in education, and the organisation of engineering training, one hears little in engineering circles of steps for the development of the commercial side of engineering education. We are discovering now various gaps in our whole educational system which will doubtless be gradually made good; but it seems strange that so little attention is being given to one very evident hiatus—the lack of any systematic training for those entering the commercial side of engineering. Engineers with Continental experience have pointed out this deficiency in the past. There have been in this country few men capable of handling the business side of a large engineering proposition—men who have both a commercial training and a technical knowledge of engineering—such men, for example, as are very largely trained and employed by the great German industrial banks in their manifold activities. There is still a considerable degree of prejudice against what is termed "business training." It is only gradually that the value of college training in engineering has become appreciated. So far as commerce is concerned, the encouragement bestowed on college courses of a business type has been even less. Yet, within recent years, commercial courses have been started at many of our leading universities. Cambridge has an Economic Tripos; in London there is the London School of Economics, which, however, is rather special in character; at Leeds, Manchester, Birmingham and Liverpool Faculties of Commerce already exist. The latter universities are also fortunately placed in having well-established and progressive engineering faculties, and we should like to see systematic co-operation between the two. After the war the business man who is also an engineer will have many unique opportunities in reconstruction work, and, if we are to hold our own in this critical period, we shall be well advised to be already organising our facilities for technical business training.

The Metric System in Export Trade.

IN view of the interest being taken in the proposition to adopt the metric system of weights and measures, a report by Mr. F. A. HALSEY to the American Institute of Weights and Measures deserves notice. At the outset, perhaps we ought to say that, as far as we are aware, the Institute is not an official body. The report summarises the result of a comprehensive inquiry addressed to 6,000 manufacturers in the United States on the subject of the Metric System in Export Trade. About 1,450 replies were received. The questions were framed with a view to ascertaining the extent to which

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metric measures were used by firms exporting to countries where this system is in use. From the replies received it appears that about 42 per cent. of manufacturers exporting from the United States make use of the system to some extent, but only 8 per cent. can be said to make extensive or exclusive use of it. A list of 600 industries is also given, all of which export goods to metric countries, but make no use of the metric system. It is contended, therefore, that "the commerce of the world is conducted by the English system"—a somewhat sweeping conclusion on a 42 per cent. basis, though the figures quoted show that apparently a good foreign trade could still be carried on without resort to metric measures. On the other hand, it will be observed that the inquiry merely shows, what is common knowledge, that manufacturers in English-speaking countries have up to now been chary to adopt metric measures, and have rubbed along surprisingly well in spite of it. The arguments in favour of the metric system, based on its simplicity and convenience, &c., remain, and we believe that during recent years before the war the disinclination of the English-speaking countries to use metric measures was proving more and more of a drawback in foreign trade. That export trade has flourished in spite of it must be attributed largely to the long industrial start formerly gained by such countries. But with the resumption of normal international relations after the war there may be less advantage in this respect, and ultimately a general "levelling up" of industrial capacity, which will make a knowledge of the measures of other countries an industrial weapon that we cannot afford to neglect.

Electricity at Shanghai.

IN this country we are apt to look upon the electricity undertaking in Shanghai as something comparatively small though interesting. A reference to the current annual report, however, reveals the fact that this undertaking is now becoming of very considerable size, as is evidenced by the fact that the engineer, Mr. T. H. U. ALDRIDGE, has placed an order in the United States for a 20,000-kw.turbo-generator. Consequently the units which are now to be employed at Shanghai are as large as any of those which are to be put in immediate commission in this country. The load factor has reached the satisfactory figure of 44·4 per cent., and during the past year 104·57 miles of cable were erected as extensions. Among the many power consumers we notice that cotton manufacturers use 12,017 H.P. and flour milling accounts for 2,719 H.P. It is evident that the undertaking is growing very rapidly and we are glad to see that the sound financial policy has been adopted of carrying forward the large sum that appears as net profit.

Factories and Workshops.—The annual report of the Chief Inspector of Factories and Werkshops for the year 1917 has just been issued. We hope to give an abstract of this in our next issue.

Association of Mining Electrical Engineers.—A new branch of this Association has been formed for the Lothians.

The president is Mr. Peter Milligan, general manager of the Arniston Coal Co.; the vice-presidents are Messrs. J. R. Laird (Bathgate) and Bunting (Edinburgh), and the secretaries are Messrs. D. Landale Frew (45, Hope-street, Glasgow) and Arthur Robinson (48, North Bridge, Edinburgh).

Tramways and Light Railways Association.—The 10th annual congress and the 21st ordinary general meeting of this Association were held in London on Friday last.

In the absence of the president (Viscount Chilston) Mr. R. J. Howley opened the proceedings. The president's address, which was read by Mr. de Turckheim, dealt with labour and wages problems, the Statutory Undertakings (temporary increase of charges) Bill, &c. After the discussion on the presidential address, Mr. W. V. Edwards raised a debate on National Industrial Councils. There was also some criticism of the Bill dealing with the temporary increase of fares and of the Coal Restriction Order.

Ships Without Rivets.—On Tuesday the first steel vessel built without rivets was launched in the presence of Lord Pirrie Controller-General of Merchant Shipbuilding.

The vessel was built in a shipyard operated by the Inland Waterways and Docks section of the Royal Engineers. Instead of being riveted and caulked, the plates are electrically welded. They are held together temporarily by bolts. This is the first time that a vessel has been produced entirely by the new method. Its general adoption would increase the rate of production, more particularly in the assembly of bulkheads, deck structures, fittings and other interior work. It is computed from the results obtained on this experimental vessel and other Admiralty work that a saving of 20 per cent., or possibly 25 per cent., could be effected in both time and material.

Fuel-Saving in Private Houses.—A Technical Paper (No. 199), issued by the Bureau of Mines, Washington, contains some suggestions by Mr. H. Kreisinger on "Five Ways of Saving Fuel in Heating Houses." The five methods, which are discussed in detail, are:—(1) Of the coals available in your market select the one that requires the least attention in burning; (2) Use an economical method of burning your coal; (3) Keep your house temperature 62°F. to 65°F. instead of 72°F. to 75°F.; (4) Heat as few rooms as the comfort of your family will permit; (5) Shorten the heating season as much as possible. The leaflet also contains a list of other publications issued by the Bureau dealing with the utilisation of coal and lignite.

An Interesting Rack-and-Pinion Railway.—In the "Schweizerische Bauzeitung" an account was given a short time ago of a new type of rack-and-pinion railway, which presents some interesting features. In the various systems of this type adopted in the past the usual principle has been to obtain a grip by a number of vertical cog-wheels, whereas in this case the cog-wheels are mounted horizontally, gripping the two sides of the track. The vertical arrangement had the drawback that as the incline increased the factor of safety became less and, as a matter of fact, the method was rarely used on inclines exceeding 25 per cent. The present system, due to Mr. H. H. Peter, is said to permit inclines up to 35 per cent., and curves as small as 60 m. radius. A further advantage is that the grip is much less affected by snow and ice; moreover, the grip does not depend directly on the weight of the train, and it is therefore possible to use lighter rolling stock.

Institute of Metals.—Membership Booklet "C," issued by the Institute of Metals, is an enterprising publication which will no doubt be useful in furthering the increase in membership which the Institute desires. Progress in this respect has already been rapid, the numbers having grown from 250 in 1908 to over 1,000. The pamphlet contains an account of recent meetings, of the work of the "Journal," and the research on corrosion and other matters which the Institute has initiated. A series of messages from a number of well-known authorities on metallurgy, pyrometry, &c., speak in warm terms of the aims of the Institute. Photographs of Prof. H. C. H. Carpenter (now president) and of Engineer vice-Admiral Sir Henry Oram, Sir George Beilby and Sir Gerard A. Muntz, and other past-presidents are included. The pamphlet also contains a list of officers, the titles of publications from 1909 onwards, and a form of application for membership.

Institution of Electrical Engineers.—The Electrical Research Committee, which was appointed last autumn, under the auspices of the Department of Scientific and Industrial Research, is at present engaged in superintending a research on insulating materials (fibrous materials, porcelain, ebonite, mica, composite materials), and the waterproofing treatment of insulating windings of electrical machines, in respect of which grants have been made to the Committee by the Research Department, the B.E.A.M.A. and the Institution. The Committee consists of three members nominated by the Institution of Electrical Engineers and three members nominated by the British Electrical and Allied Manufacturers' Association, the nominees of the former being Mr. C. H. Wordingham, C.B.E. (chairman of the Committee) Mr. C. C. Paterson, O.B.E. and Mr. C. P. Sparks, and those of the latter,

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Mr. F. R. Davenport, Mr. D. N. Dunlop and Mr. A. R. Everest. The temporary address of the Committee is No. 1, Albemarle-street, London, W. 1, and its secretary is Mr. P. F. Rowell.

The Testing of Scientific Glassware.—Two leaflets issued by the Metrology Department of the National Physical Laboratory, deal with the testing of scientific glassware. Arrangements have been made, after consultation with the Ministry of Munitions and the Department of Scientific and Industrial Research, and in conjunction with the British Chemical Ware Manufacturers' Association and the British Laboratory Ware Association, for the testing of such glassware at the laboratory. The tests will include :—

(*a*) Volumetric tests on graduated vessels of all kinds.

(*b*) Tests on resistance to chemical action and as to the general suitability of vessels for use in chemical processes.

(*c*) Tests on filter paper, porcelain ware, &c., as used in physical and chemical laboratories.

These tests are further sub-divided, and a schedule of fees is presented. A supplementary leaflet gives detailed instruction as to the conditions to be complied with in sending scientific glassware to the laboratory for tests.

The Vibration of a Stretched Wire Forming Part of a Closed Electric Circuit.—Some interesting experiments on the above subject were described by Admiral Sir Henry Jackson at a recent meeting of the Royal Society. A large thermo-microphone consisting of a long loop of wire warmed by an electric current, subjected to vibration produced by sound waves, continued to respond to the effect of the vibration in suitable receiving apparatus, after the electric battery had been cut out of its circuit, and when the wire was at the same temperature as the air. This result of the wire's vibration could not therfore be solely attributed to the wire being maintained at a different temperature to that of the surrounding air by an electric current in it. Varying the angle of the wire with line of the earth's magnetic force produced entirely negative results. Wires of various materials and of lengths up to 220 ft. (the longest tested), stretched and subjected to forced vibrations, almost invariably generate a current of electricity in the circuit of sufficient intensity to be audible in a suitable telephonic receiver, with or without an added E.M.F. in the circuit. The addition of a valve amplifier greatly increases the intensity of the sound. Resonance plays an important part. No conclusion can yet be drawn as to the quantitative effect of altering tension or length of wires, or their displacement, on current generated ; the energy expended in producing vibration does not appear to be proportional to the effect produced unless resonance is present.

Effect of Clean Surfaces on Resulting Illumination.—The important influence that cleanliness of lamps, reflectors and surrounding surfaces may have upon the illumination in an average room was strikingly brought out in some figures quoted by Mr. Ward Harrison in a recent article in the "Electrical Review and Western Electrician." The data show, what is now generally recognised, that a diminution of 30 per cent. in light may easily follow if the lamps and reflectors have not been wiped clear of dust for some weeks. But, what is less appreciated, the discoloration of a ceiling with age, in a room where any considerable proportion of the illumination is obtained by indirect means, is also responsible for a considerable loss of illumination. In the room referred to, the ceiling was a yellowish cream paint, which had become somewhat blackened through two years' service. In renovating the installation the first step was to clean the reflectors, after which the illumination was again measured. Next, new lamps were installed and the measurement again made. Finally, the ceiling was repainted, and a concluding measurement taken. The results are summarised as follows :—

	Illumination (foot-candles).	Per cent.
Before cleaning reflectors	3·75	100
After cleaning reflectors	4·68	125
Cleaned reflectors and new lamps	5·26	140
Cleaned reflectors, new lamps and repainted ceiling	6·75	181

The total improvement was thus an increased illumination of 81 per cent. It is noteworthy that the substitution of new lamps in place of those that had been in use for two years, only altered the illumination by about 11 per cent.

Women's Nightwork at Generating Stations.—The Home Secretary has recently had under review the question of the employment of women at night in electrical generating stations and sub-stations.

As the employment of women at night is illegal unless it is specially authorised in pursuance of the emergency provision in Sec. 150 of the Factory and Workshop Act, 1901, and No. 6A of the Defence of the Realm Regulations, the Home Secretary reminds owners of electrical stations that special application must be made to the Home Office (through the District Inspector of Factories) before any women are employed on a day and night shift system. The authorities of some stations appear to be unaware of this and have employed women at night without authority. A certain number of Orders have been made during the war to permit the employment of women at night, or for other special hours, in electrical generating stations and sub-stations, but in view of the special suitability of the work for discharged soldiers and sailors and of the fact that the employment of women at night must in any case cease with the end of the war, the Secretary of State considers it desirable that vacancies should be filled by the employment of discharged men in preference to women. Disabled men are being trained for electrical sub-station work at several schools and centres, but if no trained men should be available the local Employment Exchange may be able to supply disabled men to be trained at the works.

The Secretary of State has accordingly decided not to grant any fresh Orders to allow the employment of women, unless he is satisfied that a bona fide attempt has been made to employ disabled men. This decision does not apply to stations or sub-stations at which the employment of women for special hours has already been authorised—in such cases the Secretary of State is prepared, if necessary, to continue the permission during the war.

In connection with the employment of fresh labour new to the work of electrical stations and sub-stations, the Secretary of State calls attention to the requirements of No. 28 of the Home Office Regulations under the Factory Act. While such persons, if carefully selected, can be adequately trained within a comparatively short time to do the routine work of an electrical station, they must not, without a longer and more thorough training, be allowed to undertake the class of work indicated in the second part of the first paragraph of the regulation—which includes cleaning of, or near, live apparatus (*e.g.* switchboards)—where technical knowledge or experience is required in order to avoid danger. They may, however, if necessary, be allowed to undertake the cleaning of the fronts (only) of medium pressure switchboards of a simple character, provided (1) that adequate instruction has first been given ; (2) that any necessary safety appliances, *e.g.* insulating gloves and goloshes, are used ; and (3) that such cleaning is not done when the person is unaccompanied.

Obituary.

LORD PARKER.—We regret to record the death of Lord Parker of Waddington, which took place on the 12th inst.

The deceased, who was born in 1857, was appointed a Chancery Judge in 1906 and in this capacity he tried many important patent cases, including the celebrated Marconi "7777 patent," the validity of which he upheld in 1911. His judgments were noted for their lucidity and were seldom upset on appeal. In 1913 he served as Chairman of the Committee appointed by the Postmaster General to consider and report upon the relative merits of the existing systems of long-distance wireless telegraphy and in particular as to their capacity for continuous communication over the distances required by the Imperial Wireless Chain. He also served as a member of the Postmaster-General's Committee on Wireless Telegraph Research which was appointed in the same year and presented its report in June, 1914.

A. F. MILLER.—The death of Mr. Andrew Forrest Miller, sometime assistant electrical engineer to Glasgow Corporation, occurred at a sanatorium on the 15th inst.

Personal.

Sir Joseph Larmor, M.P., has been awarded the Poncelet Prize for the mathematical sciences this year by the French Academy of Sciences.

Mr. A. G. Cooper, borough electrical engineer of Colne (Lancs) having received a Government appointment, has resigned.

MILITARY HONOURS.—The following honours and promotions are gazetted :—

Sec.-Lieut. Evan M. M. Balfour (Scots' Guards), who has been awarded the Military Cross, was formerly an apprentice to Messrs. Bruce, Peebles & Co., and at the outbreak of the war was on the staff of the Victoria Falls and Transvaal Power Co.

Major Hubert Carey Thomas, who is an electrical engineer, and who has been appointed director of signalling at the Horse Guards, after serving more than three years in France, has been gazetted Lieut.-Colonel at the early age of 28 years.

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A Study of Electric Range Efficiency.*

By R. G. KLOEFFLER.

Summary.—In two successive articles the author describes a series of investigations undertaken at the Kansas State Agricultural College on electrical heating appliances. The first instalment deals with surface-heating units, the second chiefly with the conditions of radiation from ovens.

I.—SURFACE-HEATING UNITS.

The efficiency of surface-heating units was obtained as follows: One quart (0·94 l.) of distilled water at a temperature of 60°F. (15·6°C.) was placed in a covered dish upon a unit. Current at a constant potential of 110 volts was turned on the unit (beginning cold) until the water rose nearly to the boiling point (206°F., or

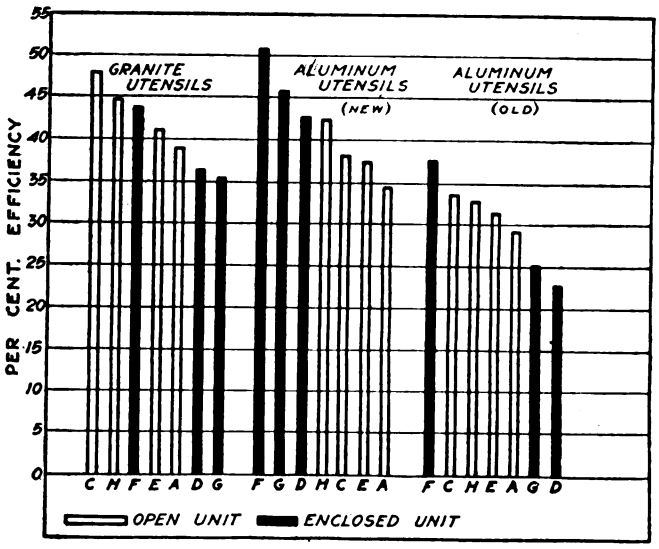
GRANITE UTENSILS
ALUMINUM UTENSILS (NEW)
ALUMINUM UTENSILS (OLD)
PER CENT. EFFICIENCY
C M F E A D G F G D M C E A F C M E A G D
OPEN UNIT
ENCLOSED UNIT

FIG. 1.—CHART PLOTTING PART OF TABULATED DATA (TABLES I. AND II.)

96·7°C.), as registered by a mercury thermometer At the same time, the energy consumption was recorded by a standardised watt-hour meter. The energy in B.T.U. utilised is the product of the pounds of water and the change in temperature, while the energy input (B.T.U.) is the product of kilowatt-hours and the constant 3,415. Efficiency=[pounds water × change in temperature (Fahr.)] ÷[3,415 × kilowatt-hours]

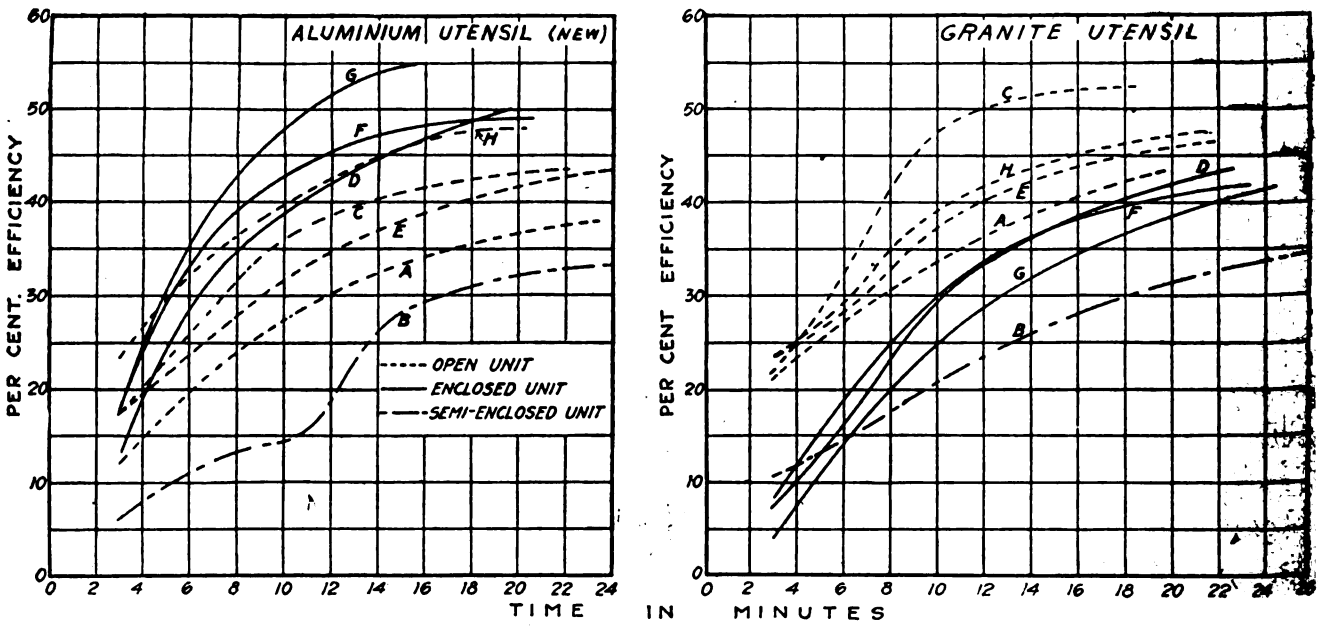

FIG. 2.—CHART PLOTTING EFFICIENCIES AT STATED INTERVALS OF TIME.

If the water should reach the boiling point and boil for some time, the efficiency could be again obtained with fair accuracy by re-weighing the water and adding to the previously computed absorption that required to change the water into steam; thus: Efficiency =[pounds water × change in temperature + pounds evaporated × latent heat of evaporation] ÷ [3,415 × kilowatt-hours]. The efficiencies of surface units on eight different electric ranges were computed, of which seven are dealt with in the article, three units being of the enclosed or disc type and four of the open or radiant type.

It might be expected that the efficiency would vary with the size, colour and material of construction of the utensil used in the tests. In order to get an average value for such variation the following utensils were chosen: A small bluish-grey granite kettle, having a diameter of 6 in. (15·2 cm.) on the bottom; a small aluminium kettle 6 in. (15·2 cm.) in diameter, called "new" in this article, since it had a bright, new lustre and a perfectly flat bottom; a small aluminium kettle same as above, except that it was discoloured with use and dented at the bottom (called old); an aluminium fireless cooker pan 8 in. (20·3 cm.) in diameter, and having a perfectly flat bottom (called new); an agate granite pan and a white granite pan, each having a diameter of 8 in. (20·3 cm.) on the bottom. All of the above utensils were fitted with suitable covers before the experiments began.

The efficiencies on the seven units illustrated are presented in the original article in tabular form. It is observed that the open type has 4·9 per cent. more absolute efficiency when used with granite than with aluminium utensils. This figure relative to the efficiency with aluminium makes the granite utensils 12·7 per cent. more efficient

For the enclosed type of unit, however, the reverse is true. The new aluminium utensil gives an 8 per cent. higher absolute efficiency than the granite. This value in terms of relative efficiency makes the aluminium utensil 20·7 per cent. more efficient The results are plotted in Fig. 1. It appears that the open-type units give up their heat principally by radiation, though some convection and conduction will take place. The granite dishes readily absorb radiated heat, while the aluminium, if bright, has a tendency to reflect the radiated heat downward again; but the enclosed unit gives out most of its heat by conduction. Since the coating of enamel is a poor conductor of heat, the granite dish does not receive the heat readily, and the aluminium dish acts more efficiently in this respect.

The efficiencies on an old and a new 6 in. (15·2 cm.) aluminium utensil are also compared. For the open type of unit the new aluminium utensil has an average absolute efficiency of 2·45 per cent more than for the old, and therefore the former is relatively 7·75 per cent. more efficient (*see* Fig. 1). The second open type of unit has a slightly higher efficiency with the old aluminium utensil than with the new one, because it absorbs heat more readily from the darker coloured utensil bottom. The enclosed units show the maximum of all the efficiencies obtained when used with the new

* Abstract of an article in the "Electrical World."

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aluminium utensils, but there is a big reduction in comparative efficiencies as the bottom of the utensil becomes discoloured and dented offsets this advantage.

Particulars are next given of the efficiencies with and without a cover on the utensil. For the open type of unit the cover adds an average of 23·7 per cent. to the relative efficiency; for the enclosed type the relative efficiency is increased by an average of 10·9 per cent. For all seven units the average increase is 16·4 per cent.

From a comparison of an agate, a dark blue and a white granite dish, all containing 2 quarts of water, it appears that the colour of the enamel affects to some extent the amount of heat absorbed.

An increase in the volume of water boiled tends to improve the efficiency. The average improvement is the same for the open and for the enclosed type of units. The author also compares the efficiency and time required for a given rise of temperature of 2 quarts of three minutes. Beyond the three-minute point the efficiency of the enclosed units rises very rapidly, approaching a maximum in about 15 minutes. The curves on the granite utensil show that at the end of three minutes all the open type of units have about 22½ per cent. efficiency, while the average of the enclosed type at the same period is only about 7½ per cent. It takes about eight minutes for the enclosed type to reach the efficiency obtained by the open type at the end of three minutes. The open-type units rise to an average of nearly 40 per cent. in the first 10 minutes. The particularly rapid rise of unit C to almost a maximum in 10 minutes should be noted, since there are some hasty operations in the kitchen where the surface unit may be in use for only five to eight minutes. This is more especially true where hot water is available at the tap. For such operations, obviously the surface unit with the higher efficiencies obtained in a short time has a decided economical advantage.

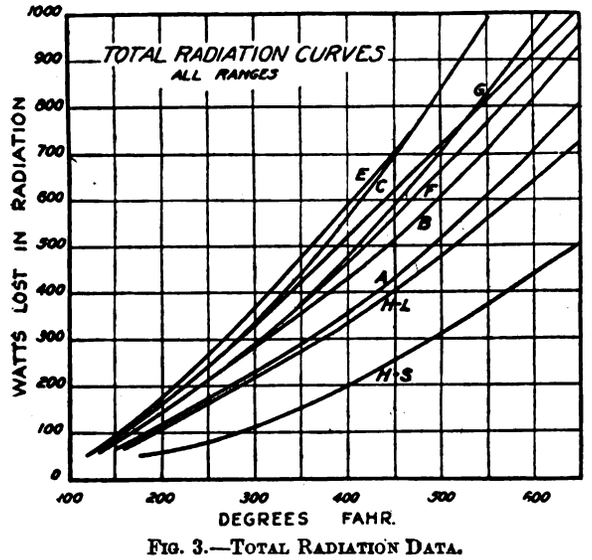

FIG. 3.—TOTAL RADIATION DATA.

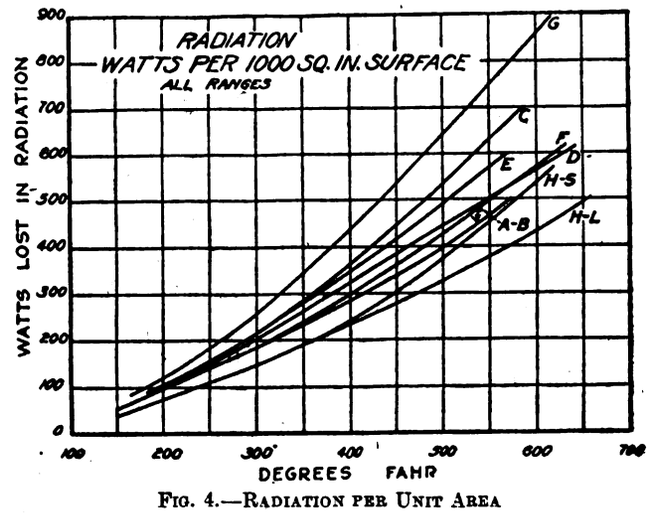

FIG. 4.—RADIATION PER UNIT AREA

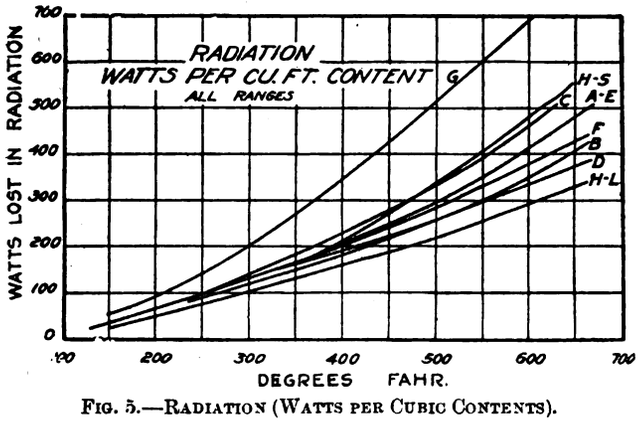

FIG. 5.—RADIATION (WATTS PER CUBIC CONTENTS).

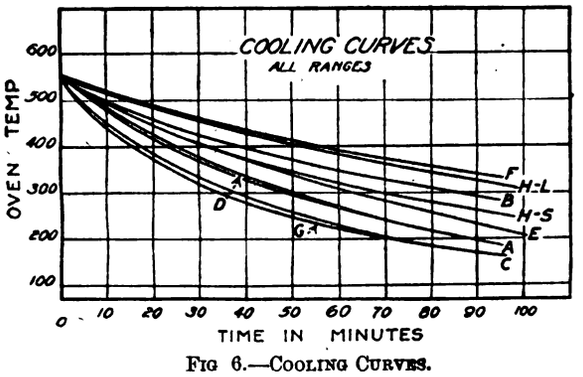

FIG 6.—COOLING CURVES.

FIGS. 3-6.—RADIATION AND COOLING CURVES FOR ELECTRIC OVENS

(1·9 l.) of water on 1,100 watt and 1,500 watt units. The average of the results shows that about three minutes in time is gained at a sacrifice of almost 12 per cent. in efficiency by using the larger unit. Hence an effort to hasten results by using a surface unit of the higher wattage will increase the cost of operation. Attention is drawn to the difference on units of the reflector type in efficiency obtained from a bright new reflector and the discoloured, dirty reflector which results from use. The average for four utensils on two different units shows a decrease of 6·3 per cent. in relative efficiency after being in service for a time.

Thus far consideration has been given only to the efficiency obtained on raising the temperature of water from 60°F. to 206°F., which requires from 15 to 25 minutes. It is also of interest to know how the efficiency has varied from the beginning, and to get this variation in efficiency readings of temperature and kilowatt-hours were taken at 3, 6, 10 and 15 minutes from start on two of the utensils tested. From these values the efficiencies, computed according to the method previously described, are plotted in Fig. 2.

With the new aluminium utensil, both the open and the enclosed units have an average efficiency of about 17½ per cent. at the end

II.—ELECTRIC OVENS

Since the heat insulation of the oven is important, it is desirable to learn the conditions of radiation. Accordingly a fixed input was given the oven until its internal temperature became constant. This test was made for inputs of 50, 150, 250, 500, 750 and 1,000 watts. The temperature was measured by a carefully calibrated resistance thermometer near the centre of the oven.

When the oven temperature became constant at 1,000 watts input the circuit was opened, and the temperature was then read at time intervals, giving points for the cooling curve. The time and number of kilowatt-hours required to bring each oven successively to temperatures of 250, 300, 400, and 500°F. (121·1, 148·9, 204·4, 232·2 and 260°C.) was also measured, these being characteristic baking temperatures.

These tests were made on ovens of a large variety of sizes, which would affect their total radiation losses materially. Therefore the radiation of each oven has been reduced to watts per 1,000 sq. in. (6,450 sq. cm.) inside surface and watts per cubic foot contents. In Fig. 3 the total radiation curves for all the ovens are plotted. These show, for instance, that at 450°F. (232·2°C.)—a high baking tem-

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perature—the radiation varies from 709 watts for large oven *E* to *D* 258 watts for small oven H-S, Yet Fig. 4 shows that the difference in radiation for the same ovens is comparatively small when reduced to unit surface area. The radiation at 450°F. varies from 540 watts on small oven *G* to 280 watts on large oven *H-L* when reduced to watts per 1,000 sq. in. (6,450 sq. cm.), whereas the total radiation of the same ovens shown in Fig. 3 does not differ widely. The ovens *A*, *B*, *F* and *H-S* and *H-L* all have radiation losses below 360 watts per 1,000 sq. in., or 0·36 watt per square inch.

In Fig. 5 the radiation has been reduced to watts per cubic foot. Some have contended that this should be the proper basis for comparison, but this is not the opinion of the writer. For example, both *H-S* and *H-L* are in same range, are constructed similarly, and should have the same radiation per unit. The comparison by watts per 1,000 sq. in. (6,450 sq. cm.) shows this to be true, while the comparison per cubic foot places the radiation on *H-S* near the top and *H-L* at the bottom, which is not consistent. Both sets of curves agree that the radiation loss on oven *G* is very high. This oven has glass panels in the door, which permits a large heat radiation.

A comparison of the cooling curves is given in Fig. 6. Oven *C* and *G*, with largest radiation, fall off most rapidly, and *F*, *B*, *H-S* and *H-L*, with smaller radiation, cool much more slowly.

From the analyses made above it is evident that there is a large difference in the heat-retaining efficiency of the ovens. But judgment should not be based on this alone, since an oven which retains its heat longest may require more energy to heat it than another not so well insulated. This is brought out clearly in the curves of Fig. 7, which show the kilowatt-hours required to bring the various ovens to temperatures from 250°F. to 500°F. A range of from 1·035 kw.-hours for large oven *F* to 0·330 kw.- hours for small oven *A* was required to bring them to 450 deg.

It should be observed that the four ovens requiring the most energy to heat are the ones which retain their heat the best or really store it up. Hence for an operation which requires a short time, like baking biscuits, the oven which requires the fewest kilowatt-hours for pre-heating is obviously the best. Again, for the longer operations, such as baking bread or roasting, the heat-retaining oven with lower radiation losses may require less energy and give a more uniform temperature.

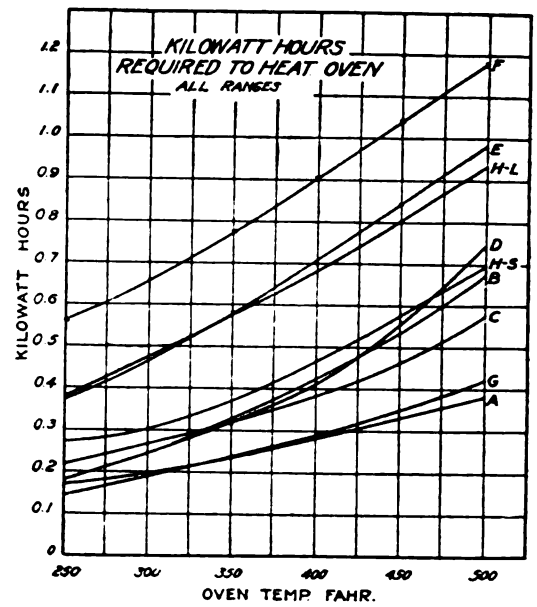

FIG. 7.—RATIO OF ENERGY CONSUMED TO OVEN TEMPERATURE.

Theory of the Static Frequency-Doubler.*

BY M. OSNOS.

The action of the static frequency-doubler is based upon the superposition of a steady field upon an alternating field. The apparatus is shown in its simplest form in Fig. 1, in which the symbols have the following meanings:—

D', D'' are two similar reactive coils.
Z_1', Z_1'', primary windings.
Z_2', Z_2'', secondary windings.
Z_c, continuous current winding.
F_a', F_a'', alternating-current fluxes.
F_c', F_c'', continuous-current fluxes.
F', F'', resulting fluxes.
B, a source of continuous current.
f_1, f_2, primary and secondary frequencies.

The windings Z_1', Z_1'' are connected in series, and the windings Z_2', Z_2'' in opposition with respect to the fluxes F_a', F_a''. On the other hand, the windings Z_1', Z_1'' are connected in opposition, and the windings Z_2', Z_2'' in series with respect to the fluxes F_c', F_c''. It will be seen that the fluxes F_a', F_a'' neutralise each other in the continuous-current windings, while the fluxes F_c', F_c'' add their effects in the same windings. As the continuous-current winding is placed magnetically in a similar position to the windings Z_2', Z_2'', the latter may be replaced by a single winding coaxial with the winding Z_c, and this may in turn be combined partially or wholly with the continuous current winding.

If alternating currents of frequency f_1 are supplied to the windings Z_1', Z_1'', alternating currents may be taken off from the combination of the windings Z_2', Z_2'' of a frequency f_2 double the value of f_1. This may be explained as follows on the approximate assumption that the magnetising curve is the mean of the ascending and descending values.

The curve *F* in Fig. 2 represents the normal saturation curve of one of the reactive coils. The continuous current ampere-turns are x, and the corresponding field strength F_c. If the primary alternating current is zero, then the resulting fields F' and F'' are respectively equal to F_c' and F_c''. If at any time t the alternating current has a given value and produces a ampere-turns in each coil, then the resulting flux in the reactive coil D', in which the fluxes subtract, has decreased from F_c' to F' by an amount u, while the resulting flux in the reactive coil D'', in which the fluxes add, has increased from F_c'' to F'' by an amount v. Thus the effect of the variations u and v of the fluxes in the separate windings Z_1' and Z_1' is equivalent to an ideal variation $(u+v)$ of the flux in the two coils combined. The two reactive coils can, therefore, be replaced by an equivalent single coil in which the flux F_c' has decreased by an amount $(u+v)$. Furthermore, we may consider the decrease of flux $(u+v)$ to be equivalent to an ideal alternating flux F_{a1} that varies about a mean value and has at the time t a negative value $(u+v)$. The maximum value of this ideal flux F_{a1} may be determined by marking off its maximum value a on either side of x and measuring the corresponding value of $(u+v)$ in the saturation curve as shown in Fig. 2.

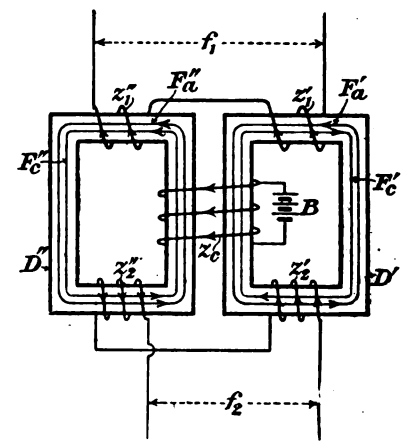

FIG. 1.

When the alternating current is zero, the flux F_{a1} is also zero, and it follows that as the primary alternating current sinks from its negative maximum to zero, the ideal flux F_{a1} also sinks from its negative maximum to zero. When the direction of the current changes, the resultant flux increases in D' and decreases in D'', and this is equivalent to an increase of the ideal flux in the coil D' in the positive sense. Thus a negative quarter period of the ideal flux in one coil corresponds to a negative quarter period of the alternating

* Abstract of an article in the "Elektrotechnische Zeitschrift," Vol. XXXVIII.

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current, and *vice versa*, and the frequency of the ideal field is, therefore, the same as that of the primary alternating current.

Owing to the fact that the windings Z_2' and Z_2'' are connected in opposition with reference to the alternating flux, the flux variations u and v are together equivalent to an ideal variation $(u-v)$ in one of the windings. From the shape of the saturation curve the decrease u in one winding is always greater than the increase v in the other winding, so the difference $(u-v)$ represents a weakening of the resulting continuous flux $(F_c'+F_c'')$ in the windings $Z_2'+Z_2''$ for every value of the primary alternating current, and this weakening takes place for either direction of flow of the primary alternating current.

In Fig. 3, i_1 represents the variation of the primary alternating

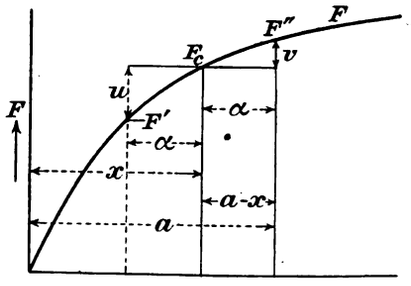

FIG. 2.

current, and in Fig. 4, y_0 represents the continuous current flux $F_c=F_c'+F_c''$ for $i_1=o$. If the values of $(u-v)$ are plotted downwards from y_0, the variation of the field F_c is obtained. The character of the variation $(u-v)$, as shown in Fig. 4, follows from the consideration that $u-v=o$ for $i_1=o$, *i.e.*, for $t=o$, $T/2$, T, $3/2T$, &c., and that $(u-v)$ has its maxima at the same times as i_1 has its maxima, *i.e.*, for $t=T/4$, $3/4T$, $5/4T$, &c. It is seen that the flux curve $(u-v)=F_{a2}$ completes a whole period during half a period of i_1 and, therefore, has twice the frequency of i_1.

In ordinary transformers the primary and secondary fluxes are nearly equal, but this is not the case in frequency changers. For instance, the resulting secondary flux F_{a2} may be zero while the resulting primary flux is large, *e.g.*, when the continuous-current excitation is zero.

As the value of F_{a2} depends on the magnitude of the continuous

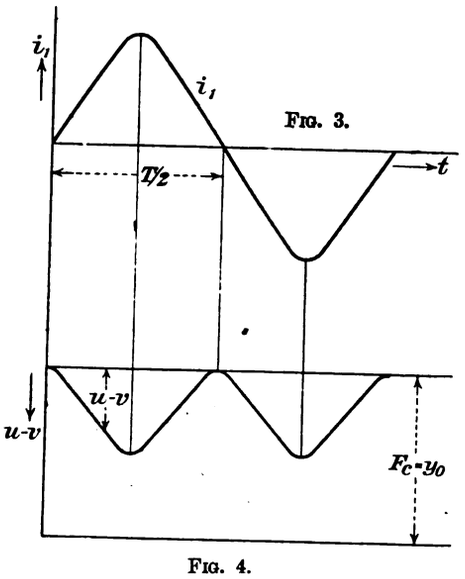

FIG. 4.

current excitation, the question arises whether there is a most favourable ratio between the continuous current and the alternating current ampere-turns.

We have $F_{a2}=u-v$,

and from Fig. 2 $u=f(x)-f(x-a)$

$v=f(a)-f(x)$.

Hence $y=F_{a2}=2f(x)-f(x-a)-f(a)$.

Owing to the symmetry of the saturation curve relatively to the origin we have $-f(x-a)=+f(a-x)=+f(a-2x)$.

Thus $y=F_{a2}=2f(x)+f(a-2x)-f(a)$.

Assuming the sum a of the continuous and alternating-current ampere-turns to be constant, it follows by differentiation that

$$y'=2f'(x)-2f'(a-2x)$$

and $y'=o$ when $a-2x=x$ or $a=3x$.

A further differentiation shows that this condition corresponds to a *maximum* value of y.

Again $a=x+a$, and putting $a=3x$, we obtain the relation $a=2x$.

Thus it has been shown that for a constant sum of the alternating and continuous-current ampere-turns *the secondary flux has its greatest value if the ratio of the maximum value of the alternating current to the continuous-current ampere-turns is equal to* 2.

In the article a graphical construction is given by which the maximum values of the primary and secondary fields may be determined. From this construction it is also possible to obtain

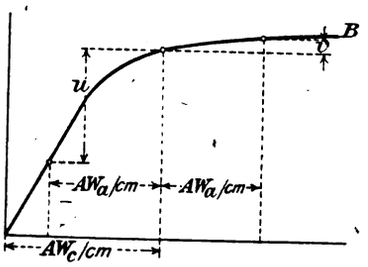

FIG. 5.

the ratio between the primary and secondary voltages. This ratio is also obtained by calculation, as follows :—

If e_1 and e_2 are the primary and secondary voltages,

σ_1 and σ_2, primary and secondary leakage coefficients,

K_1 and K_2, primary and secondary form factors,

z_1 and z_2, primary and secondary number of turns on the alternating-current windings.

We have $e_1=\sigma_1 K_1 (u+v)_{max} f_1 z_1 10^{-8}$,

and $e_2=\sigma_2 K_2 \left(\frac{u-v}{2}\right)_{max} f_2 z_2 10^{-8}$,

and $f_2=2f_1$.

Also putting $u=2f\left(\frac{a}{3}\right)$ and $v=f(a)-f\left(\frac{a}{3}\right)$

in $(u+v)_{max.}=F_{a1}$ and $(u-v)_{max.}=F_{a2}$,

we obtain $$\frac{e_1/z_1}{e_2/z_2}=\frac{3-\xi}{1+\xi}\cdot\frac{\sigma_2}{\sigma_1}\cdot\frac{K_2}{K_1},$$

where $$\xi=\frac{f(a)}{f(a/3)},$$

The results obtained above are confirmed by calculations made

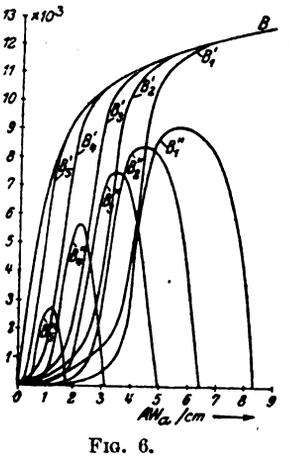

FIG. 6.

for a special case, taking as a basis the saturation curve for a particular sort of transformer iron.

We have $F_{a1}\cdot f_1=B'\cdot Q\cdot f_1$

and $$\frac{F_{a2}}{2}\cdot f_2=F_{a2}f_1=B''\cdot Q\cdot f_1,$$

where Q is the section of the magnetic path,

and B', B'' ideal saturations corresponding to the ideal fields F_{a1} and F_{a2}.

Fig. 5 is a saturation curve, u and v now being taken to represent the differences of ordinates B as shown in the figure, in which

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AW_c/cm and AW_a/cm represent the ampere turns per cm. of the continuous and alternating currents respectively.

We have $B'=u+v$

and $B''=u-v$

where B' and B'' are both referred to the primary frequency f_1.

A particular saturation curve B is taken in Fig. 6 and choosing a constant value for $(AW_a+AW_c)/cm$ the values of B' and B'' are calculated as functions of AW_a/cm. In this manner the curves B_1', B_1'' were determined for $(AW_a+AW_c)/cm=8{\cdot}3$.

Similarly the curves B_2', B_2'' were determined for

$$(AW_a+AW_c)/cm=6{\cdot}4$$

and so on.

The curves show that each of the curves B'' has a maximum value, and that this maximum value occurs at the point for which $AW_a/AW_c=2$, as was obtained from purely theoretical considerations.

The choice of the most favourable value of $(AW_a+AW_c)/cm$. forms the subject of German patent 283,235.

We have $F_{a_1}=B'Q$ and $F_{a_2}=B''Q$.

B'' is chosen with reference to the permissible losses.

The magnetising current of an ordinary transformer is determined by the value of the primary flux, but in the case of a frequency-doubler the saturation caused by the continuous current flux also has its effect, and widely varying magnetising currents will be obtained for a given value of the alternating flux if the continuous current excitation be varied. The best design will be the one for which the magnetising current is a minimum.

If in Fig. 6 we take $B''=3{\cdot}10^3$ it will be seen that for this value there are corresponding values of AW_a/cm for all the curves B'' excepting the curve B_5''. Furthermore, for a given value of B'' the alternating-current ampere-turns, and therefore the magnetising current, are least for the curve B_4'' and greatest for the curve B_1''.

Thus it follows that for a given ideal secondary saturation B'' *the magnetising current is smallest for the smallest value of the sum* $(AW_a+AW_c)/cm$.

Now for the value of $(AW_a+AW_c)/cm$ corresponding to the curve B_4'' much higher saturations are obtainable than the value $B=3{\cdot}10^3$, and it is clear that in order to utilise the ampere-turns to the best advantage a curve must be selected that lies between B_4'' and B_5', and has its maximum value at $3{\cdot}10^3$.

This consideration leads to the selection of the value of the quantity $(AW_a+AW_c)/cm$ that gives the minimum magnetising current.

A graphical method is given in the article by means of which this selection may be effected.

Calculation of Performance of Induction Motors Working in Conjunction with Flywheels and Slip Regulators.

By HERBERT VICKERS, M.Eng.

Summary.—The author deals with the subject mathematically, taking the two cases of continuous slip regulator and intermittent slip regulator; also the automatic slip regulator and the Ward Leonard system. Numerical examples are given.

Perhaps no development in electrical engineering has been so rapid as the application of the alternating-current motor to the driving of rolling mills and to electric winding. The first great impetus given to the electrification of steam mills seems to have been made when the U.S. Steel Corpn. decided to adopt the electric drive about 11 years ago.

The Westinghouse companies alone have been responsible for half a million brake-horse-power of such rolling mill plant,

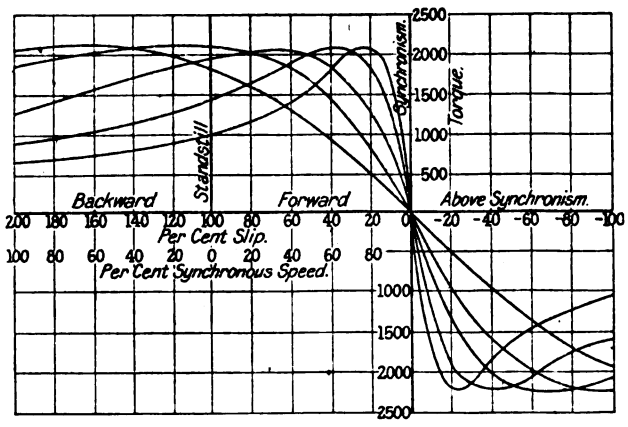

FIG. 1.—TYPICAL SPEED TORQUE CURVES FOR INDUCTION MOTORS WITH DIFFERENT VALUES OF RESISTANCE IN THE ROTOR CIRCUITS.

and since the war began the figures for this country alone are an ample testimony to the increased output, decreased cost of product, and much more satisfactory service given by the adoption of the electric drive. In such applications it is of great importance to equalise the load on the generating plant as much as possible to ensure that maximum efficiency shall be obtained in operation. To that end a flywheel is coupled to the induction motor, which is caused to drop its speed by the introduction of resistance in the rotor circuits, and thus enables the flywheel to give up some of its energy when peak loads have to be met. The energy of a flywheel $=W.v^2/2g$, where W=weight in lb., v=velocity in feet per minute, and g=acceleration due to gravity in feet per second per second. The energy given up will therefore be proportional to the difference in the squares of velocity. With a 20 per cent. slip of the induction motor the percentage of energy given up by the flywheel will be 36 per cent.

The resistance is introduced into the rotor circuits in two ways. In one, the resistance is inserted permanently in circuit and constitutes what is commonly known as the "Continuous Slip Regulator." In the other, the resistance is introduced at a pre-determined value of the load and its function is to keep the current to the motor as constant as possible. This type is known as the "Intermittent Slip Regulator." It is a matter of considerable interest to analyse the behaviour of the motor in the two cases; to investigate the advantages and disadvantages of both systems; and to show how the speed, torque, output of motor and input from the line vary under load conditions.

We will consider in the first place a rolling mill of the continuous type, and deduce the torque and speed equations when permanent resistance is adopted.

Let: I=Moment of inertia of the flywheel in lb. (ft.)^2.

ω=angular velocity in radians per second at any time "t" seconds from the commencement of the pass.

T_3=Total torque in the pass, assumed constant in lb. ft.

T=torque exerted by the induction motor at any time "t" seconds from commencement of pass in lb. ft.

T_2=maximum torque exerted by the induction motor in the pass in lb. ft.

ω_0=synchronous speed in radians per second.

ωf=speed of motor in radians per second at full load with permanent resistance in.

The torque equation is:—

$$T-I\frac{d\omega}{dt}=T_3. \quad \ldots\ldots\ldots \quad (1)$$

During the pass $d\omega/dt$ is negative, since the speed is falling.

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In the normal range of operation of the induction motor the torque exerted is proportional to the slip.

That this is so can be shown as follows: The torque in synchronous watts is equal to the input to the rotor—*i.e.*,

$$T=EI\cos\varphi\times m,$$

where E=voltage in the rotor per phase at standstill.
I=rotor current per phase in amperes.
$\cos\varphi$=power factor in rotor circuit.
m=number of rotor phases.
R=resistance of rotor per phase in ohms.
$L\omega$=reactance of the rotor per phase at standstill in ohms.

$$s=\text{slip}=\frac{\text{synchronous speed}-\text{speed.}}{\text{synchronous speed.}}$$

Now
$$I=\frac{sE}{\sqrt{R^2+s^2L^2\omega^2}},$$

since the E.M.F. generated per phase$=sE$ at slip s.

$$\therefore\ T=\frac{E\times sE}{\sqrt{R^2+s^2L^2\omega^2}}\times\frac{R\times m}{\sqrt{R^2+s^2L^2\omega^2}}=\frac{sE^2R\times m.}{R^2+s^2L^2\omega^2}\quad .\ (2)$$

in synchronous watts.

This, then, is the equation connecting slip and torque.

When "s" is small, $s^2L^2\omega^2$ is negligible, and the torque-slip relation is —given by

$$T=\frac{sE^2\times m}{R},$$

i.e., the torque *a* slip.

The torque-slip curves of an induction motor for both positive and negative slip are given in Fig. 1.

The slip usually taken is about 20 per cent. in the passes, and for such values our assumption will be sufficiently accurate for practical purposes, as will be seen from Fig. 1.

$$\therefore\ \frac{T}{T_F}=\frac{\omega_0-\omega}{\omega_0}\div\frac{\omega_0-\omega_F}{\omega_0}=\frac{\omega_0-\omega}{\omega_0-\omega_F},$$

where T_F=torque at full-load.

$\therefore$ Equation (1) may be written—

$$T_F\frac{\omega_0}{\omega_0-\omega_F}-\frac{T_F\omega}{\omega_0-\omega_F}-I\frac{d\omega}{dt}=T_3.$$

Let
$$\frac{T_F}{\omega_0-\omega_F}=a,$$

then
$$a\omega_0-a\omega-I\frac{d\omega}{dt}=T_3,$$

i.e.,
$$\frac{d\omega}{dt}+\frac{a}{I}\omega=\frac{a\omega_0-T_3}{I}=\frac{c}{I},$$

where $c=a\omega_0-T_3$.

The integrating factor of this equation is $e^{\int\frac{a}{I}dt}=e^{\frac{at}{I}}$, where "$e$" is the base of the Naperian logs.

$$\therefore\ \frac{d}{dt}(e^{\frac{at}{I}}\omega)=e^{\frac{at}{I}}\frac{c}{I},$$

i.e.,
$$\omega e^{\frac{at}{I}}=\frac{c}{I}\int e^{\frac{at}{I}}dt+E,$$

where E is the constant of integration.

$$\therefore\ \omega=\frac{c}{a}+Ee^{-\frac{at}{I}},$$

when $t=0$, $\omega=\omega_1$ $\therefore\ \omega_1=\frac{c}{a}+E$,

and
$$E=\omega_1-\frac{c}{a}.$$

$$\therefore\ \omega=\frac{c}{a}+\left(\omega_1-\frac{c}{a}\right)e^{-\frac{at}{I}}\quad .\ .\ .\ .\ .\ .\ .\ (3)$$

$$\therefore\ \omega=\omega_0-\frac{T_3(\omega_0-\omega_F)}{T_F}+\left\{\omega_1-\omega_0+\frac{T_3}{T_F}(\omega_0-\omega_F)\right\}e^{-\frac{at}{I}}\ (4)$$

This is our speed equation, and from it the speed at any time of the pass can be determined.

At the commencement of the first pass, ω_1 will be the speed corresponding to friction load. At the beginning of the second pass, it may happen that the speed has not fallen to the frictional load speed. In that case the speed at the end of the first interval between passes can be found, and this speed must be substituted in equation (4) for the speed at the beginning of the second pass.

The *average* speed during the pass

$$=\frac{1}{t}\int_0^t\omega\,.\,dt,\text{ where } t=\text{time of pass.}$$

$$=\frac{1}{t}\int_0^t\left\{\frac{c}{a}+\left(\omega_1-\frac{c}{a}\right)e^{-\frac{at}{I}}\right\}dt.$$

$$=\frac{c}{a}+\left[-\frac{I}{a}\left(\omega_1-\frac{c}{a}\right)e^{-\frac{at}{I}}\right]_0^t\times\frac{1}{t}$$

$$=\frac{c}{a}-\frac{I\left(w_1-\frac{c}{a}\right)}{t}e^{\frac{at}{I}}+\frac{I}{at}\left(\omega_1-\frac{c}{a}\right)$$

$$=\frac{c}{a}+\frac{I\left(w_1-\frac{c}{a}\right)}{at}\left\{+1-e^{-\frac{at}{I}}\right\}$$

$\therefore$ average speed during the pass

$$=\omega_0-\frac{T_3}{T_F}(\omega_0-\omega_F)+\frac{I}{t\,.\,T_F}\left[\left\{\omega_0-\omega_F\right\}\left\{\omega_1-\omega_0+\frac{T_3}{T_F}(\omega_0-\omega_F)\right\}\right]\left[1-e^{-\frac{at}{I}}\right]\quad .\ .\ .\ .\ .\ .\ .\ .\ (5)$$

During the intervals between passes, we have

$$T=T_0+I\frac{d\omega}{dt}.$$

Here $d\omega/dt$ is positive and T_0=frictional torque.

$$T=T_F\frac{\omega_0}{\omega_0-\omega_F}-T_F\frac{\omega}{\omega_0-\omega_F}.$$

$$\therefore\ I\frac{d\omega}{dt}+a\omega=a\omega_0-T_0,$$

i.e.,
$$\frac{d\omega}{dt}+\frac{a}{I}\omega=\frac{a\omega_0-T_0}{I}=\frac{f}{I},\text{ where } f=a\omega_0-T_0,$$

i.e.,
$$\frac{d}{dt}(\omega e^{\frac{a}{I}t})=\frac{f}{I}e^{\frac{a}{I}t}.$$

$$\therefore\ \omega e^{\frac{a}{I}t}=\frac{f}{I}\int e^{\frac{a}{I}t}dt+F.$$

When $t=t_2$=time to end of first pass; $\omega=\omega_2$=angular velocity at the beginning of the first interval,

then
$$\omega_2=\frac{f}{a}+Fe^{\frac{a}{I}t_2}.$$

$$\therefore\ F=(\omega_2-f/a)e^{\frac{a}{I}t_2}.$$

$$\therefore\ \omega=\frac{f}{a}+(\omega_2-f/a)e^{+\frac{a}{I}t_2}\times e^{-\frac{a}{I}t}$$

$$=\frac{f}{a}+(\omega_2-f/a)e^{\frac{a}{I}(t_2-t)}.\quad .\ .\ .\ .\ (6)$$

$\therefore\ \omega$ in interval$=\omega_0-\frac{T_0}{T_F}(\omega_0-\omega_F)$

$$+\left\{\omega_2-\omega_0+\frac{T_0}{T_F}(\omega_0-\omega_F)\right\}e^{\frac{a}{I}(t_2-t)}\quad .\ (7)$$

The average speed during the interval

$$=\frac{1}{t_3-t_2}\int_{t_2}^{t_3}\omega dt=\frac{1}{t_3-t_2}\int_{t_2}^{t_3}\left\{\frac{f}{a}+(\omega_2-f/a)\ e^{\frac{a}{I}(t_2-t)}\right\}dt$$

$$=\frac{1}{t_3-t_2}\left[\frac{f}{a}t-\frac{I}{a}(\omega_2-f/a)\ e^{\frac{a}{I}(t_2-t)}\right]_{t=t_2}^{t=t_3}$$

$$=\frac{f}{a}-\frac{I}{a(t_3-t_2)}(\omega_2-f/a)\,e^{\frac{a}{I}(t_2-t_3)}+\frac{I}{a(t_3-t_2)}(\omega_2-f/a)$$

$$=\frac{f}{a}+\frac{I}{a(t_3-t_2)}(\omega_2-f/a)\left\{1-e^{\frac{a}{I}(t_2-t_3)}\right\}.\quad .\ .\ .\ .\ (8)$$

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Coming now to the question of torque, we find during the pass

$$T=T_3+I\frac{d\omega}{dt}$$

$$T=T_3+I\left\{-\frac{a}{I}\left(\omega_1-\frac{c}{a}\right)\right\}e^{-\frac{at}{I}}$$

$$=T_3-a\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t} \quad \ldots\ldots\ldots (9)$$

$$=T_3-\frac{T_F}{\omega_0-\omega_F}\left\{\omega_1-\omega_0+\frac{T_3}{T_F}(\omega_0-\omega_F)\right\}e^{-\frac{a}{I}t} \quad (10)$$

From this the torque at any instant during the pass can be determined.

Let T_1=torque exerted by the motor at the beginning of the pass, *i.e.*, $t=0$, then from (9) we have

$$T_1=T_3-a(\omega_1-c/a),$$

and T_2 the torque at the end of the pass, $t=t_2$.

$$T_2=T_3-a(\omega_1-c/a)e^{-\frac{a}{I}t_2}$$

$$=T_3-(T_3-T_1)e^{-\frac{a}{I}t_2}$$

$$=T_3+\frac{T_1-T_3}{e^{\frac{a}{I}t_2}} \quad \ldots\ldots\ldots (11)$$

$$\text{Now } \frac{at_2}{I}=\frac{T_Ft_2}{(\omega_0-\omega_F)I}=\frac{T_Ft_2}{\omega_0(\omega_0-\omega_F)I}$$

$$=\frac{T_Ft_2}{\omega_0sI}$$

$$\therefore T_2=T_3+\frac{T_1-T_3}{e^{\frac{T_Ft_2}{\omega_0sI}}}=T_3+\frac{T_1-T_3}{A^t},$$

where $s=\frac{\omega_0-\omega_F}{\omega_0}$=slip at full load and $A=e^{\frac{T_Ft_2}{\omega_0sI}}$.

This is a useful form in which to have the maximum torque exerted by the motor during the pass. During the decelerating period the minimum value that T_2 may reach is $T_2=T_1$, and during the accelerating period the maximum value that T_2 may reach is $T_2=T_1$, and this condition is reached when $A^t=1$.

The maximum value that T_2 may reach during the decelerating period is $T_2=T_3$ approx., and the minimum value that T_2 may reach during the accelerating period is also $T_2=T_3$.

This is reached when $(T_1-T_3)/A^t$ is very small as compared with T_3 and as a limit $\frac{T_1-T_3}{A^t}=\frac{T_3}{100}$ may be set.

T_2 is about 20 per cent. of T_3 during the decelerating period. It will be found that all cases in practice are included between the limits of $A^t=1$ and 1,000. The calculation of this quantity is very readily obtained by the aid of a slide rule possessing a log. log. scale.

The torque exerted by the motor during the interval

$$T=T_0+I\frac{d\omega}{dt}$$

$$=T_0+I\frac{d}{dt}\left\{f/a+(\omega_2-f/a)e^{\frac{a}{I}(t_2-t)}\right\}$$

$$=T_0-I\times\frac{a}{I}(\omega_2-f/a)e^{\frac{a}{I}(t_2-t)}$$

$$=T_0-a(\omega_2-f/a)e^{\frac{a}{I}(t_2-t)} \quad \ldots\ldots\ldots (12)$$

When $t=t_2$, $T=T_2$.

$$\therefore \quad T_2=T_0-a(\omega_2-f/a),$$

and when $t=t_3$ the time of the beginning of the second pass, $T=T'_3$.

$$\therefore \quad T'_3=T_0-a(\omega_2-f/a)e^{\frac{a}{I}(t_2-t_3)}.$$

$$\therefore \quad T'_3=T_0+(T_2-T_0)e^{\frac{a}{I}(t_2-t_3)} \quad \ldots\ldots\ldots (13)$$

It is no purpose of the present article to go into the considerations which determine the relative proportions of flywheel and motor. It may be remarked, however, that where the power is generated at the works, it is important to use relatively heavy flywheels to keep the load on the generating plant as constant as possible. In those cases where power is supplied from an outside source, the method of charging affects the proportions, a heavy flywheel being necessary when the maximum demand system is in vogue and a small flywheel and relatively large motor when power is charged for on the flat-rate system, it being very important in the latter case to reduce the friction losses as much as possible.

(To be continued.)

Higher Harmonics in Polyphase Electric Systems.*

By V. KARAPETOFF.

Summary.—Higher harmonics in a symmetrical m-phase system are considered for both the star and the mesh connection. It is shown which harmonics cannot exist in the mesh voltage, although present in the star voltages, and which harmonics give rise to circulating currents in a mesh. The phenomenon of the oscillating neutral is explained, and the effect of secondary mesh currents in furnishing transformer magnetising currents is discussed. Formulæ are given for the order of harmonics which produce gliding and pulsating M.M.F.s.

Higher harmonics of currents, voltages, fluxes and magnetomotive forces have been treated extensively in the electrical literature in application to the three-phase system.

Occasionally a number of phases is employed in practice greater than three, and the time is ripe for a general treatment of higher harmonics in any symmetrical m-phase system (*i.e.*, one in which the induced sinusoidal voltages are displaced in time-phase by an angle $2\pi/m$ from one another).

1. Star and Mesh Voltages.

Let the armature windings of an m-phase alternator be star connected, and let an n-th harmonic be present in each induced E.M.F. The time-phase angle between the E.M.F.s of fundamental frequency in the adjacent windings is $2\pi/m$; the same angle between the corresponding n-th harmonics $2\pi n/m$.

Let the windings and the line terminals be numbered consecutively 1, 2, 3, . . . k, . . . $(m-1)$, m, and let it be required to find the value of the n-th harmonic, E_n, in the mesh voltage between the terminals 1 and $(k+1)$. The amount e_n of the same harmonic in each star-connected winding is supposed to be known.

The vector E_n is a geometric difference between the vectors e_n of the star voltages in phases 1 and $(k+1)$. These vectors are displaced by $2\pi nk/m$ with respect to each other. From the isosceles triangle e_n, e_n, E_n one readily finds that:—

$$E_n=2e_n\sin(\pi nk/m).$$

A number of special cases of this relation are presented in the original Paper.

Oscillating Neutral.—The time angle between the star voltages e_1 of the fundamental frequency in two adjacent windings is $2\pi/m$. For the n-th harmonic voltage e_n this angle is $2\pi n/m$. When $n=m$, all the e_n's are in time phase with each other, and all the star windings are like parallel branches of a single-phase winding. Let the neutral point of the generator be grounded, and let that of a star-connected load at the other end of the line be insulated. The potential of the insulated neutral point will then vary periodically above and below that of the ground at the frequency of the n-th harmonic, these variations being caused by the voltages e_n. This phenomenon is known as the oscillating neutral. It is also caused by the harmonics of the order $2m$, $3m$, &c. If the second neutral point be also grounded, considerable harmonic currents of the above frequencies will flow through the system and through the ground connections. Troubles due to such effects and their remedies are well known, and need not be discussed here.

2. Currents in Star and in Mesh.

Let the windings of an m-phase armature be connected in mesh. The voltage vectors of the fundamental frequency are displaced by $2\pi/m$, and their addition gives a regular closed polygon, the resultant fundamental voltage around the mesh being equal to zero.

* Abstract of a Paper presented before the American Association for the Advancement of Science.

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For the n-th harmonic the time angle between the voltages in consecutive phases is $2\pi n/m$, and the polygon which represents the addition of vectors may be regular, multiple re-entrant, or star-shaped.

It is of interest to determine whether or not the resultant n-th harmonic voltage around a mesh is always equal to zero. If the direction of the voltage vector in phase 1 is taken as the reference axis X, the vector of the k-th phase voltage forms with this axis an angle equal to $2\pi n(k-1)/m$. The projection of the resultant vector E_r upon the axis is $E_r \cos(E_r X) = E_n \sum_{k=1}^{k=n} \cos 2\pi n(k-1)/m$.

The angles follow an arithmetical progression, and the vectors are uniformly distributed over a total angle $2\pi n$. Hence, the resultant E_r is equal to zero, except when all the vectors E_n are in phase with one another—*i.e.*, when n is a multiple of m, so that each cosine is equal to unity. In this case $(n=pm) E_r = mE_{pm}$. Thus, in an m-phase mesh-connected system the harmonic E.M.F.s of the order m, $2m$, $3m$, &c., are not cancelled, but may give rise to a considerable internal circulating current. It is well-known that in a three-phase delta-connected winding circulating currents caused by the 3rd, 9th, 15th, &c., harmonics of the voltage are sometimes observed.

Magnetising Current in Saturated Transformer Cores.—When a single-phase transformer core is saturated, and the applied voltage is sinusoidal, the magnetising current has a peaked wave form. The effect of hysteresis is to make the wave unsymmetrical, and various harmonics, both odd and even, are commonly superimposed upon the fundamental current. In a bank of m star-connected transformers, with the neutral insulated, some of these harmonic currents cannot flow; for example, currents of frequency $n=m$, $2m$, $3m$, &c., which require two ground connections in order to form a closed circuit. But if these currents cannot exist, the induced counter E.M.F. of the transformers cannot be sinusoidal; it must have voltage harmonics of the order $n=m$, $2m$, $3m$, &c. This leads again to the phenomenon of oscillating neutral.

Let, now, the secondary windings of these transformers be mesh-connected. The harmonic voltages of frequency m, $2m$, $3m$, &c., are all in phase with one another, and cause circulating currents, which by eliminating the corresponding harmonics in the flux and in the voltage counteract the formation of an oscillating neutral. In other words, the secondary mesh furnishes the lacking primary harmonics in the magnetising current. This is one reason for which transmission engineers often prefer the Y-delta connection of transformers.

Sometimes one m-phase transformer may be used in place of m single-phase transformers, that is, a transformer with m windings and m interlinked iron cores, the same being provided with two common yokes for flux return. With a star connection of the windings, the m-th, $2m$-th, $3m$-th, &c., harmonics are lacking in the magnetising current, and the fluxes of these frequencies are also limited on account of the common yokes. Thus, the polyphase magnetic circuit is also star-connected, and the harmonic fluxes of these frequencies, being all in time phase with one another, "buck" each other, and have to find closed paths through the air.

3. Magnetomotive Forces of Polyphase Armature Windings.

(*a*) *With Sinusoidal Magnetising Currents.*—Consider a regular m-phase winding such as would be used in the armature of a synchronous machine or on the stator of an induction machine. At a certain constant value of the current a turn consisting of two conductors 180 electrical degrees apart produces a "rectangular" distribution of M.M.F. along the air gap. For convenience of analysis such a rectangular distribution in space is replaced by a series of sinusoidal distributions. The frequencies *in space* of the higher harmonics of this distribution will be denoted by N, to distinguish them from frequencies *in time* of the harmonics of the magnetising current which in the next section of the Paper are denoted by n.

First, let us assume the magentising current to be truly sinusoidal in time, only the harmonics in space being present. As the magnetising current varies in time, the space harmonics of the M.M.F. pulsate at the same rate. But an alternating M.M.F. can be replaced by two M.M.F.s gliding synchronously in space in the opposite directions. Thus, finally, each phase of the winding produces an infinite number of sinusoidal M.M.F.s of various wave-lengths (space frequency), some gliding to the left, others to the right. The harmonics of each frequency belonging to all the phases are combined into one wave, and the following combinations are possible:—

(*a*) The waves going to the left have a resultant equal to zero, while those going to the right are combined into a larger resultant wave

(*b*) The same statement as (*a*) with the words "left" and "right" interchanged

(*c*) Both left-going and right-going waves are cancelled

(*d*) Both the left-going and the right-going waves have a resultant different from zero, and the resultant waves are combined into a pulsating one This case arises only when the magnetising current has harmonics in time.

Let the fundamental flux glide from right to left, so that the fundamental current in any phase winding *lags* by $2\pi/m$ with respect to the one in the adjacent winding to its right. Now, in a three-phase winding the N-th harmonic waves follow each other at an angle $2\pi(N-1)/3$. Similarly in an m-phase system these waves follow each other at an angle $2\pi(N-1)/m$. The waves gliding to the right follow each other at an angle $2\pi(N+1)/m$.

But m equal sinusoidal waves uniformly spaced over a total angle of 2π, or over any multiple of 2π, give a resultant equal to zero. The only exception is when the angular distance between two consecutive waves is 2π or a multiple thereof—*i.e.*, when either $(N-1)$ or $(N+1)$ must be a multiple of m—because then all the waves are simply superimposed. Thus, in an m-phase winding with purely sinusoidal magnetising currents and with the main flux travelling to the left the following harmonics only can be present:—

Gliding to the left.	Gliding to the right.
$N=1$ (fundamental),	
$N=m+1$	$N=m-1$
$N=2m+1$	$N=2m-1$
$N=3m+1$	$N=3m-1$
$N=4m+1$, &c.	$N=4m-1$, &c.

As an application of the above table we find that in a three-phase winding the flux harmonics multiple of three are absent, and of the other odd harmonics the 7th, the 13th, the 19th, &c., travel with the main flux, while the 5th, the 11th, the 17th, &c., glide against it.

(*b*) *Effect of Higher Harmonics in the Magnetising Current.*—Let, now, the magnetising current possess an n-th harmonic in time. The M.M.F. waves *in space* which such a harmonic produces pulsate n times faster than the corresponding M.M.F. harmonics due to the fundamental current. Therefore, the component gliding waves also move at an n-times greater speed. By analogy with the foregoing formulæ we find that for the N-th harmonic in space due to the n-th harmonic in time the angular distance between the adjacent waves moving to the left is $2\pi(N-n)/m$; the angular distance between the adjacent waves moving to the right is $2\pi(N+n)/m$.

Many sets of the waves give a resultant wave equal to zero, and only those have a real existence for which either $N=n$, $(N-m)$ is a multiple of m, or $(N+n)$ is a multiple of m.

The M.M.F. waves for which $N=n$ are of particular interest, because their direction and speed of rotation are the same as for the fundamental M.M.F., and they cause a permanent distortion of the revolving flux. For other harmonics the speed of rotation is (n/N) times that of the fundamental, and their effect is often wiped out by eddy currents induced in the rotor bars or in some other part of the machine.

For the sake of generality it has been assumed above that all the space harmonics are present. In reality some of them can be neutralised or considerably reduced by a judicious use of a fractional-pitch winding.

Thus, recapitulating, we find that:—

(*a*) The waves that glide in the same direction as the fundamental are those for which either

$$N=n,$$

or,

$$\pm(N-n)=pm.$$

(*b*) The waves that glide against the fundamental are those for which $N+n=pm$.

(*c*) Pulsating waves are caused by harmonics for which

$$N=p_1 m \text{ and } n=p_2 m.$$

(*d*) No waves can exist for which neither $(N+n)$ nor $(N-n)$ are multiples of m; the case of $N-n=0$ is covered in (*a*) above.

The foregoing rules can be readily used to check the tables given without proof in Arnold ("Wechselstromtechnik," Vol. III., 1912, p. 275) for two-phase and three-phase machines.

Separators for Accumulators.—A French patent taken out by Mr. T. A. Villard, describes a form of separator for accumulators. This appears to consist of two ingredients, *i.e.*, a porous material, such as a cheap textile, and a non-porous pliable substance such as rubber. The layers of the materials are compressed and vulcanised. Horsehair, cotton or wool fibre is suggested for the textile substance, while celluloid may take the place of rubber.

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The Saving of Industrial Fuel in Detail.

Although no scheme can be suggested for saving large quantities of fuel in some simple fashion (unless it be restriction of supplies, which generally means restriction of useful effort), there are many ways in which economy can be practised; and although individual cases may show only a small saving, the net aggregate result may be considerable. As a first line of attack one's thoughts naturally turn to the small private power plant. It is well known that such plants are generally inefficient, and if the coal used by them were consumed in an up-to-date power station, four or more times the amount of electrical energy would be produced for the coal that is used. Owing to the high cost of coal in these days it might be worth while, from the financial point of view, to shut down such plants temporarily, and to substitute for them electric power from a public supply. The great difficulty, however, in adopting any such course is that in many districts the power stations are already overloaded, and in others—for example, the London district—the necessary extensions of mains would present a difficulty. The fact is that, in dealing with a situation of this kind, a far-seeing policy is essential. It is useless to wait until the position becomes acute, because it is then probably very difficult to apply a remedy, owing to essential demands in other directions. For example, two years ago it would have been much easier to meet requirements for the extension of power stations and mains than it is to-day. But, unfortunately, two years ago we were inclined to the view that the present circumstances would not arise.

It will, of course, be realised that private power plants which supply steam for industrial purposes as well as power are in a peculiarly happy position. As was pointed out by Mr. GEORGE WILKINSON at the Convention of the Incorporated Municipal Electrical Association, only double the amount of fuel is required if power is generated by steam leaving the turbine at 20 lb. pressure as compared with the case when steam is used at a high vacuum; so that if the steam can be employed for industrial purposes after passing through the turbine, the financial result may be extremely good, and the saving of fuel, as compared with the raising of steam on the one hand and generation of power on the other, may be considerable. Plants of this kind, however, are unusual except in certain industries.

In a recent issue of the "Electrical World," Mr. C. E. STUART describes some of the steps which are being taken in the United States with a view to economising fuel. A body of engineers has been organised and stationed at the Fuel Administration at Washington, and this is co-operating with the Engineering Department of the United States Geological Survey and the Power Division of the Council of National Defence. There are also certain sub-divisions which deal with questions locally.

One of the most interesting and promising developments is what is known as the "Skip-stop" policy applied to electric tramcars. As the name implies, this means that some of the voluntary stopping places are being eliminated. Hitherto tramcars might be stopped by signal at any street corner, which results in 12 to 14 stops per mile. With the Skip-stop system the stopping points are reduced to not more than 8 per mile in business areas, 6 per mile in residential districts and 4 per mile in the open country. As is well known, where the stops are numerous, quite a large proportion of the electrical energy is spent in re-starting the car. Mr. STUART mentions that the decrease in the stopping points has led to the saving of 10 to 15 per cent. in electric energy, whilst at the same time the average speed of the cars has been increased. Thus the Connecticut Co. has reported a saving in fuel of 10 per cent. for its New Haven lines, and reports indicate a saving in other places at rates varying from 3,600 tons per annum in Columbus to 21,000 tons in Detroit. It appears to us that a similar policy might well be adopted in this country. Anyone using, for example, the tramcars in London, knows that the number of stops per mile, when the traffic is heavy, is high and makes travelling tedious. If this number were reduced to 8 per mile the hardship would not be material, and the saving on the basis above mentioned would be worth having.

Another way in which economy has been effected is by the appointment of Committees in shops to look after waste of fuel resulting from the unnecessary use of artificial lighting, lamps of too high candle-power, the replacement of arc and carbon lamps by more economical types, &c. Another source of waste is the running of shafting and belting without adequate inspection. It is also possible to improve economy by staggering operations so as to maintain a high load factor. Reports have shown that such steps lead to savings in fuel ranging from 10 to 34 per cent.

At first sight these may seem matters of small detail, but when the results are all combined their effect may be considerable. In fact, the reports which now come in to the United States Administration show a saving of fuel ranging from 10–45 per cent. owing to the adoption of these and similar methods.

Reviews.

Telephone Troubles and How to Find Them. By W. H. HYDE. 18th Edition. (London: S. Rentell & Co.) Pp. 56. 7d.

This little book is based upon an American work, revised to suit British readers. It will appeal particularly to those having charge of private magneto and central battery installations. It does not deal with intercommunication systems.

No attempt is made to explain the theory or principles, or even the circuits of the instruments, the author's effort being directed entirely to describing the construction and the troubles of telephone apparatus in plain non-technical language. The manner in which this somewhat limited object is fulfilled, and a price within the reach of all, should make the book useful to electricians who have to undertake the fitting and maintenance of telephone installations without special training or experience.

A synopsis of instrument and switchboard troubles and their probable causes is followed by a detailed discussion of each trouble, each group of troubles being prefaced by a description of the construction of the apparatus concerned. Methods of locating all classes of faults on aerial cables are fully dealt with and a brief specification for instrument wiring is given as well as recommendations regarding earth wires and a simple arrangement for connecting an extension instrument. The installation of phantom circuits and the transpositions necessary are described. Tables giving weights of and depths for setting poles, data for open wire circuits and a table of weights and

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resistances of telephone wires conclude the booklet. Numerous diagrams, primitive but clear, illustrate the descriptions.

In a future edition it would be well if the sections dealing with party lines, selective ringing systems and condensers on rural telephone lines, which are of little use to readers in this country, could be omitted and a section dealing with internal distribution wiring and its troubles added. The fact that the arrangement of the contents follows the list of troubles given at the commencement might be made clearer either by a note or by choice of other type for section headings, and, finally, so useful a book surely needs a more durable cover.

W. H. G.

The Electron. By ROBERT ANDREWS MILLIKAN. (Chicago: University of Chicago Press.) Pp. xii.+268. $1.50 net.

This work, which is one of the University of Chicago Science Series, is written by one of our foremost experimenters on the subject of delicate measurements relating to the electron, and may be expected on its practical side to be quite authoritative. It fulfils this expectation completely. No serious measurements of the charge on an electron, or of the various quantities derivable from the study of such phenomena as the Brownian movement, are left untouched, and the description and historical development of such methods of investigation, written in a literary style of considerable and quite unusual charm in a scientific work, make a fascinating story for the lay reader.

It is natural that a great part of the book should be taken up with work done at Chicago by the author and his fellow-workers, for one of the most fundamental problems of the electron is the exact determination of its electrical charge, and the complete proof that this charge is invariable. This is a problem which the author has made peculiarly his own for many years and it has led him into a great amount of important experimental detail, which is of value in other connections also. A full account of it is essential to a lay reader who wishes to become familiar, in simple terms, with the real nature of investigations of this kind.

There is one specially interesting feature of this work which is rarely met with. The historical account of the early days of electricity is peculiarly complete, and has evidently involved some research. There is, perhaps, a tendency to read too much into the statements of the ancients, but this is pardonable in view of the really considerable amount of information collected here for the first time in an appropriate sequence.

We must join issue with the author on one point, however. The chapters on the structure of the atom and on the theoretical significance generally of certain results, are in no sense complete. Perhaps the author did not intend them to be so. But it is necessary to warn the reader that these chapters present only one side of the picture, which in the minds of many of our leading theoretical physicists and mathematicians is not the best side. As examples we may cite, in the first place, the discussion of Moseley's epoch-making experiments. It is by no means proved that the atomic numbers of the elements are those given as proved in the book. Hicks and Rydberg, to mention only two workers, have given very strong reasons for the belief that Moseley's experiments prove a different result, and some reference should have been made to this fact. The difficulties underlying Bohr's theory and its extension, in any fair account, should at least have been hinted at, and there is a total absence of any reference to the bearing of astronomical spectra on the constitution of the atom, the investigations on which, by Nicholson for example, preceded Bohr's theory and gave it the necessary starting point in the constancy of atomic angular momentum—a constancy which is emphasised in the book. These are illustrations which could be multiplied considerably —for further example Ritz's theory of spectra and atomic magnetic fields ought to receive extended mention.

With this warning, the book in other respects can be recommended without reserve. It is well printed and excellently produced, and almost entirely free from misprints.

A New Method of Measuring Alternating Currents and Electric Oscillations.*

By I. WILLIAMS, M.Sc.

Alternating currents may be measured by means of the electromagnetic, the electrostatic or the thermal effects which they produce, but when the frequency is high the electromagnetic effect cannot be usefully applied on account of the excessive dielectric currents, the values of which are functions of the frequency. Up to the present the thermal effect has proved the most satisfactory basis for instruments for measuring currents at frequencies common in wireless telegraphy. If the resistance of the conductor which is heated by the current remains constant, the rate of generation of heat is strictly proportional to the square of the current. The rate at which the heat is generated has been measured by observing (*a*) the expansion, (*b*) the change of electric resistance, or (*c*) the thermoelectric electromotive force which is produced in the wire itself or in its immediate surroundings.

In this Paper a new thermal method of measuring alternating currents and electric oscillations is proposed, and two new types of instruments are described. Type 1 is based on Crookes† well-known work on radiometers; the heat generated by the currents in a wire

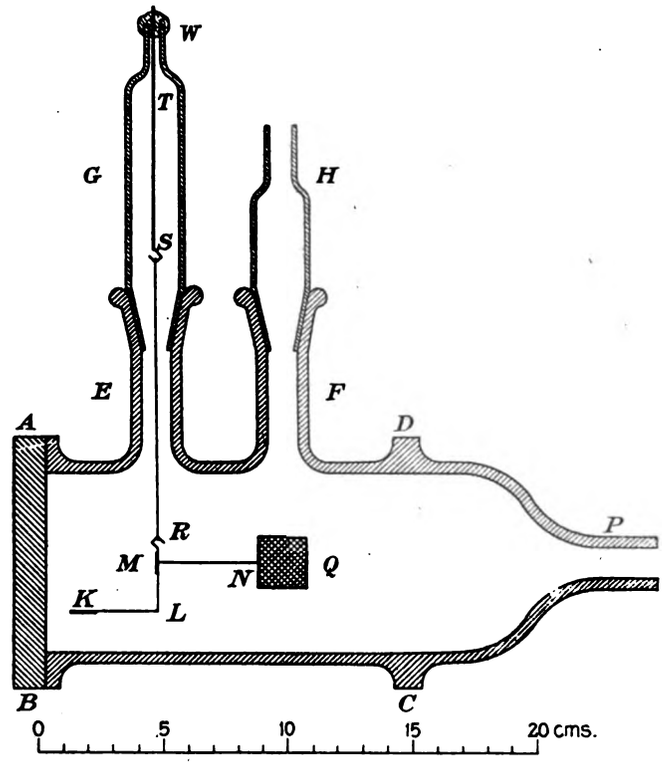

FIG. 1.—HIGH-FREQUENCY AMMETER. TYPE 1.

causes the deflection of a mica vane suspended in a vessel, the pressure in which can be maintained at a suitable value. Type 2 is based on work done by Osborne Reynolds ‡; the mica vane is replaced by a filament or narrow strip of suitable material, the deflection of which can be observed directly by means of a microscope. Type 1 may be said to resemble an electrometer, while Type 2 resembles an ordinary gold-leaf electroscope. The author in the original Paper describes a preliminary form of apparatus which was ultimately abandoned, owing to leakage difficulties, in favour of that shown in Fig. 1.

ABCD is a hollow cylinder with flanges at each end, and ground joints in the vertical tubes *E* and *F*. The vane suspension passed through *E* and the leads to the heater through *F*. The end *AB* was closed by a piece of plate-glass 0·5 in. thick and the end *CD* by a bell shaped tube, *CDP*. The vane *Q* was a rectangular plate of very thin mica, 20 mm. × 20 mm., blackened on the side exposed to radiation from the heated wire. *K* was a damping plate made of very thin copper foil, moving over the pole of a magnet. *KL* and *MN* were short light glass capillaries, while *RML* was an aluminium wire to which the mirror *M* was attached. The heater was a short straight length of platinum wire which had a resistance of about 0·9 ohm.

* Abstract of a Paper read before the Physical Society.
† "Phil. Trans.," Vol. CLXV., p. 579, 1875.
‡ "Phil. Trans.," Vol. CLXX., p. 768, 1879.

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The two leads passed out through the ground joint in *F*. The vane could be adjusted to any distance from the fixed heater by rotating the tube *G*. The end *P* was connected to the storage chamber, Gaede pump and McLeod gauge by a flexible glass connection. Observations were made by means of a telescope and scale, the latter being placed at a distance of about 120 cm. from the mirror.

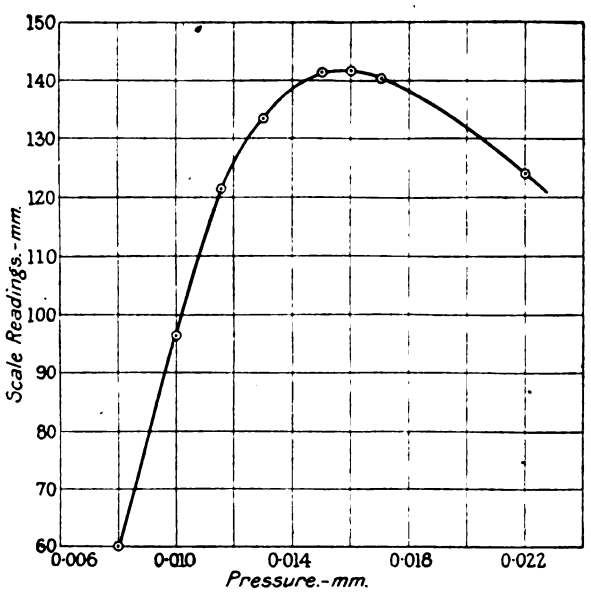

FIG. 2.

This form of apparatus was free from leakage troubles. Dry air at low pressure had been standing in it for about a week before the recorded observations were made. Fig. 2 shows the relation between pressure and scale reading. For a current of 0·1 ampere the repulsion reached its maximum value at a pressure of about 0·0155 mm. In other observations the current was maintained at 0·077 ampere, while the pressure was varied from 0·020 mm. to 1 atmosphere The repulsion decreased at first fairly rapidly, and then more slowly, until it became zero at a pressure of 4·6 mm. From this point the repulsion at first increased and then decreased to zero again at 288 mm. Over the pressure range 288 mm. to 1 atmosphere the vane was subject to an attraction which increased in value up to atmospheric pressure.

The pressure was next reduced to 0·014 mm. and the current varied from zero to 50 milliamperes. A current of 5 milliamperes then gave a deflection of 4·2 mm., whilst a P.D. of 4·4 millivolts gave a deflection of 3·8 mm. The maximum deflection for the apparatus used is obtained at a pressure of about 0·015 mm., being about six times as great as the deflection due to attraction at atmospheric pressure. The instrument is quite satisfactory as an ammeter or voltmeter. The sensitiveness, 4·2 mm. for 5 milliamperes, can be increased to a very considerable extent by using heaters of higher resistance, thinner and somewhat longer fibre suspensions and a lighter mirror. The instrument is suitable for large and small currents, as the sensitiveness can be varied by (1) change of heater, (2) change of control or (3) change of vanes. Instruments of this type are subject to considerable changes of zero, and must be shielded as completely as possible from extraneous radiation—*e.g.*, by surrounding the instrument with a thick layer of cotton wool, leaving uncovered just sufficient window area to permit of readings being made with a telescope and scale.

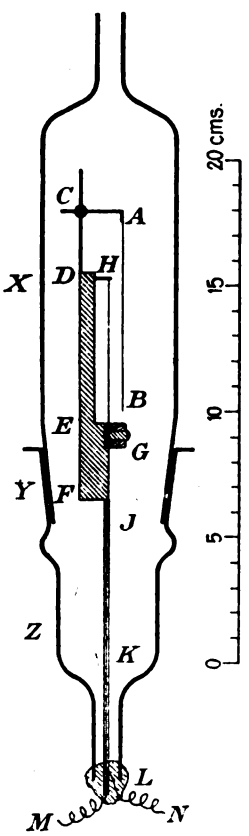

FIG. 3.

Experiments have also been carried out with an apparatus of the electroscope form, referred to above as Type 2, and shown in Fig. 3.

It has been shown by Osborne Reynolds* that a silk fibre suspended in an exhausted tube is subject to forces similar to those acting on the vanes of a radiometer. Reynolds found that when the silk fibre was exposed to radiation from an external source it was repelled over the pressure range 0·6 mm. to 200 mm., and attracted over the range 200 mm. to 1 atmosphere. Hence, if the deflection of the Crookes' vanes could be used for current measurement, the motion of a fibre could also be so used. A silk fibre, *AB*, about 75 mm. long, attached to the end *A* of a metal rod, *AC*, which could slide up and down, rotate about, or be moved to or from the vertical rod *CD*. The latter was mounted on an ebonite block, *DEF*, and connected to one terminal, *G*, and also to earth. Starting from the terminal *G*, the heated wire *GH* passed over a hook at *H*, over two more hooks not shown, and finally was clamped to the terminal *G'* immediately behind *G*. The ebonite block *DEF*, with its heating coil and fibre,

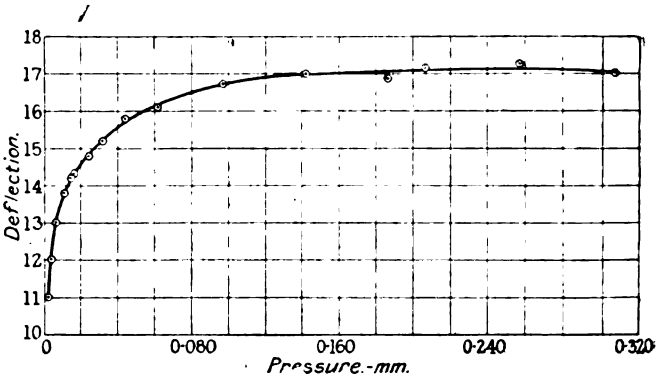

FIG. 4.

was mounted in the lower half of a wide vacuum tube, *XYZ*, the leads to the terminals at *GG'* being cemented in at *Z* and insulated from one another by a glass tube. The end *X* of the tube was permanently connected to the McLeod gauge, storage chamber and Gaede pump as in previous work. When a current was passed through the wire *GH* the motion of the end *B* of the fibre was observed by means of a microscope having an eyepiece scale.

The apparatus was pumped out repeatedly, as in the previous work, and then filled with dry air from the reservoir. Before the

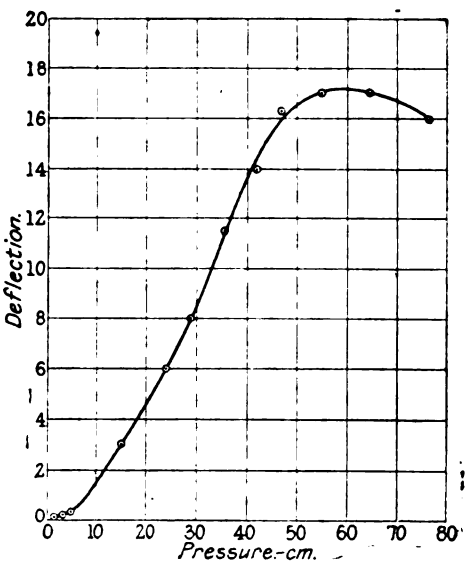

FIG. 5.

observations recorded in the tables were made the dry gas had been standing in the apparatus for some days. The pressure was reduced as far as possible, and the deflection of the fibre was then observed for various pressures from 0·002 mm. to 2·94 mm., the current being kept constant and equal to 0·05 ampere.

The zero was very steady, and the deflection for a given current and a given pressure could be repeated over and over again. Within the pressure range 0·002 mm. to 3 mm. the repulsion reaches its maximum value at a pressure of about 0·28 mm. As seen in Fig. 4, between 0·1 mm. and 0·4 mm. the curve is very flat, and the instrument can be used as a current measurer at any pressure between these limits. The pressure was next maintained constant at 0·28 mm., while the current was varied from 0 to 75 milliamperes; the current

* "Phil Trans," Vol. CLXX., p. 768, 1879.

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was measured with a Siemens milliammeter, as before. Over the pressure range 1·4 mm. to 1 atmosphere the deflection reached its maximum value at a pressure of about 60 cm., as shown in Fig. 5.

Finally, the author described experiments on fine fibres of glass and quartz. The quartz fibre used for the early experiments was home made. It was rather coarse and stiff, and was replaced by fibre made by the Cambridge Scientific Instrument Co. The variation of the deflection with pressure was somewhat similar to that observed in the case of the silk fibre. The curve was practically flat over the pressure range 0·4 mm. to 0·8 mm. The repulsion decreased to zero at a pressure of 1·5 cm., and from this point to atmospheric pressure the fibre was attracted. The attraction seemed to approach a maximum at atmospheric pressure. Observations made with the same current over the whole pressure range indicated that the magnitude of the attraction at atmospheric pressure was about 16 times as great as that of the maximum repulsion over the lower pressure range. In the case of quartz, a deflection current curve was not given, as some irregularities arose which are being investigated.

Correspondence.

THE TERCENTENARY OF COMMON LOGARITHMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I read with great interest Mr. Bower's article on "The Tercentenary of Common Logarithms" which appeared in your last issue. He did not mention, however, the vexed point about the spelling of the name of the inventor of logarithms. There is a legal document extant in his handwriting in which he signs himself *Jhone Neper, Fear of Merchiston.* This probably means "feuar" and not "Baron" of Merchiston. In the title-page of his books also his latinised name—in the ablative case—appears as Ioanne Nepero. In the early part of the 17th Century the spelling of the name Napier was still in a fluid condition, but those authors who write about Neperian logarithms are historically accurate.—I am, &c.

ALEXANDER RUSSELL.

London, July 12.

ARMATURE WINDINGS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The excellent series of articles on continuous-current armature winding by Mr. F. M. Denton has been read with much interest because of its new point of view of familiar facts and because of its presentation of relations not so well known, notably the effect of the parallel paths on symmetry due to the positions of the conductors in the slot. Certain comments are suggested, however, by the classification of windings, for which the writer seeks the privilege of your columns.

The evolution of the bipolar drum winding (either by the method described or by a slightly different one) is highly illuminating and should be familiar to every student of the subject. Instead of deriving multipolar drum windings from multipolar ring windings, it is the writer's belief that it is simpler and more instructive to regard multipolar windings, of either type, as combinations of bipolar windings of the corresponding type. It is easy to show, by diagrams, how a multipolar drum winding, for instance, may be composed of a number of identical bipolar windings connected either in parallel or in series, and how, with the customary methods of construction, the conducting path through a parallel combination of bipolar windings laps back upon itself with every coil, while the conducting path through a series combination progresses continuously in one direction, like a travelling wave, as it leads backward and forward across the core. It is thus made clear that the terms "parallel" and "series" refer to electrical characteristics of the combinations, while "lap" and "wave" refer to mechanical or geometrical characteristics.

Ordinarily, the respective terms are assumed to be synonymous, and a winding is spoken of as parallel *or* lap, or as series *or* wave. Such an assumption is hardly justified, for it is not difficult to construct a wave winding which is also a parallel winding in every sense of the word, without being a series-parallel winding. The possibility of the fourth combination, a lap winding that is also a series winding the writer is not prepared to deny, but he is unacquainted with such an arrangement and it does not appear feasible.

It would seem then that Mr. Denton's classification might advantageously be expanded sowewhat as follows:—

(*a*) Lap windings. (Otherwise called parallel, or by the more inclusive term multiple-circuit.)

(*b*) Parallel-wave windings.

(*c*) Series-wave windings. (Otherwise called two-circuit.)

(*d*) Series-parallel windings. (Otherwise called multiplex series-wave.)

The parallel-wave winding combines the desirable electrical characteristics of the parallel and the wave types, discussion of which here would occupy too much space. Unfortunately, it has certain constructional disadvantages, which, however, can be largely overcome by standardisation. The writer has used this winding repeatedly on non-interpole motors for continuous duty at high speeds and ratings with uniformly good results, the performance greatly surpassing that of similar machines with the standard types of windings.—I am, &c.,

Ampere, N.J., U.S.A., June 21. A. A. NIMS.

The Shanghai Electricity Works.

The annual report of the working of the Shanghai municipal electricity department for the year 1917, with the estimates for 1918, have reached us.

At the end of August last, the engineer and manager (Mr. T. H. U. Aldridge) set out for America to call for tenders for various plant that is urgently required, and he has placed orders in that country with the General Electric Co. for one 20,000 kw. turbo-generator, one 600 kw. Westinghouse motor-generator set and a large synchronous condenser, and 10 miles of 22,000 volt underground cable. An additional 5,000 kw. turbo-generator is urgently required. Mr. Aldridge was expected back about the end of June.

In spite of shortage of plant and the restrictions that have had to be enforced, the units sold show an increase of 26 per cent. (78,490,442 against 62,160,796 units in 1916), and the load factor has reached the high figure of 44·38 per cent. It has been found necessary to increase the rate for lighting and small power and heating both in 1916 and 1917, and the rates are now 40 per cent. over pre-war times. The large power users have a coal clause in their agreements.

The maximum load was 20,927 kw. and the units sold per kilowatt of maximum demand was 3,888. The plant capacity is 29,600 kw. (24,000 kw Riverside and 5,600 Fearon-road). The total works costs were 0·636d., an increase of nearly 20 per cent., entirely due to the higher price of coal. Of the units sold, 15,206,019 were for private lighting (increase 6·44 per cent.): 1,128,896 for public lighting (increase 6·62 per cent.), 1,129,754 for heating and cooking (increase 25·58 per cent.), 57,182,340 for power (increase 36·01 per cent.), and traction 3,843,433 (decrease 0·78 per cent.) As soon as conditions again become normal greater increases in the demand for electricity are expected.

The year was the most difficult one with which the department has ever had to deal. Owing to the serious breakdowns in November, it was necessary to restrict the supply of power during the heavy load period (from 4 p.m. to 10 p.m.) for some considerable time, and to cut off all sign and outside lighting. The department is suffering from the cumulative effects of serious plant shortage for several years. Owing to alterations carried out during the year to the boilers at Riverside it was possible with the same boilers to supply an increased load of 2,600 kw. In October the new 10,000 kw. General Electric Co. set was put in commission, and has been on continuous load since that time. The number of units generated between October 4th and December 31st was 24,615,680 units, of which the machine generated 16,845,830, or 68 per cent. of the total. During the year 104·57 miles of cable have been erected for extending and enlarging the overhead mains and 7·44 miles of extra high tension, 1·08 miles of low tension and 0·12 mile of pilot cable laid. The total number of transformer sub-stations is 62, and of pole transformer stations 12. There are 105 transformers, of a capacity of 30,867·5 kw. There are 1,718 (against 1,683) metal filament lamps for street lighting—viz., 944 of 60 c.p. each, 226 100 c.p., 202 200 c.p., 320 400 c.p., 8 800 c.p., 14 1,000 c.p. and 4 2,000 c.p.

The net increase in house service connections, after allowing for disconnections, was 1,594, making the total at the end of the year 23,453. The number of additional 30 watt (equivalent) lamps connected is 27,531, bringing the total up to 722,424. This number would have been very considerably increased if it had not been for the restrictions enforced during the year: a large number of lamps are awaiting connection. In spite of the restrictions on the connection of radiators, the number of units sold for heating and cooking increased from 899,585 to 1,129,754

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(25·58 per cent.), due in a great measure to the number of people who keep their radiators all the year round, and find them so useful in the damp summer months. The effects of the war upon the working results of the power department have been less than anticipated, the number of motors connected and the resultant horse-power showing increases of 18 and 16 per cent. respectively, compared with the previous year. The net total motors connected during 1917 was 230, of 3,194·9 H.P., making the total number of motors connected 1,527, of 23,338·25 H.P., of which 423 motors (of 9,471 H.P.) are on hire. The larger power installations dealt with during the year include two cotton and two oil mills, and the local potassium chlorate company. The following is a schedule of industries operated by electric power derived from the Council's undertaking, with the approximate horse-power utilised in each industry :—

Chemical plants	418	Oil milling	783
Construction (building)	193	Printing	1,023
Cigarette manufacture	142	Rice milling	1,455
Cotton manufacture	12,017	Saw mills	728
Engineering	660	Silk winding	23
Flour milling	2,719	Tea polishing	151
Ice and cold storage	322	Sundry industries	1,814
Lifts	888		

The year's net profit was £58,739, after meeting all capital charges and writing off £48,470 for depreciation. The estimated profit was £38,725, the increase being accounted for by interest charges (£11,197) being less than allowed for and by the additional sale of 7,000,000 units. The estimated profit for 1918 is £54,165. Interest to the extent of £51,749 is allowed for and £56,251 for depreciation. The four new trunk mains between Riverside and Fearon-road have been completed and are in use at 6,600 volts. They cannot be used at present at their designed pressure of 22,000 volts owing to the impossibility of taking any plant out of Fearon-road station to make room for the necessary step-down transformers, until more plant has been put into commission at Riverside. The new switch and transformer house has been completed and most of the switchgear delivered. The new pump house is nearly completed, but the pumps have not yet been shipped. Two of the new boilers have been erected. A large amount of boiler material has been delivered, but, unfortunately, a good deal of the material has been lost at sea : four more boilers can be erected during the year. The new buildings are nearly completed and the overhead coal bunkers have been erected. The plant most urgently required at present time is the 5,000 kw. Fraser & Chalmers' set and the circulating pumps for condensing purposes, which are being made by Mather & Platt. A large consignment of the coal conveyor gear for the new boiler house ordered from Messrs. Fraser & Chalmers is now being delivered.

Parliamentary Intelligence.

SHROPSHIRE, &c., ELECTRIC POWER BILL.

The Bill promoted by the Shropshire, Worcestershire and Staffordshire Electric Power Co. (as amended by the House of Lords) was considered by the Private Bill Committee of the House of Commons last week.

Mr. HONORATUS LLOYD, K.C. (for the promoters), said the Bill would enable the company to supply a very pressing need. At present in the Black Country there was an enormous demand for electric power, and the existing stations were full loaded. They proposed to set up a new generating station at Stourport, close to the Great Western Railway, and having a junction with the railway coming right on to the site. They would also get a frontage to the River Severn and to a canal system. A large station of that kind would not be carried on without creating some amount of nuisance to surrounding occupiers, but the works were necessary, and he hoped the Committee would not accede to the opponents' claim that they should be liable to indictment for any nuisance created.

Mr. W. L. MADGEN said the company had been pressed by the Ministry of Munitions from time to time to provide further power. The Ministry had given them every possible facility to enable them to produce as much electricity as possible.

Mr. C. P. SPARKES, consulting engineer, said that no better site could possibly have been selected for the generating station. It was the site selected or nothing so far as the company was concerned. The site was not a desirable residential district. If the Committee inserted the nuisance clause he would strongly advise the promoters to drop the Bill. The greater part of the ground surrounding the generating station would be used for coal storage : the company expected to use about 1,000 tons of coal a day.

On Tuesday the Committee approved the preamble of the Bill.

Legal Intelligence.

Horrox v. Leeds Corporation.

At Leeds Assizes last week before Mr. Justice Bailhache and a jury, plaintiff sought to recover damages for personal injuries and for damage to a motor wagon alleged to have been caused by a Corporation tramcar. Evidence was given that plaintiff was driving the motor-wagon out of a side street into Burley-road, when the vehicle was run into and damaged by a tramcar, which was being driven negligently and at an excessive speed.

The defence was that plaintiff was responsible for the accident, and the Corporation counter-claimed for five guineas, damages to the tramcar. It was urged that the plaintiff should have exercised more care in entering a busy street, and that if she had kept an ordinary look-out she could have seen the approaching car and avoided the collision.

His LORDSHIP, in summing up, said that traffic going along a main thoroughfare like Burley-road had precedence over that emerging from a side street, but the main road traffic must be conducted with care.

The jury returned a verdict for plaintiff, assessing the damages at £250, and judgment was entered for this sum accordingly.

Isaacs v. Hobhouse.

On Tuesday Mr. Justice Darling and a special jury commenced the hearing of an action by Mr. Godfrey C. Isaacs for damages from Sir Chas. H. E. Hobhouse for an alleged libel in reference to the Marconi Contract for the equipment of an Imperial chain of wireless telegraph stations.

Counsel for plaintiff made his opening statement on Tuesday and Wednesday, and a report of the case will be given in our next issue.

Patent Record.

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

June 7, 1918.

9,360 McEVOY. Automatic telephone exchange.
9,363 HAMNETT. Electric horns.
9,399 HEATH. Connection of electric wires to magnetos, &c.
9,400 HELLYAR. Electric connections.
9,419 BREEDEN & LUCAS. Electric switches.
9,430 ATELIERS SOC. ANON. & H. CUENOD. Electrical installation systems. (21/6/17, Switzerland.)

June 8, 1918.

9,453 WATSON. Internal electric heating element for liquids.
9,454 FULLER ACCUMULATOR CO. & WELCH. Electric safety lamps.
9,469 MORGAN CRUCIBLE CO. & SPEIRS. Electrically heated crucibles, &c.

June 10, 1918.

9,525 MARTIRE. Ignition magneto switches for internal combustion engines. (8/6/17 Italy.)
9,495 JAMES. Controlling means for electromagetic feed reel brakes.

June 11, 1918.

9,562 FRIENDLY. Telephone systems.
9,578 GHIJSEN, & VITRITE WORKS. Manufacture, &c., of contact plates in Swan lamp bases.
9,579 GIBBONS. Re-energisation of luminous paint by means of electric torch.
9,582 DRAKE & GORHAM. Lamp holders.
9,592 EWBANK. Controlling power transmission.
9,601 IMRAY. (R. Bosch Akt. Ges.) Regulating device for electrica lmachines.

June 12, 1918.

9,620 KEAN. Electro-dynamical devices for purification of oil.
9,622 ROGERS. Electrolytic apparatus.
9,628 TACKER. Switches.
9,642 TAGGART. Instrument for measurement of capacity and calibration of electrical condensers.
9,651 LAMKIN. Magnetos.
9,678 EDISON ACCUMULATORS (LTD.), MONNET & LEWIS. Switches.

June 13, 1918.

9,735 B.T.-H. Co. (G.E. Co.) Switches.
9,740 VANDERVELL & Co. Ignition systems.
9,745 ROMAIN. Frequency meters.
9,750 & 9,751 BRITISH WESTINGHOUSE ELECTRIC & MFG. Co. Motor control. (13/6/17, U.S.)
9,754 N. Y. DE NEDERLANDSCHE THERMO-TELEPHOON MAATSCHAPPIJ & LYNDEN. Telephones or micro-telephones.

June 14, 1918.

9,773 STIRK. Solenoids.
9,791 KNIGHT. Electrically operating reciprocating tools.
9,822 MORGAN CRUCIBLE CO. & SPEIRS. Crucibles for electric furnaces.
9,828 COX (H. W.) & Co. & STENNING. Vibrating switches for induction coils, &c.
9,829 COX (H. W.) & Co. & STENNING. Adjustable contact screws for contact breakers, &c.
9,831 COLLETTE. Generators and motors.
9,836 BROWN. Utilisation of high-frequency oscillations in wireless installations.

June 15, 1918.

9,871 SUCHOSTAWER. Magneto motor.
9,872 NIX. Inductor magnetos.
9,887 B.T.-H. Co. (G.E. Co.) Glass bulb cutting machines.
9,898 BREEDEN & LUCAS. Accumulators.
9,901 FORSTER. Electric furnace.
9,906 HARROP. Portable electric batteries or cells.

June 17, 1918.

9,915 CARRARD, RAILING & SEARLE. Switches.
9,916 BEIN. Contact devices.
9,918 HURST & MCBROOM. Ignition plugs.
9,938 BULLOCK. High-tension magneto electric machine.
9,943 B.T.-H. Co. (G.E. Co.) Circuit-breakers.
9,959 BROWN, BOVERI ET CIE. Electric ignition apparatus. (16/6/17, Germany.)
9,965 MATHE. Electric traction.
9,970 PHILIPS-BRINTON CO. Electric condensers. (20/7/17, U.S.)

June 18, 1918.

10,007 LEA. Continuous electromagnetic wave syntonisers.
10,025 BINETTI & ROTA. Concentration of electric waves upon a fixed point.
10,031 PETO. Storage batteries.
10,033 MEAD. Recording machines for wireless, &c., telegraphs.
10,037 GUASTAVINO & SIGNORINI. Service installations.
10,049 B.T.-H. Co. & WEDMORE. Reverse current electric devices of the Wheatstone relay type.
10,059 LANGUEPIN. Electrode for electric arc welding.
10,075 BIBBY. Transformation of three-phase current to two-phase, and vice versa.

June 19, 1918.

10,081 FERGUSON, PAILIN & Co. Oil switches.
10,093 LONGWORTH. Fire alarm.
10,099 AUTOMATIC TELEPHONE & MFG. Co., HARRISON & SMITH. Telegraph systems.
10,104 BRITISH WESTINGHOUSE ELECTRIC & MFG. Co. Differential relays. (19/6/17 U.S.)
10,105 MORTON. Electric welding.

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10,108 WESTERN ELECTRIC CO. Automatic telephone exchange systems.
10,119 B.T.-H. CO. & WEDMORE. Reactances.
10,120 B.T.-H. CO. (G.E. Co.) Motor control.
10,126 VICKERS (LTD.) & FIELD. Dynamo-electric machines.
10,131 BOLDORONI & REVEL. Electric steam generators.

June 20, 1918.

10,160 FERGUSON, PAILIN & CO. Oil switches.
10,183 WHITE. (Industrial Electric Furnace Co.) Electric furnaces.
10,187 ZORZI. Battery electrode of tapering cellular elements.
10,188 REBORA. Eletro-mechanical arrangement for distant working of searchlights, &c
10,201 B.T.-H. CO. (G.E. Co.) Multiple filament lamps.
10,205 EAST STRATFORD WORKS & JENKINS. Electrolytic cells.
10,212 ELECTRICAL IMPROVEMENTS (LTD.), BEARD & STIGENT. Transformers.

June 21, 1918.

10,229 SCHATTNER & WALTON. Motor control and switchgear.
10,256 B.T.-H. CO. (G.E. Co.) Power transmission.
10,286 MURPHY. Generators of electric oscillations.
10,289 & 10,290 W. H. ECCLES & JORDAN. Ionic relays.

June 22, 1918.

10,306 AUTOMATIC TELEPHONE MFG. CO. & REMINGTON. Signalling systems for mines &c.
10,309 CAMPION. Director of X-ray of normal incidence.
10,331 LUND & LAWERENTZ AKTIESELSKAB. Automatic switches. (23/6/17. Denmark.)
10,348 & 10,349 COODMAN. Electric condensers.

June 24, 1918.

10,374 DRAKE & GORHAM & BARBER. Lampholders and switches.
10,380 B.T.-H. CO. (G.E. Co.) Electric time limit devices.
10,382 WESTERN ELECTRIC CO. High-frequency signalling.
10,388 GREENHILL. Accumulator containers and material therefor.
10,408 FOREMAN. Sparking plug electrodes.
10,412 BINYON. Electromagnetic wave transmission.

June 25, 1918.

10,[illegible] PATTERSON. Electrical heating and cooking apparatus.
10,418 PATTERSON. Electrical cigar, cigarette and pipe lighters.
10,448 SUCHOSTAWER. Magneto motor.
10,453 ELEKTRO-OSMOSE A.G. (Graf Schwerin Ges.) Charging material to electro-osmotic apparatus for removing liquids from substances. (20/10/17. Germany.)
10,454 ELEKTRO-OSMOSE A.G. (Graf Schwerin Ges.) Electrodes for electro-osmotic processes. (20/10/17. Germany.)
10,455 ELEKTRO-OSMOSA A.G. (Graf Schwerin Ges.) Electro-osmotic processes for removing water from materials. (20/10/17. Germany.)
10,456, 10,457, 10,458, 10,459 & 10,460 ELEKTRO-OSMOSE A.G. (Graf Schwerin Ges.) Apparatus for electro-osmotically removing water. (20/12/17. Germany.)
10,462 KAWAKITA. Electrically indicating depth of sea water.
10,466 COOKE. Electric contact breakers.
10,467 HOLLISTIR. Electric ignition devices.
10,477 N. V. DE NEDERLANDSCHE THERMO-TELEPHON MAATSCHAPPIJ. Wireless telegraphy or telephony. (12/7/17. Germany.)
10,488 QUEAD (LTD.) & MACDONOGH. Electrical resistances.

June 26, 1918.

10,491 LOWENTHAL. Electro-deposition of zinc and nickel.
10,500 COLSON. Locking incandescent lamps in holders.
10,526 JENSEN & PRIDHAM. Telephonically transmitting speech.
10,531 SUMITOMO CHUKOSHO. Magnet steel. (15/5/17, Japan.)
10,548 GAMBS. Electric generator for motor vehicles. (2/7/17. France.)
10,550 DININ. Ensuring liquid-tight passage for connections of accumulators with celluloid containers. (25/7/17. France.)

June 27, 1918.

10,577 RHODES MOTORS (LTD.) & FIELDEN. Single-phase commutator motors.
10,601 TAYLOR. Removing and replacing lamp globes, &c.
10,626 VICKERS (LTD.) & BARCLAY. Dynamo-electrical machines.
10,630 CREED & CO. & CARPENTER. Production of h.t. electrical discharges.

June 28, 1918.

10,650 GAMBLE. Removing trollies from overhead wires.
10,654 GOLDSTONE. Electro-magnets.
10,658 C.I. SYNDICATE & JENKINS. Electrolytic cells.
10,665 LANCASTER. Devices for suspending electric lamps.
10,687 PATELSKI. Electric railway systems.
10,702 WESTERN ELECTRIC CO. Modulating means for high-frequency oscillations.
10,714 VAUGHAN. Direction finders, &c., for wireless signalling.
10,717 MARCONI'S W.T. CO. & FRANKLIN. Receivers for wireless telegraphy.
10,671 MASTERS. Improvements in telephones, wireless receivers and transmitters.
10,676 SCHNEIDER ET CIE. Electrical apparatus for indicating and repeating movements at a distance. (13/2/18. France.)

June 29, 1918.

10,730 NICHOLLS. Caps or holders for electrical fuses.
10,747 KAULBACK. Dynamo-electrical machines.
10,760 BELLING. Electric ovens.
10,769 TYER & CO. & LEAKE. Electromagnetic relay for railway signalling, &c.
10,771 TRABACCHI. Obtaining h.t. one-direction currents from three-phase currents.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES' VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain of the Week.—Capt. W. Darley Bentley.

Next for Duty.—Capt. E. G. Fleming.

Sunday, July 21.—Commandant's Parade at Waterloo Station 8.45 a.m. for work at Esher. Dress: Drill Order with Haversacks and Water-bottles. Mid-day and tea rations to be carried.

Monday, July 22.—Adjutant's Technical Lecture (Earthworks), 6.30-7.30.

Thursday, July 25.—General Meeting of the whole Corps, 6.30.

Friday, July 26.—Adjutant's Technical Lecture (Earthworks), 6.30-7.30.

Saturday, July 27.—Engineering Reconnaissance Scheme for Officers at Esher.

SPECIAL NOTICES.—All drills will take place at headquarters unless otherwise stated.

The medical officer will attend for the examination of recruits on Thursday evening at 6.30.

ANNUAL CAMP.—This camp will be held at Esher from Aug. 3 to Aug. 11, both dates inclusive. During this period headquarters will be transferred to Sandown Park, Esher.

Commercial Topics.

Increased Tramway and Lighting Charges.

On Monday a private meeting of representatives of public gas, electricity, tramways and water undertakings was held at Caxton Hall, Westminster, to consider the proposals of the Statutory Undertakings (Temporary Increase of Charges) Bill.

The general opinion was that the proposals contained in the Bill were wholly inadequate to meet the case. Companies could not fulfil their obligations to the public unless they were empowered to pay a sufficient rate of interest to attract the necessary capital, and so raise money for the important developments which would be necessary to the country after the war.

* * * *

A Manufacturers' Council.

The Federation of British Industries, the British Empire Producers' Organisation and the Imperial Council of Commerce have agreed to form a joint council for the following purposes:—

To consider and report upon questions of mutual interest reflecting the common aims of the three bodies—viz., to ensure the conservation and development of the industry, production and commerce of the United Kingdom and her Overseas Dominions, and submitted by any one of the three constituent bodies; to initiate the consideration of any such subject; and to take any action in relation to such subjects that may be specially authorised by the constituent bodies.

* * * *

Industrial Reconstruction Council Lectures.

An important series of lectures is announced by the Industrial Reconstruction Council for the autumn and winter.

The first lecture will be given on Oct. 2 by the President of the Board of Trade, with Mr. G. N. Barnes, M.P., in the chair. Other lectures will follow at fortnightly intervals, the second being delivered by the Minister of Reconstruction. Mr. W. L. Hichens, Sir Arthur Steel-Maitland, Bart., M.P., Mr. Ernest J. P. Benn and Sir William S. McCormick, will carry the series up to Christmas. The lectures will be held at the Saddlers' Hall, Cheapside, at 4.30 p.m. A full prospectus of the series can be obtained from the secretary, I.R.C., 2 and 4, Tudor-street, E.C. 4.

* * * *

U.S.A. Census of Electrical Manufactures.

The Bureau of the Census of the Department of Commerce recently published a report for 1914 on the manufacture of machinery apparatus and supplies for use in generation, transmission or utilisation of electrical energy. A number of interesting tables are included in the report.

In addition to dynamos, transformers, switchboards, motors and batteries for its generation, regulation, application and storage, the general utilisation of electric energy for supplying power, transportation, light, heat, intelligence, &c., involves the use of a vast variety of electrical manufactures, such as insulated wire and cables, starting and controlling apparatus, electric measuring instruments, telephone and telegraph apparatus, incandescent and arc lamps, electric heating and cooking apparatus, therapeutic apparatus, &c., but the manufacture of poles, glass and porcelain ware, copper wire drawing, and the production of electrochemical and electrometallurgical products, are excluded.

	Number or amount.		
	1914.	1909.	1904.
Number of establishments .	1,030	1,009	784
Persons engaged.....	144,712	105,600	71,485
Wage earners (av. number).	118,078	87,256	60,466
Primary horse-power.....	227,731	158,768	105,376
Capital	$355,724,756	$267,844,432	$174,066,026
Salaries	35,291,281	20,193,395	11,090,885
Wages	73,806,329	49,381,145	31,841,521
Cost of materials	154,728,076	108,566,404	66,836,926
Value of products	335,170,194	221,308,563	14 ,809,369
Value added by manufacture	180,442,118	112,742,159	73,972,443

The table summarises the statistics of establishments engaged in the manufacture of electrical machinery, apparatus and supplies for each census from 1889 to 1914, and gives percentages of increase. Electrical apparatus first appeared among the classified industries in 1850, when two establishments, engaged primarily in the manufacture of electro-magnetic instruments, were reported with products valued at $5,100. In 1860 there were four establishments with products valued at $59,000, but in the census of 1870, which covered the year 1869, the industry was not separately reported. In the census of 1879 there were 76 establishments reported as engaged in the manufacture of electrical apparatus and supplies, including telegraph and telephone apparatus. These establishments gave employment to 1,271 wage earners, and their products were valued at $2,655,036. The decrease in proprietors and firm members for 1914 compared with 1909 is in keeping with the tendency to incorporate the business of firms and individuals. Although in most items the per cent. of increase for 1909-1914 is less than that for 1904-1909, on account of the larger base on which the former is computed, the actual gains for 1914 as compared with 1909 for every item, except number of establishments, proprietors and firm members, capital and contract work, exceed the gains for any prior five-year period.

The more important statistics of the industry, by states, arranged according to the value of products reported for 1914, are given in a table. Although establishments engaged in the manufacture of one or more

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of the various classes of products embraced in this industry were reported from 33 states and the District of Columbia in 1914, the industry was largely centralised, as in 1909, in the six states of New York, Illinois, Pennsylvania, Massachusetts, New Jersey and Ohio. These states reported 84·1 per cent. of the total average number of wage earners, 85 per cent. of the total value of products, and 85·5 per cent. of the total value added by manufacture. Pennsylvania ranked second in 1909, but third in 1914. Illinois advanced from fifth to second place. New Jersey ranked third in 1909 but fifth in 1914, and Massachusetts was fourth at both censuses. New York was the leading state in the industry, ranking first at the censuses of 1914, 1909 and 1904. During 1914 the state produced electrical machinery, apparatus and supplies to the value of nearly $74,000,000, or more than one-fifth of the total for the United States. Illinois showed the most conspicuous gains among the six leading states. The average number of wage earners increased by 6,842, or 71 per cent., and the value added by manufacture, $13,090,000, or 99·2 per cent.

Establishments owned by corporations constituted 73·1 per cent. of the total number of establishments reported, and the value of their products represented 97·4 per cent. of the total value in 1914, 96·3 per cent. in 1909, and 95 per cent. in 1904. In 1914, 97·5 per cent. of the total number of wage earners were employed in establishments owned by corporations, 1·9 per cent. in those under individual ownership, and but six-tenths of 1 per cent. in those under other forms of ownership, chiefly firms. The tendency of the industry is to become concentrated in large establishments. Establishments with products valued at $1,000,000 and over were the only class which increased in every particular not only as to actual numbers and amounts but in the percentages which these formed of the totals for the industry. Of the 1,030 establishments reported for 1914, 53 manufactured products valued at $1,000,000 or over. In 1909 there were 31 establishments of this class out of a total of 1,009; and in 1904, 22 out of 784. The average value of products per establishment increased from $179,604 in 1904 to $219,335 in 1909, and to $325,408 in 1914, and the average value added by manufacture from $94,353 in 1904 to $111,737 in 1909, and to $175,186 in 1914.

Electricity Supply.

General.

Accrington.—The Council has agreed to supply Messrs. Lang Bridge (Ltd.) with 250,000 units of electric current per annum.

Birr (Ireland).—The Urban Council will carry out an electric supply scheme.

Water-power facilities were granted by the late Earl of Rosse, and it is therefore proposed to put down hydro-electric plant.

Bury St. Edmunds.—The Electric Supply Committee is considering an application for the extension of the electric supply mains to the railway station.

Carmarthen.—The Council has consented to the local electric supply company's proposal to increase the price of electric current from 5d. to 6d. per unit.

Ipswich.—The surplus on the past year's working of the electricity undertaking was £2,174, of which £473 has been applied to the liquidation of the adverse balance brought forward from previous year, £118 applied to capital expenditure and £1,583 transferred to reserve.

Nottingham.—On the past year's working of the electricity department the gross profit was £5,274 and net profit £1,012. The output of current increased by 63 per cent.

Sheffield.—At the meeting last week the Corporation considered an interesting report of the engineer and general manager of the electric supply department (Mr. S. Edgar Fedden) an the question of the "possibility of enabling occupiers of all classes of houses in the city to be supplied with electricity for lighting purposes."

In the report Mr. Fedden pointed out that for many years past endeavours had been made to extend the use of electricity in the smaller houses, and certain experiments in that direction had from time to time been made. In the case of new houses under construction to let at rentals of £25 and over it had become the general practice for the builders to instal the necessary wiring (in some cases to the exclusion of gas), but in very many instances in addition to gas, thus leaving the tenant freedom of choice as to whether he should purchase electric light or gas fittings. The fact of the prospective tenant already owning the gas fittings in use at his previous residence often influenced the decision in favour of gas, but it seemed to be established that where the benefits of electricity had once been experienced there was a reluctance to revert to the use of gas. In houses already occupied and fitted with gas, the cost of wiring was rarely undertaken by the landlord, and the tenant was naturally averse to incurring the necessary expenditure, particularly when the house was held on short notice, as in the event of removing to an unwired house the whole expense had to be incurred again, only the actual fittings being tenant's fixtures and removable by him. It appeared inevitable that for the present the wiring of occupied houses must be paid for by the tenant, and in the case of the lower rented houses it appeared unreasonable to expect the tenant directly to undertake that responsibility and expense. After dealing with various difficulties in connection with the supply of electricity to small houses, Mr. Fedden comes to the following conclusion: "On financial grounds, I think the scope must, for the present, be limited to suitable areas where the supply mains are now laid, or within reasonable access. I recognise that the subject is important on the question of health, cleanliness and convenience, and I shall be pleased to bring before the Committee, as an after-the-war measure, the most practicable and modern scheme dealing with this subject.

Stockton-on-Tees.—The Lighting Committee is to consider a scheme of the borough electrical engineer (Mr. J. J. Smith) for providing a supply of three-phase current from a sub-station in the borough.

Mr. Smith reports inquiries from three different parts of the town, and it became necessary to make a decision that wherever it was possible, all future demands of moderate proportions should be three-phase current, because eventually that change would have to be made, and the longer it was delayed the greater would be the dislocation, and probably the greater the cost. Power should, therefore, be obtained to lay down a three-phase supply and to make provision for the reasonable power requirements of the district, as by that means only the electric supply committee would be able to keep the distribution of electricity in their own hands. The Corporation should be able to buy from the owners of the large super-station in the district electricity at a rate which would admit of them distributing the same in their area at a reasonable profit over and above the cost of distribution. In regard to one of the prospective consumers, Mr. Smith suggested that an extra high tension three-phase 11,000 volt main be run from the sub-station to the works, and that it be laid along a certain route; but a modified scheme was also submitted. The preliminary estimate of the full scheme is £10,150, the total cost to the Corporation being £8,400; and of the second, £6,495, the cost to the Corporation being £4,745.

Stratford-on-Avon.—At last week's meeting the Council decided not to sanction any further increase in the charges of the Stratford-on-Avon Electricity Co.

At the same meeting the Council approved increases in the Corporation's charges for gas, meter rents, &c.

Wages in South Wales.—The Executive Committee of the South Wales and Monmouthshire Municipal Wages Board recommend that the applications from men in the electric and gas departments for a 12½ per cent. increase be granted.

Worcester.—The Council has increased the salary of the city electrical engineer (Mr. C. M. Shaw) by £100 a year, with two further annual increases of £50 in 1919 and 1920.

Electric Traction.

Edinburgh.—The following four candidates for the position of manager of the city tramways have been selected by the Tramways Committee:—

Messrs. William Clough (Bury), Wm. J. M'Combe (Hull), R. Stuart Pilcher (Aberdeen), and R. H. Wilkinson (Huddersfield). The matter was referred to a sub-committee to select two for final interview.

L.C.C. Tramways.—The introduction of women tramcar drivers has been delayed by negotiations between the Ministry of National Service and the Trade Union concerned.

Sheffield.—The Board of Trade has extended for one year from Feb. 14, 1918, the periods limited for the construction of certain tramway authorised by the Sheffield Corporation (Tramways) Acts, 1907 and 1912.

Tramway Workers' Wages.—By the new award on the demand of the tramway and omnibus workers for a 12½ per cent. increase, the war bonus of £1 a week is increased to 25s. a week.

In regard to women, it was stated on behalf of the employers at the hearing that they accepted the principle that in cases in which women are doing the same work as men, and doing it as efficiently, and provided their employment does not involve increased expenditure compared with the employment of men, they should be paid the same wages as men. They showed, however, that in the case of tramway and motor-omnibus undertakings a large number of women employees stay only a comparatively short time, and their attendance is less regular than that of men, necessitating the keeping of a large spare staff, which adds to the cost of employing women. Therefore, the claim that the award of March 8, 1918, should be revised so as to provide equal payment to women and men both as regards war wages and basic rates has not been established.

The result of the arbitration on the Liverpoool tramway emplyees' wages question is a 5s. increase to the men and nothing to the women.

Imperial Notes.

Hydro-Electric Power in India.—The Secretary of State for India (Mr. Montagu) recently announced that the Government of India would constitute a small committee of electrical, mechanical and irrigation experts to visit the different provinces, and (after conference with the local officers) to examine promising sites and to report

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whether a detailed water-power survey is worth undertaking. The local Governments are being asked to collect information in advance, in order to facilitate the committee's investigations.

Mr. E. Batchelor, I.C.S., has written three pamphlets containing suggestions for developing the resources of the Central Provinces. Amongst the proposals is one for combined water works and hydro-electric works at Chikalda, from which electrical energy would be supplied at 1½ annas (1½d.) per unit. In a pamphlet on "The Silewani-Ghat hydro-electric power project in the Chindwara District," the value of cheap power in the manufacture of aluminium and ferro-manganese, for spinning and weaving and for lighting, heating and driving machines in small factories, is clearly pointed out. There are large deposits of bauxite in the Jubbulpore and Balaghat districts. Mr. Batchelor estimates that 5 kw.-years of power are required to produce 1 ton of aluminium from about 2 tons of pure alumina, and that current could be supplied at 0·2 anna per unit for this purpose. He estimates that 1 kw.-year will smelt about 4 tons of manganese ore, and produce 2 tons of ferro-manganese from 50 per cent. ore at a cost of Rs. 55 at 0·1 anna per unit. In regard to spinning and weaving, the author states that the furthest town is 318 miles from the proposed power-station, there are only four towns at a greater distance than 200 miles, 18 towns between 100 and 200 miles and 19 less than 100 miles. With transmission up to 100 miles power could be sold for less than ½ anna per unit, and current for lighting, heating and small factories, could be sold at 2½ annas per unit and give a profit of 10 per cent. For pumping water the charge for electric power would be 2 annas per unit. Pipe lines, plant, land, &c., bring the total capital cost up to Rs. 3,27,93,740 (£2,186,249), for a scheme capable of developing 70,000 kw. continuously.

Niagara Water Power.—The Ontario Government has issued an order authorising the generation of 150,000 H.P. at Nepigon, New Ontario, in order to supply power for developing the mineral resources of the district.

The Ontario Government has also authorised an increase in the electrical equipment at Niagara Falls to the amount of £100,000, and the development of 300,000 H.P. on the Rideau and St. Lawrence rivers.

Sir Adam Beck, chairman of the Hydro Commission, has telegraphed to the chairman of the Power Committee of the House of Representatives at Washington that the Commission could supply the American side with 200,000 H.P. by the autumn of 1919, increasing by 30,000 H.P. a month until the maximum 300,000 H.P. was reached. It is hoped to have available in five years 2,250,000 H.P., stated by Sir Adam Beck to be equivalent to 50,000,000 tons of anthracite coal.

Foreign Notes.

Electric Furnace Progress in Italy.—According to "La Metallurgia Italiana," there were 187 electric furnaces in operation in Italy at the end of 1917.

The following types of furnace were in use: Angelini 22, Ansaldo 1, Bassanesi and Stassano-Bassanesi 40, Catani 2, Girod, 4, Héroult 14, Keller 10, Kjellin, 1, Iloa, 3, Sopranzi 1, Stassano 26, Tofani 5, and unnamed 58. Some furnaces are of 8 to 15 tons, many 3 to 5 tons, but the majority are of between 1 and 2 tons capacity.

Norway.—Financial statistics show that during the period 1897-1915 the number of industrial plants increased from 9,422 to 15,754, or 67 per cent.

During the same period the horse-power, both steam and electric, increased from 172,396 to 1,261,205, about 632 per cent. From 1900 to 1915 the number of electric motors increased from 391 to 18,313, and the horse-power roughly from 3,900 to 243,000.

Standardisation in France.—A Decree has been issued providing for the creation of a permanent Standardisation Committee, attached to the Ministry of Commerce.

The Committee, which will study measures necessary to ensure standardisation of mechanical and metallurgical construction, will consist of representatives from the Ministries of War, Commerce, Munitions, Marine, Public Works, Blockade, Colonies, Labour, Commerce, the Academy of Sciences, the consulting Committee of Arts and Manufactures, the Society for the Encouragement of National Industry, the Society of Civil Engineers, the Society of Electricians and the Society of Mineral Industry.

U.S.A. Telegraphs and Telephones.—The Senate has passed the measure giving the Government control of the telegraphs and telephones during the war.

Miscellaneous.

Alien Enemy Patents.—In the House of Commons on Thursday last, the Home Secretary (Sir Geo. Cave) announced that no further applications by enemy aliens for patents would be received. Those received during and prior to the war had been vested in the Public Trustee.

The Board of Trade have now revoked the general licenses of Dec. 7, 1915, and Sept. 5, 1917, under which, subject to certain conditions the payment was permitted of fees, &c., due in enemy countries in respect of the grant, registration, or renewal of patents, designs and trade marks, and also the payment in his Majesty's Dominions and Allied territory on behalf of enemies of similar fees, &c., in respect of such industrial property. All such payments are consequently prohibited in future.

County of London Royal Engineer Volunteers.—We have received a neat booklet describing the work of the London Army Troops Companies of the County of London R.E. Volunteers and it should assist in the recruiting necessary to bring the Corps up to full strength, which, we are informed, it is desired to do as quickly as possible. The headquarters are at Balderton-street, Oxford-street, W. 1.

Fraudulent Use of Electricity.—At Wallasey Police Court recently Albert Middleton pleaded to having fraudulently consumed Corporation electric current.

Mr. LIVSEY (Deputy Town Clerk), who prosecuted, said defendant had occupied certain premises since August, but he had only been taking electricity for three weeks. He had connected his sitting-room and workroom with the main wires left in by the previous tenant.

Defendant said he had accidentally discovered that the terminals were alive and he yielded to the temptation.

He was fined £10, or 21 days imprisonment

Inquest.—An adjourned inquest was held at Bradford last week on Wm. Hy. Kershaw, who was killed at Messrs. Thwaites Bros. on the 30th ult.

Evidence was given that deceased, who was at work in the transformer sub-station at the firm's works, went to test the high-tension cubicle. In order to discover a fault he went to the wheel switch, but it would not move. He then went to the back, unscrewed a steel plate, and entered, but immediately there was a sudden flash, every lamp going out. When Kershaw was extricated he was dead, his body being badly burned.

Mr. A. RYAN, electrical engineer at the works, said it was not the duty of Kershaw to remove the back plate of the cubicle.

A verdict of "Accidental death" was returned.

London Munition Workers' Sports.—In connection with this sports meeting, which will be held on the Herne Hill track on the 27th inst. at 3 p.m., a very varied programme has been arranged, including four handicap events, eight scratch races and several novelty items. Of the last named, the ladies' tug-of-war should be worth seeing. Particulars from the Hon. Sports Secretary, 24, Great Russell-street, W.C. 1.

Educational.

University of London.—The following awards have been made in the Faculty of Engineering at University College:—

Archibald P. Head Medal and Prize, W. G. Heatly. Engineering Diplomas: Mechanical, M. Bindler, Civil and Municipal, F. Gutierrez (Special), W. G. Heatly (Distinction) and J. Leech.

A Goldsmid Entrance Scholarship tenable in the Faculty of Engineering at University College, value £30 a year for three years, may be awarded in September. Entry forms must be in by Sept. 10.

G. E. C. Apprenticeship Scheme.—The London County Council has agreed to co operate with the General Electric Co. in an apprenticeship scheme.

The Company will select yearly about 12 apprentices from boys between 15½ and 17 years of age, who are specially recommended by the principals of evening institutes, or by the headmasters of secondary or central schools, or have passed the London matriculation, or an equivalent examination. The Company will allow the apprentices facilities for attendance at evening classes on three nights a week for three years.

Manchester College of Technology.—The 1918-1919 session begins on Oct. 3. The matriculation and entrance examinations will be held in July and September, and matriculated students may enrol from Aug. 1.

There are complete courses in mechanical, electrical and sanitary engineering, the chemical and textile industries, mining, architecture, &c. The college possesses well equipped laboratories and workshops for demonstration and original research. Particulars of university course or of part-time courses may be obtained from the Principal.

Tenders Invited and Accepted.

Carbon Filament Lamps.

The COMMISSIONERS of H.M. WORKS, &C., invite tenders (until 11 a.m. of July 30) for the supply of carbon filament tubular lamps. Forms of tender from the Controller of Supplies, King Charles-street, Westminster, S.W. 1. *See an advertisement.*

Turbo-Alternators, Water-tube Boilers, Economisers, &c.

BELFAST Corporation invite tenders for the manufacture and erection of two 6,000 kw. Turbo-alternators and one 30 kw. Balancer Booster; four Water-tube Boilers, Fuel Economiser, &c.; two steel Chimneys with Fans; two electrically-driven boiler-feed Pumps, Accumulators; three 500 kw. and five 1,000 kw. Rotary Converters, with Transformers, &c.; and two 250 k.v.a, two 350 k.v.a. and six 1,250 k.v.a. Static Transformers. Specifications, &c., from the consulting engineers (Messrs. Preece, Cardew, Snell & Rider), 8, Queen Anne's-gate, Westminster, S.W. 1; or, Mr. T. W. Bloxam, M.I.E.E., city electrical engineer, Belfast. Tenders must be lodged at the Town Clerk's office, City Hall, Belfast, by Aug. 16.

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Transformers.

The VICTORIAN RAILWAY COMMISSIONERS invite tenders for the supply of 800 lighting transformers for signal system. (Contract No. 31,597). Specification from the Victorian Railway Commissioners, Spencer-street, Melbourne, to whom tenders by 11 a.m. Sept. 4. A copy of the specification, &c., may be seen at the Department of Overseas Trade, 73, Basinghall-street, London, E.C.

Diesel Engine and Alternator.

GILLINGHAM (Kent) Council require tenders by noon July 22 for supply and erection of a combined 640 B.H.P. Diesel engine and alternator. Particulars from the Borough Electrical Engineer.

Electrical Stores and Materials.

The CHILIAN DEPARTMENT OF MATERIAL require tenders for the supply during 1918 of electrical articles for the Navy and the Talcahuano Naval Dockyard. Tenders to the Director of Material, Valparaiso, by 2.30 p.m. Aug. 13. Specifications from the Department of Material and the Talcahuano Naval Dockyard.

HAMMERSMITH.—The Borough Council has accepted the tender of the Stirling Boiler Co. for a water tube boiler at £4,694. There were five tenders, varying from £3,725 to £6,187.

MAIDSTONE.—The Council have placed an order with the Pirelli-General Cable Works for the supply of 740 yds. of h.t. cable, at £603. There were three other tenders, at £790, £814 and £820. respectively.

Appointments Vacant and Filled.

Senior and junior draughtsmen are required by the City of Birmingham Electric Supply Department for the lay-out of a large electric power station. Applications to the City electrical engineer, Mr. R. A. Chattock, by the 26th inst. *See also an advertisement.*

An assistant railway telegraph engineer is required for the Ceylon Government railway. Salary £400 first and £500 second year, with free passages. Applications to Crown Agents for the Colonies, 4, Millbank, London, S.W. 1. *See an advertisement.*

A technical assistant, with knowledge of switchgear, &c., is required. *See advertisement.*

A designing engineer is wanted by a large electrical firm in Lancashire. *See advertisement.*

An electrical engineer, with knowledge of d.c. machine design, is required by Messrs. Siemens Brothers Dynamo Works, Stafford.

Mr. A. Stonier has been appointed an assistant electrical engineer at Barnstaple at £180, rising by half yearly increments of £5 to £200 per annum.

Business Items.

The new London offices of Messrs. Ferranti Limited are at 180, Fleet-street, E.C. 4. Telephone: "City 7618."

An Electrically-Driven Air Compressor.—Messrs. Gerrard & Co. are agents for a small portable electrically-driven air compressor which is manufactured by the Black & Decker Mfg. Co., of Baltimore, U.S.A.

The appliance, which is known as the "Lectroflater," is so designed that it can be readily converted into a vacuum pump, but it is mainly used for inflating pneumatic tyres, spraying varnish, &c.

Hand-Operated Starting Rheostats.—The British Thomson-Houston Co.'s descriptive list No. 5,100, which has been recently issued, gives particulars of their hand-operated starting rheostats for continuous-current motors.

Mechanical Blast Furnace Charges.—Messrs. Head, Wrightson & Co. are constructing two Wrightson Ringquist mechanical blast furnace chargers for Baldwins (Ltd.) and one for Messrs. Bell Bros.

The charges are guaranteed to carry 20 skips (160 tons) of ore per hour, and the three are electrically driven.

Municipal Accounts.

Barking.—The accounts of the electricity department for the year ended March 31, 1917, show gross capital expenditure £78,218 (increase £11,426), of which £36,282 has been redeemed.

Revenue was £13,898 (compared with £12,663 in previous year), and working and general expenses were £12,063 (£11,216). Interest required £1,610 (£1,132), repayment of principal £3,540 (£2,784) and other charges £293 (£527), the net result being a deficit of £3,609 (£2,997). Total costs were 2·115d. (2·130d.) per unit sold exclusive and 3·070d. (2·974d.) inclusive of capital charges. Units generated were 1,670,740 (1,628,577) and sold 1,368,609 (1,263,944). Total maximum demand was 550 (620) kw.

Carlisle.—The accounts of the electricity supply department for the past year were adopted by the Council last week.

The chairman of the Electricity Committee (Mr. Gibbings) stated that the number of units sold and the income showed an increase over the figures of any previous year, and in spite of increased expenses, the net profit was £1,295, against a loss in the previous year of £196. The undertaking continued to make steady progress, and the cost per unit sold had been reduced to the lowest record of pre-war conditions. The chief increases of expenditure were coal and wages, and he feared they had not yet reached the limit on either of those items. To meet the increased cost they had had to increase the charges 25 per cent. over pre-war rates. The Committee recommended that the net profit be added to the balance, making £7,000 to be carried forward. With regard to the future of electricity, there were large developments looming in the future, and that made it all the more necessary that the undertaking should be placed on a thoroughly sound business footing. In conclusion he expressed the Committee's appreciation of the excellent services rendered by the chief engineer (Mr. Purse) and the staff under most difficult conditions. The successful result of the year's working had only been attained by the strictest economy and closest attention to detail.

Nottingham.—The tramway accounts for the year ended March 31 (adopted by the Council on 3rd inst.) show gross capital expenditure £735,643, of which £220,365 has been paid.

Revenue was £238,867 (compared with £203,155 in previous year), and working expenses were £155,484 (£138,716). Interest required £16,638 (£16,495) and repayment of capital £24,174 (as in previous year, leaving £42,569, of which £16,000 (£10,000) has been contributed in aid of rates and £26,569 (£13,768) carried to reserve. Revenue was 15·18d. (12·94d.) per mile and expenses were 9·88d. (8·44d.). Passengers carried were 52,690,881 (47,480,934) and car-miles run 3,776,275 (3,766,411).

Sheffield.—The accounts of the Corporation tramways department for the year ended March 25 show gross capital expenditure £1,250,495 (increase £14,129), of which £525,042 is repaid or in sinking fund.

Revenue was £601,445 (compared with £525,685 in previous year) and working expenses were £413,729 (£335,765). After providing for war allowances (£11,036), income tax, interest and sinking fund, the net balance was £83,903 (£88,478), of which £36,035 (£34,698) has been placed to renewals fund and £36,121 (£40,097) contributed in aid of rates. Revenue per car mile was 14·632d. (13·058d.) and working expenses, including power, were 10·172d. (8·340d.). Passengers carried were 153,506,213 (142,551,547), car miles run 9,761,994 (9,662,012) and units used 23,209,428 (22,479,225).

Sunderland.—The income of the electricity department for the year ended March 31 was £85,324 and the gross profit £34,123.

After paying £10,513 for interest, the balance was appropriated as follows: £17,816 for repayment of loans, £120 redemption of lands, £3,825 superseded plant, cables, &c., and £668 for depreciation of stock. Revenue contributions to capital outlay amounted to £6,428. Maximum load was 7,400 kw. (6,700 kw.), load factor 26·72 (26·53) per cent. and kelvins sold were 17,320,000 (15,610,000).

Companies' Meetings and Reports.

Callender's Cable & Construction Co. (Ltd.)

The 22nd annual general meeting of this company was held on Thursday, 11th inst., Sir T. O. CALLENDER, J.P. (managing director), presiding, in the absence of Sir Fortescue Flannery through indisposition.

The SECRETARY (Mr. Howard Foulds) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN, in moving the adoption of the report and accounts for the year 1917, said he regretted that these had been unavoidably delayed by reason of the many troubles caused by the war, but he felt sure the shareholders would be satisfied with the report and balance-sheet. Great difficulties had accompanied all engineering work during 1917, and these difficulties had affected all the operations of the company throughout the year, and the result obtained had only been got by much worry and anxiety, hard labour and long hours. While the amount of their output had been very great, he did not think the profit made was really commensurate with the work done, but they were all controlled by Government, and at times were subjected to the heavy hand of those in authority. That had been especially the case in regard to labour. Awards had been given which had been entirely unexpected, and had applied to men and to industries to which evidently they were never originally intended to apply. In addition, awards had been dated back many months, and that had hit them very heavily in some departments. They were endeavouring to pass on these claims to the Ministry, because they held that as the Government imposed upon them certain additional expenses, they (the Government) should bear those expenses when it came to paying for the goods; and though the Government had said they would probably do so, up to the present they had been strangely diffident in regard to parting with the extra money. All the factories in which they were interested had been kept very busy throughout 1917, and the outlook for the current year was also satisfactory. Their foreign work had been greatly hampered since the beginning of the war, but he was pleased to say that they had managed to keep their connections going, and things were getting a little better with regard to sending materials to certain parts of the world. He wished to put on record how much they appreciated the work that had been done by their representatives abroad, especially in India.

While they were busy at the moment, they all recognised that at the end of the war they would have to face entirely new conditions. They

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would have to start again the commercial business which they had built up in the course of many years. While they were making all their arrangements to that end, one point that struck him very forcibly was the difficulty under which they would labour by reason of the Government having taken from them so much of the profit which had been made. They were reduced practically to their old standard of profits, and out of the little surplus remaining they had had to spend large sums on new machinery and various other appliances. Although they were in negotiation with the Government in regard to that, they could not hope to be put into the happy position when peace came of having sufficient funds in their coffers to be able to fight the enemy they certainly would have at their gate. They would have no large reserve to meet the reconstruction of business which had been so much talked about. The various gentlemen who came to London and who discussed what was to be done seemed to forget that there would be some difficulty in reconstructing business when they and companies like them had had all the funds which they might have had for reconstruction purposes taken away for income tax, excess profits duty or munitions levies. German companies in the same line of business as themselves showed immense and apparently liquid reserves ready for immediate use, and which they stated openly were intended to be used in the rehabilitation of German trade in various parts of the world. When peace came it would be necessary to approach the shareholders and ask them to approve of raising further capital. Though they could carry on at present, it would be a very different case when they were again in open competition for ordinary commercial business, and their resources would probably have to be considerably increased; but he felt sure that the assistance of the shareholders would not be found wanting. In order to consolidate their business and prepare for future work in the post-war period, they were making some alterations in their management. He proposed to continue to hold the position of managing director, and the board desired to have Mr. Peterson and Mr. James Callender as managers of the company, while Mr. Charles Pipkin would be brought in as assistant manager. They would probably, as time went on, increase the number of their assistant managers.

The CHAIRMAN then dealt with the items in the directors' report (abstracted in our last issue), and said the figures showed that in the end they were about £4,000 better than last year. The report and accounts were adopted, and it was also resolved to pay a final dividend of 15 per cent., making with the interim dividend of 5 per cent. already paid 20 per cent. for the year, and also a bonus of 5s. per share on the ordinary shares.

At an extraordinary meeting which followed, resolutions were passed approving a scheme for the reorganisation of the capital of the company by capitalising £175,000 of the reserves and issuing to the ordinary shareholders the amount so capitalised in fully-paid ordinary shares. Each ordinary shareholder will receive one fully-paid ordinary shares of £5 for every ordinary £5 share now held. Owing to the decision of the Treasury the subdivision of the shares into £1 shares must be postponed.

ARBROATH ELECTRIC LIGHT & POWER CO. (LTD.)—The report for 1917 states that the quantity of current sold during the year was very satisfactory, but the cost of generation was much higher than formerly. There were a good many applications for current during the year, but Government restrictions precluded their acceptance except in special circumstances. The year's profit was £2,830, and the directors propose a dividend of 5 per cent. (less tax) on the ordinary shares.

BARCELONA TRACTION, LIGHT & POWER CO. (LTD.)—In consequence of the war conditions it will not be possible to resume interest on the bonds on Dec. 1, but a plan is under consideration by the bondholders' committee to pay in cash a portion of the interest, commencing Dec. 1, 1918, with compensating arrangements for deferring payment of the full interest;

BOMBAY ELECTRIC SUPPLY & TRAMWAYS CO. (LTD.)—The total revenue for the past year (including amount represented by sale of current to the tramways) was £439,850—an increase of £66,383 over previous year. The total expenditure was £183,457, increase £26,769. The net receipts were £256,393, increase £39,614. Interest on debentures absorbed £33,821, and after providing for depreciation (£43,333), capital amortisation (£16,340), balance of English excess profits tax for 1915 assessed and paid in 1917 (£2,633), for English excess profits tax for three months to March 31, 1916 (£10,000), Indian super tax (£3,474), and annual contribution to officers' and employees' provident fund (£3,537), the available balance of profit is £143,250, and with amount brought forward (£5,214), the available total is £148,465. The directors recommend payment of the full dividend on the 6 per cent. cumulative preference shares (£35,997) and a dividend (both free from all income tax to shareholders domiciled in India) on ordinary shares at the rate of 10 per cent. per annum and a bonus of 4 per cent. per annum (£100,800) and a bonus of one month's pay to the Company's officers and employees, (£4,900), leaving to be carried forward £6,768.

CROMPTON & CO. (LTD.)—At the meeting on Tuesday the chairman (Mr. C. F. Tufnell) said that the directors were not yet able to issue the accounts for the year ended March, 1917. The business continued to make progress in a satisfactory manner. Compared with the year ended March, 1916, the output from the works for the year ended March, 1918, showed an increase of 98 per cent., while the work in hand at present was more than double the figure at which it stood in March, 1916. The directors had given notice to the debenture holders to repay the £100,000 5½ per cent. first mortgage debentures in September next, when they would increase the issue from £100,000 to £150,000 at 6 per cent. The prospects for the current year were good, and, so far as regarded trading when the war was over, all he need say was this: If trade was good the company would be in a position to profit by it, and if trade was bad—an unlikely contingency, in the opinion of many—he could, at any rate, assure the shareholders that the company's organisation and the arrangements made during the last few years would stand them in very good stead.

EDMUNDSON'S ELECTRICITY CORPN. (LTD.)—After providing for income tax and mortgage and debenture stock charges, the net profit for the year ended March 31 amounts to £12 208. 16s. 5d., compared with £12,293. 16s. 9d. for the previous year. With £4,918. 19s. 3d. brought forward, the total amount available is £17,127. 15s. 8d. The directors recommend payment of the year's cumulative preference dividend (£12,000), leaving £5,127. 15s. 8d. to be carried forward. The total load connected to the mains of the subsidiary and other companies of the Corporation was 106,654 kw. against 99,095 kw. in 1916, and the gross profit of the companies was £203,600 against £187,441.

FELLOWS MAGNETO CO. (LTD.)—The report for the 18 months ended Dec. 31 last states that since the inauguration of the Company the new factory has been purchased at a cost of £8,000. Large extensions were undertaken, but delays incidental to the war, interfered with the output of magnetos until April, 1917. In February last an official award was made on the subject of excess profits tax, entitling all magneto manufacturers to an increased standard rate of profit in view of the importance of the industry. The available profit is £8,514, after allowing £4,361 for depreciation and the writing down of preliminary expenses, &c. The directors recommend a final dividend of 5½ per cent. on the cumulative participating preferred shares, making 9½ per cent., and a dividend of 15 per cent. (both less tax) on the ordinary shares, and to carry forward £1,182.

IMPERIAL TRAMWAYS CO—The past year's receipts of the Middlesbrough, Stockton & Thornaby Electric Tramways were £82,798, increase £12,565, total number of passengers carried was 13,219,147, increase 368,592, and net profit was £16,540, against £14,229. Net revenue account shows an available balance of £22,268. The directors recommend a dividend for the year at 2 per cent. on the ordinary shares (less tax) and to carry forward £143.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—The net profit for 1917 amounted to £383,835, which, added to balance brought forward, leaves £763,942. Deducting the preference dividend and the interim dividend of 5 per cent. (paid in February), £685,307 is available for distribution. The directors recommend payment of further dividends of 15 per cent. on the ordinary shares (making 20 per cent. for year) and of 10 per cent. on the preference shares (making 17 per cent. for year) leaving £476,904, of which it is proposed to transfer to general reserve £100,000 and to carry forward £376,904. The general reserve will then stand at £1,100,000. Owing to unfavourable rates of exchange large sums of money received in foreign countries continue to be invested temporarily or placed on deposit abroad. The loss represented by rates of exchange calculated at Dec. 31, 1917, has been written off against profit and loss account. The Company is still without any remuneration or compensation from the Government for the use since the beginning of the war of the Company's high power stations and for the considerable services which have been rendered. The negotiations with the Post Office for compensation in respect of their repudiation of the contract for the Imperial chain of stations, proved abortive, and the Company found itself compelled to proceed with its Petition of Right. The amount of damages to be paid to the Company will be decided by the referee appointed by the Court. The Marconi International Marine Communication Co. has continued to show very substantial development, and dividends for the past year amounting to 15 per cent. have been paid. The French Company (Cie Française Maritime et Coloniale de Télégraphie sans Fil) has declared a dividend for 1917 at rate of 20 per cent. on the ordinary shares and 281·25 francs per share on the founders' shares. The Amalgamated Wireless (Australasia) Limited has declared a dividend of 5 per cent. for year ended June 30, 1917. The Marconi Wireless Telegraph Co. of America has declared a dividend of 5 per cent. for 1917. The Russian Company, The Société Russe des Télégraphes et Téléphones sans Fil, declared no dividend for the past year.

SINGAPORE ELECTRIC TRAMWAYS (LTD.)—At the meeting on Tuesday it was reported that after charging debenture interest, depreciation and royalty to municipality on tramway profits for 1916 the year's profit was £4,274, and with £7,946 brought in, the available balance was £12,221. After allowing £5,000 for dividend paid in July and £3,000 transferred to depreciation, the balance of £4,221 was carried forward. Car mileage decreased 108,292; passengers per car mile were 6·53, against 6·19; power expenses £21,803 (against £17,005) due to cost of coal. Sales of energy for lighting and power increased £1,289 to £14,611. Abnormally high price of coal greatly increased cost of energy, and at close of year current was being supplied under contract to Singapore municipality at a loss. Position was put before Commissioners, who declined to agree to any increase in rate at which electricity was supplied although the net profits to the municipality for 1917 in their electric department were £10,614. In December the crank shaft of a Diesel engine broke and the engine was still out of commission, the bulk of the energy required being produced by the steam sets.

SWANSEA IMPROVEMENTS & TRAMWAYS CO. (LTD.)—The net result of the past year's operations is a divisible balance of £13,464, compared with £13,571 in the previous year. A sum of £3,000 has been placed to reserve and a dividend on the ordinary shares for the year at the rate of 6 per cent. has been declared, leaving £2,654 to carry forward.

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TELEPHONE COMPANY OF EGYPT (LTD.)—A dividend of 6 per cent. (6s. per share), tax free, has been declared on the preferred and deferred shares, making 10 per cent. for year; £12,797 has been placed to income tax account, £8,446 has been reserved for excess profits duty (1916), and £111,577 carried forward. In January a resolution was passed for the sale of the undertaking to the Egyptian Government.

UNITED ELECTRIC TRAMWAYS OF MONTEVIDEO, (LTD.)—The gross receipts of the tramway system for the year to Oct. 31, 1917, were $1,691,217 (against $1,634,537 in 1915 16), operating expenses were $1,236,993 ($1,122,715) and net receipts $454,224 ($511,822), or £96,644 (£108,898). The passengers carried were 44,883,520 (42,747,070) and car-miles run 7,511,883 (7,512,189). The heavy increase in operating expenses (due to high cost of fuel) is more than double the increase in gross receipts. The difficulties of obtaining supplies of material for the proper maintenance of the plant continue, and shipping facilities are increasingly restricted. The amount receivable from La Sociedad Comercial de Montevideo in respect of revenue was £75,164. After providing for administration expenses and charging £48,108 for debenture interest, the credit balance is £27,374, making, with £12,814 brought forward, a total of £40,188. After providing for redemption of debenture stock and of the preference and ordinary share capital and for renewals and contingencies, £13,296 has been carried forward. Owing to abnormal conditions no distribution on the preference shares was recommended.

Mr. GEO. BALFOUR, who presided over the meeting, said the item of expenditure which showed the largest increase was fuel. The average cost of coal during the year was 104s. 7d. per ton, compared with 40s. 6d. in 1914. During the six months to April 30, 1818, the average price had increased to 144s. 4d. per ton; at the present price it was about 165s. per ton, and even then it was difficult to obtain the necessary fuel. Freight was approximately 120s. per ton, as compared with the pre-war figure of from 12s. to 14s. The increase due to wages represented slightly over 14 per cent. of the total increase and, together with the increased cost of coal, accounted for 97 per cent. of the total increase in expenditure. The Government of Uruguay was considering another Bill with a view to instituting a compulsory rest day and restricting the total hours of labour to eight hours per day for five days a week and six hours on the sixth day. Should it pass, the company's employees would be compelled to take the rest at their own expense, as the company was no longer in a position to bear additional burdens until the authorities authorised the company to increase passenger fares.

WOKING ELECTRICITY SUPPLY CO. (LTD.)—Mr. John, who presided over the annual meeting last week, stated that the revenue for 1917 was £24,702 and the expenditure £17,376, leaving £7,326, with balance brought forward, &c., and amount transferred from reserve account (£1,669), the available total was £9,809. The directors recommend payment of dividends of 6 per cent. on the preference and 5 per cent. on the ordinary shares, carrying forward £470. There had been an advance in total revenue of £3,521, but coal had cost £5,346 more than in 1916. A 1,000 kw. turbo-generator had been installed and would effect a large saving in the cost of generation. Coal rationing and the compulsory restrictions on the use of electricity were bound to affect the future output, about 50 per cent. of which now went to factories. Their engineer (Mr. Joyce) had resigned, and he had just been succeeded by Mr. Woods.

New Companies.

ANTI-RUST & METAL DEPOSITION CO. (LTD.) (150,757.)—Private company. Reg. June 19, capital £11,000 in 4,000 preference shares of £1 and 7,000 ordinary shares of £1 each, to carry on the business of rendering all kinds of machinery, plant and apparatus rust-proof and metal deposition in all its branches, mechanical, electrical and general engineers, &c. First directors are W. McArthur, F. W. Kerr and H. M. Read. Reg. offices: 72, Granville-road, Cricklewood, N.W. 2.

EDINBURGH ELECTRICAL ENGINEERING CO. (LTD.) (10,065).—Capital £2,000 in £1 shares, to facilitate during and after the war the use of the joint resources of a group of electrical contractors for undertaking urgent repair and other electrical and allied work on ships and on shore. Private company.

J. B. HOLDEN (ENGINEERS, GREAT BRIDGE) (LTD.). (150,555).—Private company, reg. May 28, capital £5,000 in £1 shares, manufacturers of and dealers in case hardening pots and enamelling stoves, sheet iron workers, mechanical, electrical and constructional engineers, &c.

METALLURGISTS (LTD.) (150,599.)—Private company. Reg. May 31, capital £12,000 in 6,000 7½ per cent. tax free participating preference shares of £1 each, 5,000 ordinary shares of £1 each and 10,000 deferred shares of 2s. each, to carry on any business in connection with processes for depositing metals on internal combustion engines and manufacturing such engines and their component parts, &c., and to adopt an agreement between Sherard Cowper Coles and J. Porter. First directors are Sherard Cowper Coles (technical director) and Gustave E. de Brunner (administrative director). Reg. office: 35, Long Acre, W.C. 2.

TARANTO TRAMWAYS & ELECTRIC SUPPLY CO. (LTD.) (150,704)—Reg. June 11, capital £100,000 in £1 shares, to acquire a concession granted by the municipality of Taranto, Italy, to construct, equip, maintain and work electric tramways, &c. Agreement with Rhys-Jones, McTaggart & Co.

TELEPHONE THIRD HAND (LTD.) (150,680).—Private company. Reg. June 7, capital £100 in £1 shares. Owners of patents, &c. First director, A. E. Ford. Reg. office: 42, North Audley-street, W.1.

City Notes.

CENTRAL LONDON RAILWAY CO.—The directors have declared an interim dividend on the undivided ordinary stock of 1¾ per cent. and on the preferred ordinary stock of 2 per cent.

CITY & SOUTH LONDON RAILWAY CO.—The directors have declared interim dividends on the 5 per cent. preference stocks of 2½ per cent. and on the consolidated ordinary stocks of ¾ per cent.

EDISON SWAN ELECTRIC CO. (LIMITED & REDUCED).—A petition for confirming a resolution reducing the capital from £888,071 to £698,307 will be heard by Mr. Justice Astbury on 30th inst.

ENGINEERING AMALGAMATIONS.—Arrangements have been sanctioned by the High Court for amalgamating the businesses of Messrs. Ruston, Proctor & Co. (Ltd.) and Richard Hornsby & Sons (Ltd.), of Grantham.

FRASER & CHALMERS (LTD.)—A dividend of 7½ per cent., less tax, has been declared on the preference shares.

LONDON ELECTRIC RAILWAY CO.—Interim dividends of 2 per cent. have been declared on the 4 per cent. preference stock and of ¾ per cent. on the ordinary shares.

MADRAS ELECTRIC SUPPLY CORPN. (LTD.)—A dividend of 4 per cent. (9 3-5d. per share) has been declared on the ordinary shares; £7,009 placed to depreciation and renewal fund and £5,727 carried forward.

METROPOLITAN DISTRICT RAILWAY CO.—Interim dividends have been declared on the 4 per cent. guaranteed stock of 2 per cent., on the 4½ per cent. first preference stock 2¼ per cent., and on the 5 per cent. second preference stock 1½ per cent.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—Interest on the 6 per cent. first cumulative income debenture stock will be paid on Aug. 31 at 3 per cent., and coupon No. 21 off the 6 per cent. income bonds will be paid at 2 per cent. on Sept. 2

The Round Table.

By "kVA."

Epitaph for any Mainsman: "A man of burrows and acquainted with sheaths."

* * * *

The rationing of fuel is causing a great commotion just now. The following from "The English Mechanic" is indicative of public feeling on the matter:—

SAVING LIGHT.—I want to reduce my electric-light bill within the limits of the coming rations! Any hints will oblige, especially in passages and bedrooms. One tells me by having switches I can reduce the light down to any desired point. Another says I shall save no current by thus doing, and only pay away money for switches for nothing. Is this so? Gas I am hopeless about. I have long given it up, finding all recommended save-alls meant bigger bills and worse light.—Grumbler.

* * * *

The "Daily Chronicle" publishes the following, which may be used by any electrical manufacturer just now:—

Keep your temper, gentle sir,
Writes the manufacturer.
Though your goods be overdue
For a month, or may be two,
We can't help it. Please don't swear;
Labour's scarce and looms are rare.
Can't get yarns, can't get dyes;
These are facts, we tell no lies.
Harry's drafted, so is Bill;
All our work is now uphill.
So your order, we're afraid,
May be still a bit delayed.
Still, you'll get it, don't be vexed;
May be this week, may be next.
Keep on hoping. Don't say die;
We'll send your order by-and-by.

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, July 16, 1881.]

THE ELECTRIC LIGHT AND AERONAUTS.—At the exhibition the Academic d'Aerostation will conduct ascents by night, in which lighting by electricity will form a prominent feature.

THE COMET.—The first observer of the comet that has lately visited us, and is still to be seen, was, we believe, Mr. Newall, of Gateshead, the well-known maker of lightning conductors and cables. Mr. Newall has a small observatory of his own at his works at Gatesgate, near Newcastle-on-Tyne.

QUICK WORK.—The result of the Derby was transmitted to New York in wonderfully quick time. The following are the times of receipt and despatch of the message announcing the victory of Iroquois to the New York "Telegram": "Horses got away at 10.21.5 New York time. Iroquois passed winning post 10.23.55 New York time. Result reached New York 10.24. Time occupied in transmission, 5 seconds."

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CONTENTS.

NOTES 263
Electrical Properties of Vulcanised Fibre. By William Eves. Illustrated 266
The Stroke of an Alternating-Current Electromagnet. By A. Thomälen. Illustrated 267
Calculation of Performance of Induction Motors Working in Conjunction with Flywheels and Slip Regulators. By Herbert Vickers, M.Eng. Illustrated.—*Continued* 269
Electric Furnace for Forging and Annealing of Steel. By W. S. Scott 271
Engineers' Protective Associations 273
Newcastle Electrical Engineers and the E.P.E.A. 273
CONDITIONS IN OUR FACTORIES 274
REVIEW 274
Resistance and Reactance of Iron Transmission Lines. By A. Press. Illustrated 275
CORRESPONDENCE 277
Volunteer Notices 278
LEGAL INTELLIGENCE 278
PARLIAMENTARY INTELLIGENCE 279
Commercial Topics 279
Electricity Supply 280
Educational 282
Tenders Invited and Accepted 282
Companies' Meetings and Reports 283

Notes.

Engineers' Protective Associations.

A GOOD deal of discussion has taken place recently in regard to the formation of bodies which, technically speaking, would be trade unions to protect the position and raise the status of electrical engineers. The Institution of Electrical Engineers has taken some steps in this direction, and there are already in existence the Electrical Power Engineers' Association, which has met with a considerable measure of success, and the Chief Technical Assistants' Association. These Associations so far have recruited their membership from engineers engaged in electricity supply, and it was felt desirable to enlarge the scope so as to include electrical engineers engaged also in manufacturing. In order to avoid multiplication of associations the Council of the Institution of Electrical Engineers have made an attempt to draw into a more comprehensive scheme all those who are interested. In this attempt some difficulty has been experienced. These difficulties, however, seem now to have been overcome by a conference (held by invitation of the Institution) of representatives of the Associated Municipal Electrical Engineers of Greater London, the Chief Technical Assistants' Association and the Electrical Power Engineers' Association. As will be seen by a report which appears in another column, this conference decided that one single protective association should be formed for the whole electrical supply industry. For the time being the title and constitution of the Electrical Power Engineers' Association are to be adopted. Perhaps the most important question is that of qualification. It has been agreed that all new members elected after Dec. 31, 1921, will be required to have passed the A.M.I.E.E. examination or an equivalent. It is no doubt desirable that there should be a link of this kind between the Association and the Institution. The only difficulty that may be experienced is that the membership may be somewhat restricted thereby, so that effective action is hampered. In other words, it is always desirable in a movement of this kind to make the net sufficiently large to embrace all those who go to make up the staff and employees of the section concerned.

Commerce and the University of London.

LAST week a meeting was held at the London Mansion House, at which Mr. A. J. BALFOUR was the chief speaker, in favour of the University granting degrees in commerce. It is rather curious, considering that London may be regarded as the commercial centre of the world, that the lead should have been taken in this direction by some of the younger provincial universities. It will no doubt be said that the Senate of London University are conservative in their actions and that they felt it necessary to be convinced of the value of such degrees before taking any steps to found a corresponding faculty. On the other hand, it may be that the Senate are so constituted that the members have failed to realise the importance of encouraging the study of commerce. We can quite imagine that the subject does not appeal, for example, to eminent medical men, or possibly to those who are eminent in law; and in all probability professors who are engaged in pure science would regard the subject as entirely unscientific and, therefore, not to be encouraged. There are indeed several points of view, as Mr. BALFOUR made clear. To start with, there is the large question whether education of this kind is an advantage. We now have a broader experience to go upon than we had some 20 years ago. The value, for example, of university training in engineering is now recognised. It is not sufficient merely to pick up knowledge in the shops. Although university training will not provide gifts which Nature has not given, it is nevertheless true that if two groups of individuals are taken of equal mental calibre, the group that is educated to the standard of university training will have the advantage of the group that has had no such training. As to the scientific aspect, it may certainly be contended that a knowledge of commerce, and all the operations that commerce implies, is very closely akin to a knowledge of political economy which has long ago been recognised as a university subject. There is no good reason, therefore, to regard commerce as one of those inferior subjects which should not find a place in the university calendar. Probably the most important point, which was also emphasised by Mr. BALFOUR, is that the training given should have a really broad foundation. There should be more in the subject than the consideration of £ s. d., for it is certainly the case that the best work, generally speaking, is obtained from those who have the broadest knowledge as well as the specialised knowledge which is essential.

Electric Furnaces for Forging.

So far as we are aware, electric furnaces have not been used seriously for forging hitherto; but from an article by Mr. W. S. SCOTT, which appears in another column, it will be seen that the development of this process is taking place in the United States. The objection to gas-heated furnaces is that

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oxidation takes place, and there is also a lack of uniformity of temperature. These difficulties are obviated in the electric furnace. On the other hand, resisters of the wire type are inapplicable a tsuch temperatures, and resisters of the carbon type may give trouble. It has been found that the carbon or graphite used for such a purpose must be very pure, and, even if this material is obtained initially pure, any slag or ashes resulting from the operation of the furnace soon cause the formation of clinker, which rapidly extends through the granular mass, resulting in failure. It has also to be remembered that resisters of this type have a negative temperature coefficient, and consequently, although the surface temperature may be, say, 1,800°F., the temperature in the bottom layers of the resister may be as high as 3,600°F., due to the fact that as the temperature rises the resistance becomes less and the bulk of the current is therefore carried by the hotter parts of the resister. Such a high temperature may cause trouble with the refractory materials. For these reasons it has been found that silicon carbide is a more suitable material. Its temperature of decomposition is very high ; it may be moulded in block form, thus allowing the heating element to be placed in any desirable position around the heating chamber, and, due to the high tensile strength of the material, the roof of the heating chamber may be made out of these resister blocks. An interesting account is given of the results obtained, and it is stated that a furnace efficiency of 41 per cent. resulted. Assuming that electrical energy can be purchased at a sufficiently low rate, this type of furnace adds another to the many applications of industrial electric heating.

A Super Power Station at Nottingham.

THE reputation of Nottingham from the point of view of electric power has recently been under a cloud and subject to a good deal of criticism. Now it seems there is a desire to place the centre of the lace-making industry in the up-to-date position of having a large power station. There is much to be said in favour of a station of this character in this particular area, as it may very suitably be placed on the River Trent, though whether the river would be sufficient to provide condensing water for a really large power station may be open to question. Be this as it may, the river would certainly provide a considerable amount of condensing water, which could be supplemented by cooling towers. In the surrounding district there are a number of large collieries and iron works with power stations of their own, and in all probability these would purchase further power, even if they did not actually give up their own supplies. An interesting feature of the proposed scheme is the suggestion that low-grade fuel should be used from the Butterley collieries. There is a large quantity of this fuel, known as " top hard slack," amounting to some 700,000 to a million tons annually. It is proposed that this should be utillsed in producers, thus yielding 100,000 cubic feet of gas per ton of coal, the gas being of a calorific value of 135 B.Th.U In addition, there is an inferior coal known as " Jacks," which is a bastard cannel, and which is stated to yield 70,000 cubic feet of gas per ton. The Committee to which the scheme has been referred appear to have comprehensive ideas,as they propose to utilise gas from the coke ovens and blast furnaces in addition to the gas which would be produced at the power station. Apparently the present idea is to use ordinary recovery producers so that a yield of 60 to 70 lbs. of ammonium sulphate would be obtained per ton, and not to introduce low temperature carbonisation. It is possible, however, that the advantages of the latter method may yet be considered so that fuel oils may be obtained in addition. We do not know how far the whole scheme has been worked out in detail. There is always the difficulty that low grade fuel, however tempting from certain theoretical aspects, is very much handicapped on account of the large capital involved per ton of fuel handled, and equally the low yield of by-products per ton of coal. In other words, in our present state of knowledge, low grade fuel means inefficient use of capital which may result in a serious handicap.

The Carnegie Institution and Terrestrial Magnetism.—The annual report of the department of terrestrial magnetism at the Carnegie Institute for the year 1917 again contains a great deal of useful information on terrestrial magnetism, a feature being the data collected at sea, through the observations of the " Carnegie " and the " Galilee." Errors in magnetic charts appear to have arisen through the absence in the past of a systematic magnetic survey at sea, reliance being placed mainly on coastal observations. Observations on land at Africa, Asia, Australasia and South America stations are also recorded.

Electrical Equipment in a Large Shipbuilding Yard.—Considerable interest has been taken in the development of the great shipbuilding yard at Hog Island, Philadelphia, which is said to be as large as any six of the pre-war yards in the United States, and to have about one-quarter of the total capacity of all the shipyards in Great Britain. We observe that in a recent address to the S.N.E.L.A., Mr. W. H. Blood, assistant to the president of the American International Shipbuilding Corporat.on, gives some interesting particulars of the electrical equipment of this yard. Among other facts he mentions that over 3,000,000 ft. of mains are required for electric service, 40,000 electric lamps will be needed to illuminate the yard, and 650 motors will be available for power.

Rationing of Coal, Gas and Electricity.—We have received an advance proof of an article on this subject by Mr. George Helps (proprietor of " Gas "), who is of the opinion that the scheme now in force is unworkable, and will not bring about the desired results. Mr. Helps gives a comparison of gas, electricity and coal, from which he reaches the conclusion that gas is a more suitable medium for heating than any other, and therefore he advocates the complete gasification of coal and a much lower calorific value for the gas. Lack of space will not allow us to follow his arguments, with which we cannot wholly agree, but we may mention that his conclusion in general terms is that the rationing should be done directly through gas and electricity undertakings and the coal merchants ; not through individual consumers, who know very little about their meter readings. Also that all unnecessary restrictions should be removed, such as the minimum calorific value of gas.

Air Raid Signals.—" Engineering " publishes some interesting particulars of the Challot rotating vanes and the series of horns forming the syrens, now mounted on monuments in numerous French towns to give warning of the approach of hostile aircraft. The syren consists of a casing, or stator, within which an aluminium rotor revolves on ball bearings. The stator and rotor have each a number of openings, generally rectangular. Vanes for canalising the air start from the centre of the rotor and end at the rotor openings. When the rotor revolves, centrifugal force drives the air through the openings, and the flow is alternately permitted or interrupted according as the openings in rotor and stator coincide or not. The rotor is driven by an electric motor of 12-15 H.P. Conical horns of suitable shape and length are connected to each opening of the stator in order to amplify the sound. The Paris syrens have a total weight of 800 kg. (about 1,700 lb.), and in the city cannot be heard beyond a radius of 1·5 km. (under 1 mile), although in the open the range may be as high as 8-10 km. Hand-operated syrens have also been built for giving the alarm in small towns.

Lighting the Boiler Room.—In the United States the fuel-saving campaign has concentrated attention on boiler house efficiency, and one observes a great deal of comment on the

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matter in the electrical Press. It is stated in the "Electrical Review and Western Electrician" that plants are now to be subject to Government inspection, and the hope is expressed that this will include attention to lighting. Many boiler rooms are insufficiently lighted, and in many others the lights are badly placed. It can hardly be doubted that inadequate illumination affects the efficiency of operations in a boiler house. "Many things," it is pointed out, "go on in the dark that would not be tolerated in the light of day"—which indeed never enters many boiler rooms. Lack of light is prejudicial to proper inspection, the removal of soot and scale may be scamped, air infiltration through cracks in settings, warped doors, &c., may go on undetected. Another point is that insufficient lighting is probably responsible for not a few accidents due to men stumbling over unseen obstacles, or striking themselves against protruding obstacles. In short, the case for adequate illumination in the boiler room is a sound one.

The Expansion of Brass.—A scientific Paper issued by the Bureau of Standards (No. 321) contains an account of some investigations by Mr. P. D. Merica and Mr. L. W. Schad on the thermal expansion of alpha and beta brass between 0°C. and 600°C. Over the above range of temperature differences in thermal expansion of the alpha and beta components, which are normally in equilibrium in such alloys as Muntz metal, &c., were clearly indicated. The resultant stresses have been only partly investigated, but exist in 60 : 40 brasses, and it is significant that manufacturers never quench brasses of this description. Naval brass or manganese bronze, when quenched in such a manner as to leave the beta grains surrounded by alpha envelopes, is generally weak and brittle, and the fracture intercrystalline. The authors suggest as an explanation of such brittleness the existence of tangential tensional stresses in the beta grains adjacent to the alpha envelope. It is suggested that further investigation of this general question of the behaviour as regards expansion of various constituents of other alloys might reveal causes of mysterious failure and obscure weakness. Such metals as hypereutectoid steels, cast iron, type metal and bearing metals contain two constituents, and in many cases one of these is brittle, a fact which would accentuate the effect of local contraction stresses.

Cleaning Surfaces for Painting.—The "Railway Gazette" remarks that the cleaning of structural steel surfaces preparatory to repainting is apt to be done in a very perfunctory manner. If some attempt is made really to clean off the rust and dirt the work is hard. The workman cannot see that he is accomplishing anything; no matter how hard he works, the job is never really finished, for it could always be done just a little better. The foreman, on the other hand, is bound by the necessity of having the surface cleaned in some measure, and at the same time avoiding an excessive expenditure of time and money. The only substitute for hand labour so far devised is the sand blast, which for various reasons has been used only to a limited extent on bridge work. The question is raised as to the possibility of the development of a cleaning tool operated by air or electrically (where applicable) and designed along the line of the floor and cement surface finishers. This suggestion is open to one objection raised against the sand blast, the need of an air compressor plant on the job. But with the increased use of power tools the presence of a power plant of any kind on even a small job will eventually become more and more common. The need of mechanical equipment to eliminate this disagreeable and arduous manual labour is becoming increasingly apparent.

A Photo-Electric Cell Yielding Alternating Current.—Some interest was excited last year by the experiments of Mr. T. W. Case, of New York, on some new forms of photo-electric cells which gave an appreciable E.M.F. under the influence of light. We observe that an account of some further researches by Mr. Case has appeared in the "Transactions" of the American Electro-Chemical Society, wherein he studied the photo-electric action of voltaic couples, one electrode of which was illuminated, whilst the other was kept in the dark. A plate or wire of copper was immersed in solutions of various copper salts, *e.g.*, copper formate and acetate, became coated with a film of some lower oxide or halide. When subsequently this coated copper was coupled with an electrode of clean copper (or silver), and one of the electrodes illuminated, a current of 0·11 volt was generated, the illuminated electrode being the anode. He suggests that the film on the copper consists of cuprous oxide or hydrate, which is oxidised under the influence of light, but subsequently dissolves in the acid of the electrolyte. The E.M.F. slowly dropped under continued illumination, but when the previously dark electrode of the exhausted cell was illuminated, the current reversed. By interposing a revolving screen in the beam of an arc lamp so as to illuminate the two electrodes alternately, Mr. Case obtained a steady alternating current, and the electrodes did not appear to disintegrate.

Audibility Factor of a Shunted Telephone.—A Paper by Mr. Van der Pol, entitled "On the Relation of the Audibility Factor of a Shunted Telephone to the Antennæ Current as Used in the Reception of Wireless Signals," was referred to in THE ELECTRICIAN on May 24th. We now observe in the "Philosophical Magazine" a communication on this subject by Prof. G. W. O. Howe, who remarks that Mr. Van der Pol's conclusions apparently involved treating the receiver as a non-inductive resistance. Actually the apparent resistance to an alternating current is higher than the figure assumed, and the proportion of current entering the telephone circuit depends on its impedance in comparison with that of the shunt. Examples are given of the error due to this procedure. The matter is again taken up in the "Philosophical Magazine" by Mr. Van der Pol, who quotes Prof. Love's definition, as being based upon resistance, adding that owing to the unknown wave-form of the telephone pulsating current the determination of the true impedance is a matter of great difficulty. Prof. Howe, in a rejoinder to this, contends that Austin and Hogan, whose work is also quoted, determined the impedance with fair accuracy. The only method of establishing a relation between the antenna current and the audibility factor is to give correctly the ratio between the total sound-producing current and the fraction of it that passes through the telephone receiver. This involves determination of the impedance. It is also remarked that Austin's results support the conclusion that the current is proportional to the square root of the audibility factor, the constancy of values based on this relation being wonderfully exact in view of the experimental difficulties.

Sag-Temperature Calculations of Transmission Lines on Steep Grades.—A communication by Prof. A. Still to the "Journal" of the Franklin Institute points out the desirability of charts or tables giving the sag or tension at different temperatures for a given length of span in overhead power transmission lines. This will enable wires to be so strung that the stress shall not exceed the specified limit under weather conditions which produce maximum loading. If storm conditions are such as to produce in the wire a stress n times as great as that prevailing when the wire hangs in still air, at the same temperature, under the action of gravity only, there will be a reduction in length due to elastic contraction when the extra load is removed. Nevertheless, with a sufficient rise of temperature, the elongation of the wire may produce the same maximum deflection in spite of the reduction in the tension. The author shows that this critical temperature can be easily calculated, and the sag at any other temperature also predicted. Several typical cases are worked out. The omission of the effect of elasticity of the wire is often permissible, especially on long spans of aluminium wire, but gives inaccurate results on sport spans of copper wire. It is remarked upon as peculiar that in England, where the stringent regulations involving large factors of safety necessitates uneconomical construction with short spans, it is by no means uncommon to neglect the elasticity of the wire; while in America, where the longer spans are the cause of reduced stress variations, it is customary to take account of the changes in length due to variation in load.

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Electrical Properties of Vulcanised Fibre.*

By WILLIAM EVES.

Considerable work has been done in the measurement of the electrical properties of vulcanised fibre, but not very much of the information that has been obtained on the subject has been collected. This is largely due to the fact that it is extremely difficult to compare values obtained by one experimenter with those obtained by another, because of the lack of standardisation in testing methods.

The specific resistance, surface resistance, specific inductive capacity and breakdown voltage, often called dielectric strength, are about the only electrical properties concerning which information is ever required by the user, and of these the breakdown voltage is by far the most important, as it is one factor which is considered in 98 per cent. of the cases. Consideration will be paid here to this property only because the data available on the other three properties are so meagre that their publication would not be warranted.

Breakdown Voltage.

The breakdown voltage per unit of thickness of vulcanised fibre is a function of the thickness itself, the extent to which the gelatinisation of the individual plies of paper has been carried, the temperature of the sample at time of test, and the colour to some degree. Conditions of the material that are likely to affect the breakdown voltage are the quantity of chemical remaining in the fibre after its manufacture (which whenever present is extremely small), the moisture content, the homogeneity and density of the sample, and the physical shape of the sample.

Moisture to a certain degree is necessary for the life of vulcanised fibre. Zinc chloride is used as the gelatinising agent in the manufacture of the fibre, and any that remains after the washing processes will be in solution in the natural moisture, because zinc chloride is a very deliquescent substance. This may happen in spots, and likewise any foreign material that would tend to reduce the breakdown voltage would naturally occur in a few places and possibly not at all in some samples. At these points leakage would occur between the electrodes of the testing set; local heating would result, reducing the resistance of the small amount of solution, and breakdown would occur before the true breakdown voltage of the fibre was reached.

As has been pointed out before in connection with tests of dielectrics, the method and conditions of the test will also affect the voltage at which the sample will break down. The shape of the electrodes, whether needle points, round-edge or flat-edge discs, or spheres, will affect the distribution of the electrostatic flux throughout the material, and the medium in which the terminals are immersed, oil or air, and the rate of application and the method of application of the voltage will determine the amount of heating due to corona loss, causing consequent drying and carbonisation and premature breakdown. For these reasons due care must be taken that no peculiar conditions exist to distort the conclusions made, and that a sufficient number of samples are taken to secure good average results.

Curves Showing Effect of Temperature and Thickness.

The variations of breakdown voltage with temperature for vulcanised fibre of various thicknesses and colours are illustrated by curves. They were plotted from test data obtained at the Massachusetts Institute of Technology by Katzenstein and Burt. Each point on a curve represents the average of eight or nine tests on the same sample. Samples from four well-known manufacturers of vulcanised fibre were used in the investigation, and the results of those of approximately the same thickness and colour are compared. In all 4,000 tests were made. They were all made with the same electrodes, and the voltage was increased at the constant rate of 1,000 volts per second. At temperatures higher than room-temperature the samples were prepared by heating in an oven for one hour for the thinner specimens and from four to five hours for the thicker.

Fig. 1, referring to gray fibre curves, shows an increase of approximately 80 per cent. in breakdown voltage from 25°C. to 100°C., with a decrease in one case from 25°C. to 50°C. This dip in the curve probably would not occur in many samples of this thickness, and cannot be explained without more knowledge of the chemical properties of the particular sample.

The results for thicker gray fibre show an average decrease in the 25 deg. to 100 deg. temperature range of 77 per cent. Tests on pieces thicker than ½ in. (1·27 cm.) are not very interesting, because the voltage required to break down a sample of such thickness is greater than most commercial voltages.

A comparison of results on black fibre is given in Fig. 1. Here again one sample shows a decrease at 50 deg. and a considerable increase at 100 deg. It is interesting to notice that the breakdown voltage of one of the other two samples slightly increases with the temperature, while the other slightly decreases. The average increase is 12 per cent. It is at the thickness of these samples that the turning point occurs. Greater thicknesses show a decrease in breakdown voltage with increase in temperature.

In the case of red fibre the average decrease in breakdown voltage as shown by curves in the range from 25 deg. to 100 deg., is 60 per cent.

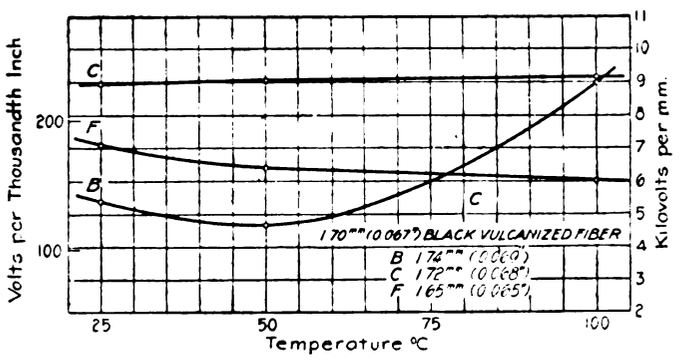

FIG. 1.

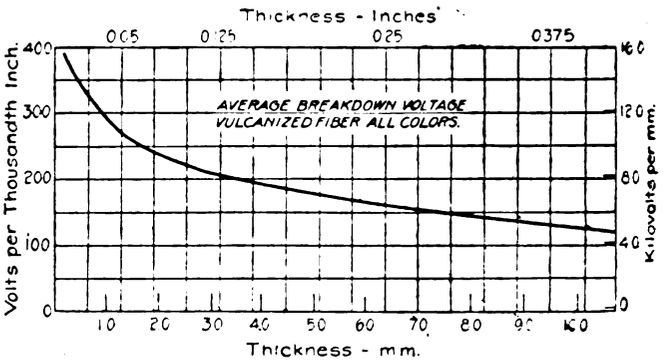

FIG. 2.

For thinner red fibre the average increase in breakdown voltage from 25 deg. to 100 deg is approximately 20 per cent., although the increase from 25 deg. to 50 deg. is slightly greater. This shows that the conditions tending to increase the breakdown voltage and those tending to decrease it about neutralise each other in the range from 50 deg. to 100 deg.

The most plausible theory for the change from an increasing variable with temperature to a decreasing variable, as the thickness increases, is that two conditions in the sample tend to offset each other. As stated before, fibre contains moisture to a certain extent and zinc chloride to an extremely small degree in solution. It is well known that the resistivity of solutions decreases with increase in temperature. On the other hand, fibre loses a certain amount of its contained moisture when it is heated, and the greater thicknesses do so much less rapidly than the lesser thicknesses, but not at all in proportion so the thickness. The thicker samples used in these tests were heated four or five times as long as the thin samples, but the thin samples would lose a far greater percentage of moisture in one hour than the thicker ones would lose in four or five hours. Hence, in the case of the thinner samples the moisture content was probably less when tested at higher temperatures, the strength of the small amount of solution in the sample was greater and the resistivity greater. This was probably the controlling condition in the thinner samples, causing the breakdown voltage to be greater at higher temperature, while the temperature of the solution controlled the breakdown voltage at higher temperatures in the thicker samples.

The results of these and many other tests made with the fibre of five large manufacturers have been averaged, and the composite results are shown in Fig. 2. This curve gives values for room temperature only. The tests were made under all conditions and with all grades of fibre.

* From the "Electrical World," somewhat abbreviated.

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Grey fibre is made from paper of the natural colour, with no colouring matter of any kind. Black contains a small amount of lampblack or other colouring matter, and red is coloured with a relatively large amount of various grades of oxide of iron. For this reason it would be expected that the coloured fibre, and particularly red, would have a lower breakdown voltage than grey fibre. Although this is true in some cases, it is not always so. Here again other conditions affect the results.

Any loading material placed in the paper from which vulcanised fibre is made tends to interfere to some extent with the chemical treatment, and the result is a less homogeneous material. Colouring matter acts as a loading material and produces a slightly more "papery" fibre, which usually has a higher breakdown value because of the greater degree of lamination. Moreover, fibre is made from three grades of paper, which vary in the degree to which they are gelatinised by the chemical action. The paper from which $\frac{1}{8}$ in. to $\frac{3}{4}$ in. (3·175 mm. to 19·05 mm.) fibre is made is treated to the greatest extent by the zinc chloride, and consequently a more homogeneous material, with low breakdown voltage, results. In a large number of cases the loading factor of red fibre is so much more pronounced than the tendency for the small amount of solution of oxide of iron to lower the breakdown voltage that the dielectric strength of red fibre will be higher than that of grey fibre. However, in other cases the reverse condition exists, but the difference is so small as to be commercially negligible. Black fibre is usually between the red and grey grades and nearer the grey in its breakdown voltage.

Other Physical and Chemical Properties.

As vulcanised fibre loses its normal amount of contained moisture its pliability decreases and finally it becomes brittle. This is caused either by application of a sustained temperature of 80°C. to 100°C. (176°F. to 212°F.) or to higher temperatures up to 200°C. (392°F.) for shorter periods of time. At this latter temperature charring commences. It has the following strengths in pounds per square inch tensile, 9,000-13,000; compressive, 33,000-43,000; shearing, 9,000-13,000.

Vulcanised fibre is not waterproof. It absorbs water to a certain degree, but it is not injured by either hot or cold water, for it returns to its original dimensions and properties when dried. Most dilute acids and alkalis cause no other effect than the effect of water, but concentrated acids cause disintegration. However, organic solvents and all oils have absolutely no effect and are not absorbed in the slightest degree.

General Uses for Electrical Insulation.

Although vulcanised fibre was first used in 1873 for axle washers and railway car-journal dust guards, it has been more widely known in late years as an electrical insulator. It was early used in large quantities for magnet bobbins, coil insulation, cleats, armature wedges, insulating blocks, gears and handles, &c. Since the development of the automobile industry another large electrical insulation field has been opened. It is of service for insulated staples and cleats, straight and bent wire conduits, flanged bushings for use wherever a wire passes through body or frame, timer rings and other insulating rings, insulating washers, switch bars and bases, switch panelboards, fuse tubes, and in general where good machining and bending qualities are a necessity.

One of the largest uses of vulcanised fibre at the present time, either for electrical or mechanical purposes, is for railway signal insulation. The specifications for this application are quite severe. The Railway Signal Association's specifications require a specific gravity of 1·3 to 1·5; an absorption when immersed in water at 70°F. for 24 hours, not to exceed 45 per cent. by weight for $\frac{1}{8}$ in. (3·175 mm.) fibre, 30 per cent. for 3/16 in. (4·76 mm.) fibre, and 26 per cent. for $\frac{1}{4}$ in. (6·35 mm.) fibre; a tensile strength of 5,000 lb. per square inch (351·5 kg. per square centimetre), and a dielectric strength of 32 volts per 0·001 in. 0·025 mm.) for all thicknesses, under the application of voltage for one minute between disc electrodes 1 in. (2·54 cm.) in diameter. The specifications require further that the fibre shall withstand bending into a circle of a radius 10 times the thickness without cracking or splitting.

The absorption and specific gravity are very important, first, because of the service conditions, and, second, because the higher the specific gravity the more homogeneous the material is and the more easily is it fabricated, punched, bent and worked into shape. Moreover, fibre with high specific gravity will have a higher tensile strength and will resist shear to a greater degree under all conditions.

To fulfil these requirements the manufacturer must pay particular attention to the stock from which he makes the paper and to the conditions under which the fibre is run up. Tests must be made on each lot in order to make sure that no conditions have entered the manufacture which might harm the properties which are so important. It can be safely said that more care must be taken with fibre made for this purpose than for any other, because, as stated before, the more homogeneous vulcanised fibre is the lower the breakdown voltage is likely to be.

Conclusion.—When the breakdown voltage per thousandth of an inch, the specific gravity and the cost per pound of vulcanised fibre are compared with the corresponding values for other insulating materials, it will be found that the commercial insulation value of vulcanised fibre is very high. In fact, it can be used in many cases where no other material will answer, when its ability to be machined with great accuracy and to be bent, punched and formed to shape is taken into account.

The Stroke of an Alternating-Current Electromagnet.*

By A. THOMÄLEN.

In the case of direct-current electromagnets it has been shown by Emde ("E.T.Z.," 1908, p. 817) that the magnetic energy increases during its stroke by an amount equal to the mechanical work done, if the current remains constant.

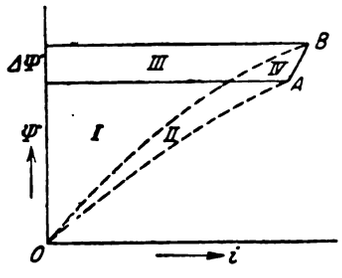

FIG. 1.

The conditions for an alternating-current magnet are different, and it is not correct to regard the action as taking place at constant flux. It is true that the instantaneous and effective values of this quantity are unaffected by the movement of the plunger, but as the flux is constantly varying the action is not comparable to that of a direct-current magnet, in which the flux is artificially kept constant during the stroke, and it is not permissible to state that the work during the stroke is covered by the diminution of magnetic energy.

Following the motion of the magnet during half a period starting from the instant when the magnetic flux is zero and denoting by ψ the flux-interlinkages produced by the current i, we may consider a period Δt in which ψ is diminished by an amount $\Delta\psi$, while the air-gap is reduced from l to $l-\Delta l$. In Fig. 1 the relation between ψ and i at constant air-gap l is represented by the dotted curve OA and at constant gap $l-\Delta l$ by the dotted line OB. If, according to the method of Emde, we represent by areas the magnetic energy $U_{(l)}$ at the beginning of the period of time, the magnetic energy $U_{(l+\Delta l)}$ at the end of the period, the work of the stroke ΔA and the electric energy ΔA_e supplied we have:—

$$U_{(l)}=\int_0^{\Psi} id\psi\ (l=\text{const.})=\text{areas } I+II.$$

$$U_{(l')}=\int_0^{\Psi+\Delta\Psi} id\psi\ (l'=\text{const.})=\text{areas } I+III.$$

$$\Delta A_e=\int_{\Psi}^{\Psi+\Delta\Psi} id\psi\ (l \text{ variable})=\text{areas } III+IV.$$

Whence it follows that the work of the stroke is

$$\Delta A=\Delta A_e+U_{(l)}-U_{(l')}=\text{areas } II+IV.$$

When the flux attains its maximum value the air-gap has a certain length. The thick dotted curve of Fig. 2 represents the

* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 39, 1917.

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dependence of ψ on i at this constant gap. If the gap changes during the stroke, the magnetic reluctance is greater before the flux has reached its maximum value than when it reaches its maximum value, and the ascending and descending values of ψ during the half-period under consideration are represented by the thin continuous lines.

Adding all the areas such as $II+IV$ the work in the first quarter-period is the area F_1, the increase of magnetic energy in this time is the area F_2+F_3, and the electric energy supplied is $F_1+F_2+F_3$. Thus, during this interval, the energy supplied is used to perform the work of the stroke and to store magnetic energy.

In the second quarter-period the magnetic energy is reduced by an amount F_2+F_3, the work of the stroke is F_2 and negative, and energy equal to F_3 is restored to the line. Thus, during this interval the reduction of magnetic energy covers the work of the stroke and the energy restored to the line.

In the half-period the change of magnetic energy is zero, and the energy supplied is F_1+F_2, which is equal to the work of the stroke.

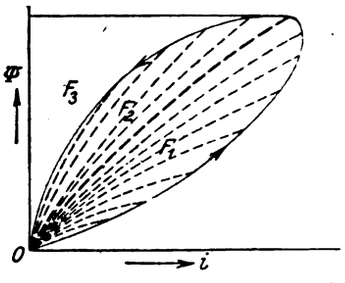

FIG. 2.

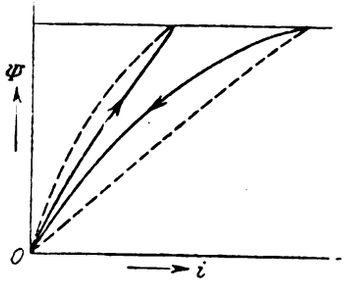

FIG. 3.

It is, however, only *numerically* correct to conclude that the work during the half-period is done by the energy supplied. This is physically true for the first quarter-period, but during the second quarter-period the work of the stroke is directly performed by the reduction in magnetic energy, which is only indirectly supplied by the outside source If the work is considered during a half-period that does not start from zero flux the conditions appear very different. Fig. 3 is drawn for a half-period beginning at the time when the flux is maximum. Here the work of the stroke is the sum of the two thin areas, and the reduction of magnetic energy is the area between the dotted curves and the upper horizontal line. Consequently, the energy restored to the line is equal to the area between the continuous curves and the upper horizontal line. It will be seen that the work of the stroke during this half-period is not supplied by the outside source, but by a reduction of magnetic energy that supplies energy to the line at the same time.

In Fig. 4 we see the conditions during a whole stroke The point first time, as in Fig. 5, and it appears that the change of magnetic energy over the whole stroke is zero, and the work of the stroke is equal to the sum of the areas of the thin loops and also to the electrical energy supplied.

On the other hand, if the half-period under consideration is supposed to start when the flux has its maximum value the conditions are represented by Fig. 6, and the work of the stroke is the sum of the thin loops, while the area between the dotted curves is the diminution of magnetic energy. The energy restored to the line is the sum of the areas external to the loops. Thus, the work of the stroke together with the energy restored to the line is now equal to the reduction in magnetic energy.

It appears, therefore, that the work of the stroke is either equal to the electrical energy supplied or to the difference between the reduction of the magnetic energy and the energy restored to the line, according to the choice of the time at which the stroke starts.

It is now possible to deduce an expression between the work during a stroke and the reduction of magnetic energy, on the assumption that the effective flux is constant.

If the time of a stroke is long compared to one period of the supply the acceleration a may be assumed to be constant during half a period and $dl=(v_0+at)dt$, where v_0 is the initial velocity of the plunger. If the field in the air-gap is $H=H_m \sin \omega t$, and if F is the area of the air-gap, then the instantaneous value of the force exerted is $H^2_m \sin^2 \omega t \,.\, F/(8\pi)$, and the work during the time τ of half a period is

$$A_\tau=\int_0^\tau \frac{H^2_m \sin^2 \omega t \,.\, F}{8\pi} \,.\, (v_0+at)dt.$$

Performing the integration and putting $\sigma=v_0\tau+\frac{1}{2}a\tau^2$=the travel of the plunger in half a period, we obtain the equation

$$A_\tau=\frac{H^2_m F}{8\pi} \,.\, \frac{\sigma}{2}.$$

If l_1 and l_2 are the lengths of the gap at the beginning and end of a number of complete periods then $l_1-l_2=\Sigma\sigma$, and the work during that time (which is nearly equal to the time of a complete stroke) is

$$A=\frac{H^2_m F}{8\pi} \,.\, \frac{l_1-l_2}{2},$$

which is the product of the mean value of the force and the length of the stroke.

Now the maximum value of the magnetic energy in the air-gap was $U_1=H^2_m \,.\, F \,.\, l_1/(8\pi)$ before the stroke and $U_2=H^2_m \,.\, F \,.\, l_2/(8\pi)$ after the stroke, and as the maximum value of the energy in the iron has remained unchanged, the difference between the maximum values of the stored energy before and after the stroke is

$$U_1-U_2=\frac{H^2_m F}{8\pi} \,.\, (l_1-l_2).$$

This is, as already shown otherwise by Emde, twice as great as the work done in the stroke.

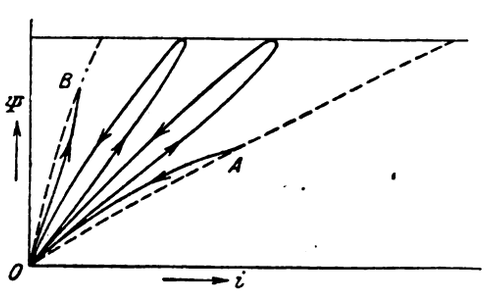

FIG. 4.

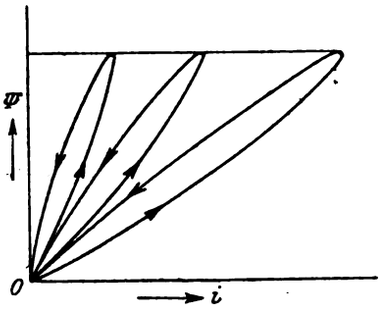

FIG. 5.

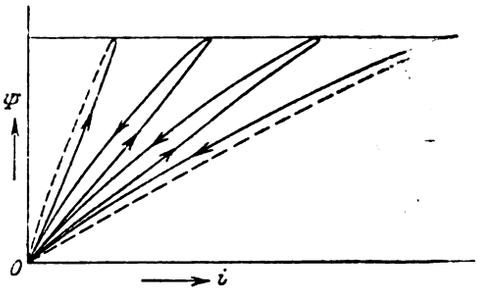

FIG. 6.

A corresponds to the constant gap before the stroke begins Starting at A the flux becomes zero, and then passes through a number of loops until at B the stroke ends at a certain value of the air-gap. Really every other loop should be drawn in the third quadrant, but the diagram becomes clearer by drawing all the loops in the same quadrant. We know nothing definite about the value of the flux at the beginning and end of the stroke, but if we suppose that the whole time occupied in the stroke is great compared to the length of a period there are so many complete loops that the irregular areas at the beginning and end of the period may be neglected without greatly affecting the calculation of the energy. Thus, the time may be reckoned from the moment when the flux passes through zero the

In this reasoning the change of magnetic energy has been advisedly referred to as a *difference* and not as a *reduction*, and therein lies the explanation of the apparent discrepancy.

If a reduction of energy is contemplated, one is led to regard this reduction as covering the work performed by the magnet, just as in the case of a direct-current magnet. This erroneous method of regarding the problem is particularly misleading if mean energy values are taken instead of maximum values, as in this case the work of the stroke appears as the difference between the values of the initial and final magnetic energy. It must be understood that this equality is only an arithmetical one, and does not constitute an expression of a balance of energy

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Calculation of Performance of Induction Motors Working in Conjunction with Flywheels and Slip Regulators.

By HERBERT VICKERS, M.Eng.

(*Continued from p. 250.*)

Summary.—The author deals with the subject mathematically, taking the two cases of continuous slip regulator and intermittent slip regulator; also the automatic slip regulator and the Ward Leonard system. Numerical examples are given.

We will illustrate the application of our formulæ to a 20″—3 high cogging mill for rolling ingots from 10″×10″ to 6″×6″.

The number of passes is six and speed of the mill 70/59·5 revs. per min.

The torque time diagram is given in Fig. 2.

The flywheel employed has a moment of inertia of 0·54×10^6 lb. (ft.)^2, and has a diameter of 20 ft.

The motor has a full-load output of 630 H.P. at 70 revs. per min. normal slip, and the speed drop arranged for is from 70 to 59·5 revs. per min.

The maximum torque exerted by the motor=83,700-ft. lb. =1·765 full load, and the speed is then 59·5 revs. per min.

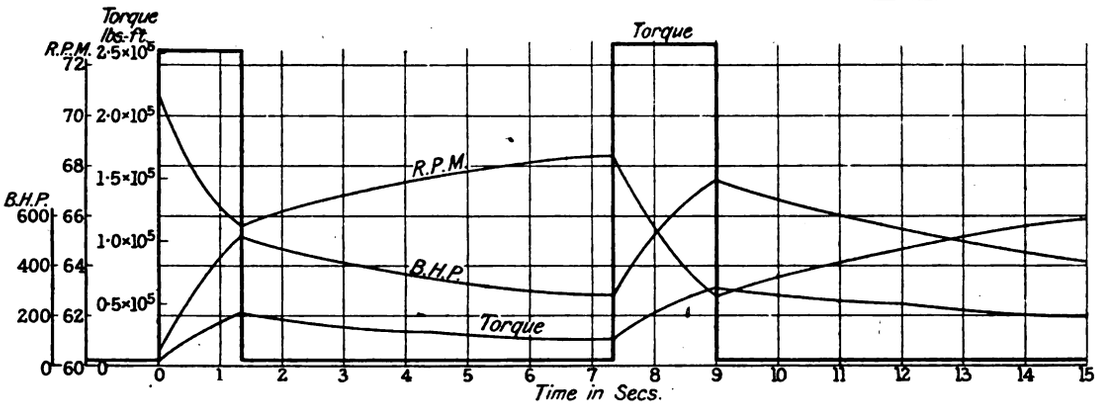

FIG. 2.—CURVES SHOWING PERFORMANCE OF THE INDUCTION MOTOR FOR PERMANENT RESISTANCE.

The slip is therefore $\frac{71·5-59·5}{71·5}=\frac{12}{71·5}=16·8$ per cent.

At full load the torque is 83,700/1·765-lb. ft.=47,500-lb. ft.

Let S=slip, corresponding to full-load torque, then

$$\frac{47,500}{S}=\frac{83,700}{0·168}.$$

$$\therefore \quad S=\frac{47,500\times 0·168}{83,700}=0·095=9·5 \text{ per cent.}$$

The full-load speed is, therefore, 64·7 revs. per min., and the full-load output is

$$\frac{47,500\times 2\pi\times 64·7}{33,000} \text{ H.P.}=585 \text{ H.P.}$$

We will calculate the torque and speed in the first pass and interval.

(1) in the pass, ω the angular speed in radians per second

$$=\frac{c}{a}+\left(\omega_1-\frac{c}{a}\right)e^{-\frac{at}{I}}.$$

$$\frac{c}{a}=\frac{a\omega_0-T_3}{a}=\omega_0-\frac{T_3}{T_F}(\omega_0-\omega_F),$$

$$\omega_0=2\pi\times\frac{71·5}{60}=7·48 \text{ radians per second.}$$

$$\omega_F=2\pi\times\frac{64·7}{60}=6·78 \text{ radians per second.}$$

T_3=2·505×10^5 lb.-ft.; friction torque=4,000 lb.-ft.

$\frac{T_3}{T_F}=\frac{2·5\times 10^5}{4·75\times 10^4}=5·28$; $\omega_0-\omega_F=0·7$.

$\frac{c}{a}=3·78$; no-load slip=0·8 per cent.; revs. per min. at no load, 70·9 revs. per min.

$\omega_1-\frac{c}{a}=3·62$; $\frac{a}{I}=\frac{47,500}{0·095\times 7·48\times 0·54\times 10^6}=0·1236$.

Using equation (3) for the speed and (9) for the torque, we will tabulate the various quantities for the first pass :—

Time, seconds.	ω.	R.P.M.	Torque (lb.-ft.).	$e^{-\frac{at}{I}}$	H.P. output of motor.
0(beginning)	7·4	70·9	4,000	1·000	54
0·3	7·27	69·3	13,500	0·965	179
0·6	7·14	68·0	22,500	0·928	292
0·9	7·0	66·8	31,500	0·89	409
1·27 (end)	6·88	65·5	41,900	0·856	524

For the first interval, we use equation (6) for the speed, and equation (12) for the torque; f/a=7·421; ω_2-f/a=6·88 −7·421=−0·541.

Tabulating the results for the interval, we have as above :—

Time, seconds.	ω.	R.P.M.	Torque (lb.-ft.).	$e^{-\frac{at}{I}}$	H.P. output of motor.
1·5	6·894	65·7	39,600	$e^{-\frac{a}{I}\cdot 1·5}$=0·973	495
2·5	6·955	66·5	35,600	,, =0·862	450
3·5	7·014	67·0	31,500	,, =0·753	402
4·5	7·057	67·5	28,600	,, =0·673	366
7·27	7·164	68·4	21,400	,, =0·475	279

For the second pass, we use equation (3) for the speed, but for ω_1 we must put the value 7·164, the value of the speed at the end of the first pass. The tabulated results for the second pass are as follows :—

Time, seconds.	ω.	R.P.M.	Torque (lb.-ft.).	$e^{-\frac{at}{I}}$	H.P. output of motor.
0	7·164	68·4	21,400	1·0	279
0·3	7·05	67·5	30,000	0·965	384
0·6	6·91	66·0	39,000	0·928	490
0·9	6·79	64·7	48,000	0·89	592
1·2	6·69	63·8	54,000	0·865	656
1·525	6·57	62·8	62,000	0·827	740

$\frac{c}{a}=a\omega_0-T_3$; here T_3=2·58×10^5.

$$\therefore \quad \frac{c}{a}=\omega_0-\frac{T_3}{a}=\omega_0-\frac{T_3}{T_F}(\omega_0-\omega_F)=7·48-\frac{2·58\times 10^5}{4·75\times 10^4}\times 0·7$$
$$=7·48-3·8=3·68.$$

$\omega_1-\frac{c}{a}=7·164-3·68=3·484$.

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Also $T=T_3-a\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t}$; $a=\frac{T_F}{\omega_0-\omega_F}=\frac{47,500}{0\cdot7}=67,855.$

In the interval of the second pass, we have

$$\omega=f/a+(\omega_2-f/a)e^{\frac{a}{I}(t_2-t)};\ f=a\omega_0-T_0;$$

and $$\frac{f}{a}=\omega_0-\frac{T_0}{a}=\omega_0-\frac{T_0}{T_F}(\omega_0-\omega_F)$$

$$=7\cdot48-\frac{4,000}{47,500}\times0\cdot7=7\cdot48-0\cdot059=7\cdot421,$$

$\omega_2=6\cdot57.$

$$\therefore\quad \omega=7\cdot421-0\cdot85e^{+\frac{a}{I}(t_2-t)}.$$

Time from commencem't. of second pass in seconds.	ω.	R.P.M.	Torque (lb.-ft.).	$e^{-\frac{a}{I}(t_2-t)}$	H.P. output.
2	6·619	63·3	58,300	$e^{-\frac{a}{I}0\cdot475}=0\cdot943$	700
3	6·718	64·4	51,700	$e^{-\frac{a}{I}1\cdot475}=0\cdot827$	632
4	6·799	64·8	46,300	$e^{-\frac{a}{I}2\cdot475}=0\cdot733$	570
5	6·871	65·5	41,200	$e^{-\frac{a}{I}3\cdot47}=0\cdot646$	515
6·525	7·017	67·0	31,350	$e^{-\frac{a}{I}\delta}=0\cdot475$	399

The average speed during the first pass is given by equation (5), viz.,

$$\omega_{av}=\omega_0-\frac{T_3}{T_F}(\omega_0-\omega_F)+\frac{I}{tT_F}\left[\left\{(\omega_0-\omega_F)\right\}\left\{\omega_1-\omega_0+\frac{T_3}{T_F}(\omega_0-\omega_F)\right\}\right]\left[1-e^{-\frac{at}{I}}\right]$$

$$=7\cdot48-3\cdot7+\frac{0\cdot54\times10^6}{1\cdot27\times4\cdot75\times10^4}\times0\cdot7\times(-0\cdot08+3\cdot7)(1-e^{-0\cdot1236\times1\cdot27})$$

$$=3\cdot78+6\cdot26\times3\cdot62\times0\cdot145.$$

$$=3\cdot78+3\cdot29.$$

$$=7\cdot07.$$

$\therefore$ average speed in revs. per min. in the first pass $=67\cdot5$.

The motor torque at any instant of the pass

$$T=T_3-a\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t},$$

the average torque during the pass

$$=\frac{1}{t}\int_0^t T\,dt,$$

$$=\frac{1}{t}\int_0^t\left\{T_3-a\left(\omega_1-\frac{c}{a}\right)e^{-\frac{at}{I}}\right\}dt,$$

$$=\frac{1}{t}\left[T_3t+I\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t}\right]_0^t,$$

$$=T_3+\frac{I}{t}\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t}-\frac{I}{t}\left(\omega_1-\frac{c}{a}\right). \quad\ldots\quad (14)$$

For the first pass

$$T_{av}=2\cdot505\times10^5+(0\cdot54\times10^6\times3\cdot62\times0\cdot855-0\cdot54\times10^6\times3\cdot62)\times\frac{1}{1\cdot27}$$

$$=2\cdot505\times10^5+0\cdot54\times10^6\times3\cdot62(0\cdot855-1)\times\frac{1}{1\cdot27},$$

$$=2\cdot505\times10^5-\frac{0\cdot283}{1\cdot27}\times10^6,$$

$$=2\cdot505\times10^5-2\cdot23\times10^5,$$

$$=27,500\text{ lb.-ft.}$$

The results for the two passes are shown in Fig. 2. In a similar manner the other passes can be figured out.

We will now proceed to investigate the case of "Constant Output," as distinct from "Constant Torque" in the passes.

The power equation for the pass is

$$T\omega-I\frac{d\omega}{dt}\omega=W.\ (15),$$

where W=constant power in pass.

As before

$$T=a\omega_0-a\omega,$$

$$\therefore\quad a\omega\omega_0-a\omega^2-I\omega\cdot\frac{d\omega}{dt}=W,$$

$$a\omega\omega_0-a\omega^2-W=I\omega\cdot\frac{d\omega}{dt}.$$

$$\therefore\quad dt=\frac{I\omega\cdot d\omega}{a\omega\omega_0-a\omega^2-W},$$

$$\therefore\quad dt=\frac{-1}{2a}\times\frac{I(a\omega_0-2a\omega)d\omega}{a\omega\omega_0-a\omega^2-W}+\frac{I}{2}\cdot\frac{\omega_0\,d\omega}{a\omega\omega_0-a\omega^2-W}.$$

$$\therefore t=-\frac{I}{2a}\log(a\omega\omega_0-a\omega^2-W)+\frac{I}{2}\omega_0\int\frac{d\omega}{a\omega\omega_0-a\omega^2-W}+C.$$

Where C is the constant of integration

$$\frac{I\omega_0}{2a}\int\frac{d\omega}{\omega\omega_0-\omega^2-\frac{W}{a}}=\frac{-I\omega_0}{2a}\int\frac{d\omega}{\omega^2-\omega_0\omega+\frac{W}{a}}$$

$$=\frac{-I\omega_0}{2a}\int\frac{d\omega}{(\omega-\frac{1}{2}\omega_0)^2+\left(\frac{W}{a}-\frac{\omega_0^2}{4}\right)}$$

$$=\frac{-I\omega_0}{2a\sqrt{\frac{W}{a}-\frac{\omega_0^2}{4}}}\tan^{-1}\frac{\omega-\frac{1}{2}\omega_0}{\sqrt{\frac{W}{a}-\frac{\omega_0^2}{4}}}$$

$$\therefore\ t=-\frac{I}{2a}\log(a\omega\omega_0-a\omega^2-W)-\frac{I\omega_0}{2a\sqrt{\frac{W}{a}-\frac{\omega_0^2}{4}}}\times\tan^{-1}\frac{\omega-\frac{1}{2}\omega_0}{\sqrt{\frac{W}{a}-\frac{\omega_0^2}{4}}}+C.$$

To determine C, we have, when $t=o$, $\omega=\omega_1$.

$$\therefore 0=-\frac{I}{2a}\log(a\omega_0\omega_1-a\omega_1^2-W)-\frac{I\omega_0}{2a\sqrt{\frac{W}{a}-\frac{\omega_0^2}{4}}}\times\tan^{-1}\frac{\omega_1-\frac{1}{2}\omega_0}{\sqrt{\frac{W}{a}-\frac{\omega_0^2}{4}}}+C.$$

$$\therefore\ C=\frac{I}{2a}\log(a\omega_0\omega_1-a\omega_1^2-W)+\frac{I\omega_0}{2a\sqrt{\frac{W}{a}-\frac{\omega_0^2}{4}}}\times\tan^{-1}\frac{\omega_1-\frac{1}{2}\omega_0}{\sqrt{\frac{W}{a}-\frac{\omega_0^2}{4}}}$$

$$t=\frac{I}{2a}\log\frac{(a\omega_0\omega_1-a\omega_1^2-W)}{(a\omega_0\omega-a\omega^2-W)}+\frac{I\omega_0}{2a\sqrt{\frac{W}{a}-\frac{\omega_0^2}{4}}}\times\left[\tan^{-1}\frac{\omega_1-\frac{1}{2}\omega_0}{\sqrt{\frac{W}{a}-\frac{\omega_0^2}{4}}}-\tan^{-1}\frac{\omega-\frac{1}{2}\omega_0}{\sqrt{\frac{W}{a}-\frac{\omega_0^2}{4}}}\right].$$

In passes the last term in brackets is usually negligibly small, and where it is not negligible the inverse tangent can be expanded, and the first term taken. An approximation can thus be obtained

$$\therefore\quad t=\frac{I}{2a}\log\frac{a\omega_0\omega_1-a\omega_1^2-W}{a\omega_0\omega-a\omega^2-W},$$

$$\frac{2at}{I}=\log\frac{a\omega_0\omega_1-a\omega_1^2-W}{a\omega_0\omega-a\omega^2-W}.$$

Put $a\omega_0\omega_1-a\omega_1^2-W=d$,

then $$\frac{d}{a\omega_0\omega-a\omega^2-W}=e^{\frac{2at}{I}},$$

$$de^{-\frac{a2t}{I}}=a\omega_0\omega-a\omega^2-W,$$

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$$i.e., \quad a\omega^2 - a\omega_0\omega + W + de^{-\frac{2at}{I}} = o.$$

$$\therefore \quad \omega = \frac{a\omega_0 \pm \sqrt{a^2\omega_0^2 - 4(W + de^{-\frac{2at}{I}})a}}{2a} \quad . \quad . \quad (15)$$

The speed is thus determined at any time during the pass.

The output of the induction motor during the pass

$$= W + I\omega\frac{d\omega}{dt}.$$

$$\frac{dw}{dt} = \frac{1}{I4a}\sqrt{\frac{8da^2e^{-\frac{2at}{I}}}{a^2\omega_0^2 - 4(W + de^{-\frac{2at}{I}})a}} = \frac{2dae^{-\frac{2at}{I}}}{I\sqrt{a^2\omega_0^2 - 4(W + de^{-\frac{2at}{I}})a}} \quad (16)$$

The motor output can thus be determined for constant total output in the passes. In the interval between the passes, the power equation is

$$I\frac{d\omega}{dt}\omega + W_0 = T \cdot \omega,$$

where W_0=frictional power, which is assumed to remain constant. The solution of this type of equation has already been indicated.

(To be continued.)

Electric Furnace for Forging and Annealing of Steel.*

By W. S. SCOTT.

Our experimental work on resistor-type furnaces for forging has continued through several years. Our first investigation was with a granular-graphite resistor bed. Other resistor materials and various combinations of materials consisting of granular graphite, coke, charcoal, and finally these materials in various combinations, also in combination with carbon blocks, were given exhaustive tests, always with the same general results. It is sometimes of equal importance to know the reasons for failures as it is to know the reasons for success, hence it should be of interest to know the reasons for discarding all of the above resistor materials as being unsuitable for an electric forging furnace.

Objections to Using Carbon as Resistor.

To secure even moderately successful results, it was found that resistor material must be of the purest carbon or graphite. It is quite difficult to obtain a supply sufficient for operating furnaces. If there is any slag or ashes left from the combustion of the resistor, it remains in the bed so that the relative proportion of such material is gradually increasing with time, causing an increase in the resistance of the furnace.

If the slag or ash is fusible at the temperature of the resistor bed, a clinker will be formed which very rapidly extends through the granular mass, resulting in a rapid increase in resistance and consequent failure to heat.

When the furnace was maintained for a considerable length of time at sufficiently high temperature to turn out heated steel at 1,800°F., we found that the temperature in the bottom of the resistor bed exceeded the safe limits of refractory materials. With a temperature of 1,800 deg. on the surface of the bed, it was found that the temperature at the bottom was approximately 3,600 deg. This great temperature difference is due to the electrical characteristics of carbon in that it has a large negative temperature-resistance co-efficient, that is, as the temperature increases the resistance decreases. It is evident that the carbon in the bottom or at the centre of the bed will operate at higher temperatures than the surface, which has an opportunity to radiate its heat to the surrounding air and chamber. An increase in temperature at any given part lowers the resistance through that part, which in turn causes more current to flow, and so on, the temperature gradually increasing with the current. Conditions tend to become stable at a very high temperature, but greatly in excess of that which may be safely withstood by any refractory material now available.

In heating a piece of work in an ordinary fuel-fired furnace, heat is transferred to the work by conduction from the hot gases and by radiation from the walls. The walls are maintained at a temperature higher than that desired at the work because they are continuously swept by the hot gases. In an electric furnace we do not have this action to heat all of the surface uniformly. If heat is generated only on the floor of the hearth, the side walls and roof must obtain their heat by direct radiation. If cold pieces of metal are laid closely over the surface of the resistor hearth, they will interfere with the radiation of the heat to the walls and roof directly in proportion to the amount of hearth surface they cover. This would mean that the work would be heated from the under side only, and instead of receiving heat from the walls and roof, it would be giving off heat, thereby always having a great difference in the temperature on the two opposite sides. In order to heat the upper surface to a sufficiently high temperature, the lower surface must be overheated.

Characteristics of Silicon Carbide as a Resistor Material.

During the latter part of 1916 we began our experiments in using carbide as a resistance material. A study of the chemical and physical properties of silicon carbide led us to believe that it possessed desirable qualities essential to a suitable resistor for an electric forging furnace, but also indicated that there were many difficulties to be overcome which were real problems in themselves The temperature of formation of this resistor is 1,950°C. (3,542°F.). The temperature of decomposition is 2,220°C. or 4,018°F. There is no oxidation of this material in pure oxygen at 1,000°C. From 1,500 to 1,800°C. oxidation is very much retarded by the fused silica coating. Neutral or reducing gases, such as carbon monoxide, nitrogen and hydrogen, have little or no action. The hardness is between that of the ruby and the diamond. Specific gravity is 3·12 to 3·20. Based on a specific gravity of 3·20, the weight of the solid block without pores is 199·7 pounds per cubic foot, or 0·116 pound per cubic inch.

Tensile Strength.—In order to adapt silicon carbide to its various uses, the tensile strength of the bonded articles may be made to vary between wide limits. In ceramic bonded articles where the bond does not introduce objectionable pnysical or chemical properties, a tensile strength of 1,400 pounds per square inch may be attained. A sacrifice of resistance to heat changes and chemical actions affecting ceramic articles must be expected with high tensile strength.

Electrical Conductivity.—This resistor is a conductor of the second class. At ordinary temperature its conductivity is very low, being several times less than that of carbon With increase of temperature its conductivity increases very rapidly, as it has a large negative temperature-resistance co-efficient.

The resistivity of the bricks varies with differences in porosity and chemical composition. However, it is interesting to note that at temperatures above 1,800°F. the resistivities have approximately the same value. A general idea of the variation of the resistance will be obtained from the following :—

75° F.	50	ohms per cubic centimetre
1,000° F.	18	ohms per cubic centimetre
1,800° F.	3·7	ohms per cubic centimetre
2,550° F.	0·65	ohms per cubic centimetre

From a résumé of the above, it may be seen that this resistor material possesses the following excellent qualities.

1. The temperature of decomposition is above 4,000°F., which is approximately 1,500 deg. higher than the hottest temperature required at the surface of the resistor. Due to the construction of furnace employed, the atmosphere in the furnace chamber is non-oxidising, and under these conditions the resistor is non-consuming.
2. May be molded in block form, allowing the heating element to be placed in any desirable position around the heating chamber.
3. Due to its high tensile strength, the roof of the heating chamber as well as the hearth may be made out of these resistor blocks.
4. The fact that it has a large negative temperature-resistance co-efficient may be utilised in the control of the furnace temperature by controlling the current input to this resistor material.

Experiences with Early Furnaces of This Type.

The first complete furnace of this type which we built and which gave promise of success was designed with two working chambers 7 in. long by 5 in. high, for the heating of 50 lb. of steel per hour to 1,800°F. in each chamber, or a total of 100 lb. per hour for the furnace. The resistors consisted of blocks having a cross section of 4½ in. by 2½ in., passing above and below the working chamber. The resistors terminated in electrode chimneys filled with granular graphite, into which steel terminal plates extended for external connections.

Owing to the high resistance of this type of furnace when cold, and due to the length of resistors used, a starting voltage of 220 volts was required, which was cut down in a few minutes' time to 110 volts, and then gradually reduced until 60 volts was reached, which maintained the proper temperature.

The time required to bring the furnace up to an operating temperature of 1,800 deg. was 8 hours, starting with the furnace cold. Owing to the great heat-reserve capacity of the furnace, the times

* From the "Electrical Review" (U.S.A.).

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required in successive heatings were greatly reduced; this depended upon the length of time the furnace was out of operation. In order to have the furnace available for immediate use, sufficient current was maintained on the furnace during the nights to supply the radiation losses. On a 20-hours continuous forging test the average input was about 18 kw., or 300 amperes at 60 volts. The hourly output averaged 20 lb., heated from 70 to 1,800°F., and 40 lb. from 900 to 1,800 deg.

Notwithstanding the light insulation that was used, a furnace efficiency of 41 per cent. was maintained. The furnace ultimately proved unsatisfactory due to unequal heating of the two chambers.

The results of the tests proved conclusively that a temperature of 1,800°F. could be obtained and maintained for an indefinite period so far as the resistor material was concerned. Hand control was used entirely in the operation of this furnace, in conjunction with a circuit-breaker for tripping the circuit should the current increase beyond a safe operating value.

The second complete furnace had an over-all dimension of 46 in. wide, 38 in. deep by 48 in. high, inclusive of an iron stand 12 in. high. The resistor consisted of two blocks 2½ by 4½ in. cross section by 9 in. in length, connected in parallel, one over the heating chamber and one underneath, 2½ in. apart, forming a heating chamber 7 in. wide, 11 in. deep by 2½ in. high. The resistors were surrounded and imbedded in a refractory lining made up principally of a crucible clay and a graphite mixture. Surrounding this extremely hot area silica bricks were used backed up by ordinary fire bricks.

Electrode chimneys or wells were used very much the same as with the first furnace. The electrodes consisted of granular graphite and an amorphous carbon rod 4 in. sq. by 20 in. long imbedded in each electrode well, and extending upward from near the steel terminal plate at the bottom of each well to the ends of the two resistors. The granular graphite insures electrical contact between the resistor blocks and the carbon block, and between the carbon block and the terminal plate. A cool terminal is thus obtained.

The heat insulation on the outside of the furnace consisted of 4½ in. of high-grade insulating brick all round, except opposite the electrode wells and around the door. Thin sheet-steel held in place by angle iron and tie rods clamped the insulating bricks together.

The starting voltage on this furnace was 75 volts, and the time required to raise the temperature of the heating chamber to a forging temperature of 1,800°F. was two hours. The power required at full load was 10 kw. or approximately 300 amperes at 33 volts. At no load, a consumption of 5 kw. or 200 amperes at 25 volts obtained. This corresponds to an efficiency of 50 per cent.

The longest continuous run extended over a period of 15 days, or 370 hours, the furnace being maintained continuously at a forging temperature of 1,800 deg. After these tests an examination of the resistors was made, but no perceptible effect due to heating could be determined.

The control equipment consisted of a 110-volt transformer with knife switches for obtaining starting voltage, and interlocked magnet switches, push-button operated, for obtaining the required running voltage. A circuit-breaker was used as in the first case for protecting the furnace against an increase in current above the safe operating value.

First Furnaces for Continuous Use Under Shop Conditions.

The first furnace to be placed in continuous operation under actual shop conditions was made early in 1917. This furnace, a duplicate of the one last described, was installed in the tool forging shop of the Westinghouse Electric and Manufacturing Co., and while it was considered that the furnace was still in its experimental stages, it was essential that we gain the experience of knowing how it would stand up under regular shop conditions. Several failures of the furnace were recorded, but in each case the failure was due to the improper functioning of the control equipment which we were developing and experimenting with at that time.

This furnace has been in operation for a period of one year, with highly encouraging results. Many runs have been made of continuous operation for periods of 400 to 500 hours, forging high-speed steel to 1,850°F., and drop forging at 2,200 deg. without any records of resistor failure, or any perceptible deterioration in the resistor due to the high operating temperature. One run of 500 hours was made at a temperature of 2,650 deg. without experiencing any difficulty whatever.

For high-speed steel work, it was found advisable to pre-heat it before being placed in the heating chamber. A pre-heating chamber was constructed under the heating chamber, consisting of an opening in the front of the furnace just below the lower resistor, into which the tools could be placed for pre-heating to eliminate strains that otherwise would be set up in the steel when placed in the furnace.

Another furnace has been built and placed in operation at our works, having a heating chamber 18 in. wide, 12 in. deep and 4½ in. high. The capacity of this furnace is 20 kw., the starting voltage 220, and the running voltage 70. The efficiency is 60 per cent. This furnace is designed to operate on steel drop forgings requiring a temperature of 2,300°F.

The control equipment at the present time is not completely automatic. That is to say, the furnace is not automatically brought up to the required temperature, but once the required temperature is obtained, then the control equipment will maintain that temperature within certain limits. Interlocked knife switches are used for connecting to the starting taps on the transformer. As the furnace increases in temperature it is necessary to step down to lower voltages. The lower-voltage taps are controlled by means of magnet switches operating over a relatively small percentage of the voltage range in order to obtain close temperature regulation.

The control equipment thus far developed is semi-automatic in its action, and may be used with entire satisfaction where the operator has a proper appreciation of the functioning of the control equipments. However, it is our intention to ultimately develop a complete automatic control equipment, which we hope to have perfected at an early date.

Advantages of the Electric Over Fuel-Fired Furnaces.

The general type of the furnace such as we have developed has a very wide application, but our experiments thus far have been largely confined to forging, vitreous enamelling, and for the reheating of glassware. A special furnace has been constructed and is successfully operated for the forming of lamp chimneys.

Forging requires an operating temperature of from 1,800 to 2,300°F., depending upon the kind of steel used. Our great difficulty with a fuel-fired furnace is not in the ability to obtain a sufficiently high heat, but in uneven heating. It is almost impossible to obtain uniform temperature throughout the entire chambers; consequently when the furnace is operated on a production basis, with several pieces being heated at one time, some of the pieces of work will be much hotter than others. The pieces in the hottest portion in all probability will heat much too rapidly, with the result that either the corners of the tools are burned before the material is heated clear through, or if it is removed before the surface burns, the centre has not reached a sufficiently high temperature. In this case the soft outside will yield much more readily than the hard inside, with the result that the outer particles will be torn asunder while the inside will be sound. The loss through oxidation takes place while the work is being heated in a fuel-fired furnace and also after it has been withdrawn and is being forged. The oxidation in the furnace is by far the larger of the two.

Superiority of the Electric Furnace for Annealing of Steel.

Annealing or softening is accomplished by heating steel to a red heat ranging from 1,300 to 1,600°F., depending upon the grade of steel, and then cooling it slowly. If the temperature is carried too high, it may leave the steel actually harder than the proper heat would leave it, besides running the risk of forming scale. If scale is raised on a piece of steel, this scale will be a granular oxide of iron and may spoil the tools used to cut it, sometimes also changing the structure of the steel, making it brittle and causing it to crack in hardening. The effect of heat on steel may be noted by taking a bar of steel nicked in 10 or 12 places about ½ in. apart, heating it in a fuel-fired furnace until the end is up to a good white heat, and then plunging it into cold water. In breaking off the pieces at each nick, it will be seen that characteristic changes have taken place in the steel. The end of the rod which had been overheated will be very open or crystalline in structure, the succeeding pieces becoming closer and closer in grain until one piece is formed possessing a close, even grain, the structure desired.

For every variation in the temperature there is a variation in grain of the steel. The effect of too high a heat is to open the grain, to make the steel coarse. The effect of irregular heat is to cause irregular grain, irregular strains and cracks in the steel.

The furnace described offers an ideal solution for the conditions as above outlined, because:—

(*a*) Uniform temperature is obtained in all parts of the heating chambers.

(*b*) The temperature found to produce the most satisfactory results may be obtained and maintained indefinitely.

(*c*) A neutral atmosphere is obtained in the furnace chamber, thereby eliminating the major part of the oxidation of the steel.

For a given class of work subjected to a given heating operation the following conditions must apply.

1. The rate at which the work is heated is capable of infinite variation, but there must be some best sequence of heating.

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2. The temperature difference between the heating medium and the work may be almost any value, but there must be some best value.

3. The maximum temperature to which the work is heated may be almost any value, but there must be some best maximum temperature for each grade of steel.

An electric furnace permits of doing such experimental work as will exactly determine these factors and, once they have been determined, it permits an operator to duplicate these results in operation —the ultimate feature in which we are interested.

Engineers' Protective Associations.

At the invitation of the Council of the Institution of Electrical Engineers, a conference of representatives of the Associated Municipal Electrical Engineers of Greater London, the Chief Technical Assistants' Association and the Electrical Power Engineers' Association was held at the temporary offices of the Institution on the 9th inst. The number of representatives sent by each Association was in proportion to its membership.

The chair was taken by Mr. C. H. Wordingham, C.B.E., President of the Institution, and the Council was further represented by Messrs. R. A. Chattock, G. W. Partridge and Roger T. Smith (vice-presidents), and Messrs. A. H. Marshall, R. Howard Fletcher and W. Lang, chairmen of the Newcastle, Western and Yorkshire Local Sections respectively. At the close of the proceedings the following resolutions were passed, subject to ratification by the governing bodies of the three Associations:

1. That one single combined protective association be formed for the whole electric supply industry.

2. That chief engineers be included in the membership, provided they are not employers or employers' representatives on an Industrial Council or similar body dealing with technical staffs, subject also to proper safeguards for special staff questions that may arise.

3. That a protective association formed from existing associations adopt the constitution and, for the present, the title of the Electrical Power Engineers' Association, seeing that it is the only existing association for the purposes in view which is constituted as a trade union.

4. That the qualifications for membership of the association be those of the Electrical Power Engineers' Association, but all new members elected after December 31, 1921, shall be required to have passed the A.M.I.E.E. examination, or an equivalent examination, and that this be the link between the Institution and the association.

5. That the Chief Technical Assistants' Association and the Associated Municipal Electrical Engineers of Greater London each appoint two representatives to meet the National Executive Committee of the E.P.E.A. at Manchester on July 27th to discuss and approve the draft constitution of the E.P.E.A. This draft in turn to be submitted to Institution for final ratification. The representatives of the two associations first named, if members of the E.P.E.A., to remain as part of the National Executive Committee of the E.P.E.A. for the current year (*i.e.*, until June, 1919).

The Institution also to send a representative of the Council to attend the meeting of July 27th in an advisory capacity.

Newcastle Electrical Engineers and the E.P.E.A.

A meeting of electrical engineers was held on the 17th inst. in the Mining Institute, Newcastle-upon-Tyne, to consider the question of joining the Electrical Power Engineers' Association. Mr. A. H. Marshall, local President of the I.E.E., was in the chair, and there was a large attendance.

The Chairman said the meeting was called to consider the matters arising out of the meeting held there on June 3rd, at which delegates were appointed to represent them at a mass meeting to be held in London for the formation of an association of British electrical engineers. It had been arranged to hold similar meetings at each of the Local Sections of the I.E.E., but, with the single exception of Newcastle, there was a great deal of hostility shown to the proposals of the I.E.E. As the result the London meeting had to be abandoned. This hostility arose, partly, because the I.E.E. was supposed to have some ulterior motive in taking the action they had done, and, partly, because of the existence of other associations, notably the E.P.E.A., who thought they were better able to look after the interests of supply engineers. He could say that the President and Council were guided solely by a desire to benefit their members and others engaged in the electrical industry; they wanted to promote unity amongst the various associations in order to look after the economic interests of the younger men. As soon as the feeling of the country was found the President of the I.E.E. (Mr. Wordingham), after negotiation with the executives of the E.P.E.A., the C.T.A., and the A.M.E.E., arranged a conference of delegates and members of the Council of the I.E.E. for July 9th in London to discuss what further steps should be taken to bring about the desired unity, and to decide how the help of the I.E.E. could best be given to set up a strong protective association. At this conference it was agreed that a protective association be formed from the existing associations, adopting, for the present, the title of E.P.E.A., seeing that it is the only association registered as a trade union; that the qualification for membership of the association remain as at present, but that after December 31, 1921, all new members shall have passed the I.E.E. associate membership examination or its equivalent. The action of the President and Council of the Institution had been misrepresented by some; all they wanted to do was to give the support of the I.E.E. as a body to that organisation which showed itself best adapted to look after the interests of the profession. The body which had the greatest claim on their support at present was, undoubtedly, the E.P.E.A.

Mr. HESLOP, of Barrow, reviewed the origin of the E.P.E.A. and its present position. The position of staff engineers could only be improved by co-operative effort. The wages paid in central stations in pre-war days, and even at present, approached a national scandal, and when they regarded the various grades getting wages little better than a labourer's there was no need for an apology for such an association as theirs. Six months ago, a conference was held in London with representatives from Birmingham and Manchester, and the result was the forming of the Association as the Electric Power Engineers' Association. They had difficulties to contend with, the first being the inertia of the staff engineers and the difficulty of convincing them that co-operation was necessary, and they had also to contend with other associations. The association was run on democratic lines, and the country had been divided into Southern, Midland and Northern Sections, with London, Birmingham and Manchester as headquarters. Having explained the scheme of government, he said the total possible membership was 4,000 or 5,000, estimating 400 stations in the country, and averaging the staffs at 10 per station. In their six months' working they had got from 1,200 to 1,500 members, or about one-third of the total possible. In Lancashire and Cheshire about 90 per cent. were in the association. Yorkshire, also, was strong, and he thought there was only the Tyneside area that was not covered. He hoped that a strong and active branch would be started on Tyneside. A little while ago they held a meeting at Glasgow and formed a branch there, which was in a strong and flourishing condition. He believed that the E.P.E.A. would be able to maintain the best traditions of central station practice.

Mr. SIMPSON submitted the rules so far as they had been approved and published. They recognised in view of the Whitley Report, that when questions of indsutrial reconstruction came forward engineers must have a definite organisation to exert their influence. The Whitley Report recognises the rights of the workmen. But where did the staff engineer come in? Where would they be unless they had an organisation? The E.P.E.A. recognised the far reaching importance of the Whitley Report, but, underlying that, was the feeling of the necessity for greater harmony and goodwill on all sides. If staff engineers were organised they could claim a voice in the Industrial Council, and, in his opinion, would have great influence.

Mr. H. W. CLOTHIER thought they should make it their duty to study the reports issued by the Board of Trade regarding the development of the trade of the country. They knew that owing to bad legislation—to blindness on their part—they allowed their electrical industry to proceed with ultra caution and slowness, giving advantage to their Continental and American competitors. To put matters right they must have very strong and keen co-ordination, active in matters of legislation and community welfare. They must also make the electrical industry the "key" industry attractive to the best brains in the country. Individual efficiency suitably rewarded would lead to national efficiency. The I.E.E. Council jumped at the A.B.E.E. because it wished to identify itself with the aims and general principles of organised protection, and the A.B.E.E. was the only proposition that was put before the Council. Had the E.P.E.A. fully declared their sensible policy earlier he thought the Council understanding it better would have acted more favourably from the start.

A number of questions having been answered by Mr. Simpson, a vote of thanks to the officials of the E.P.E.A. was carried, and the meeting terminated. A gathering of prospective members of the E.P.E.A. was held, Mr. Simpson in the chair.

The Illuminating Value of Searchlights and Fresnel Lenses.—Two recent contributions to "Annales de Physique" by Prof. A. Blondel and Mr. Lavauchy, deal with the principles underlying the calculation of the illumination derived from searchlight projectors, and the effect of arrangements of various Fresnel prismatic devices, at a great distance. Special attention is devoted to the distribution of light in the beam of projectors and the effect of removal of the source from the focus. The conditions are highly complex, and are illustrated by a number of neat graphical methods. A very small eccentricity from the focus may profoundly modify the distribution of illumination. It is possible by this means to improve the "coefficient of homogeneity" of the beam, but only at the expense of luminous efficiency or spread of the beam. The general method employed in this investigation, the authors remark, is not necessarily limited to parabolic reflectors, but may be extended to other forms (Fresnel lenses, Mangin mirrors, &c.). In the second contribution a number of typical cases of catadioptric and annular lens arrangements are worked out with characteristic ingenuity.

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Conditions in Our Factories.

The annual report of the Chief Inspector of Factories and Workshops for the year 1917 lies before us. It is a very different document from what it was in pre-war days. The whole report now occupies but 24 pages, and the report of the Electrical Inspector, Mr. G. S. RAM, is reduced to only a few paragraphs. Of technical information there is very little, but, on the other hand, the report has become an increasingly interesting document of humanity. The war has taught us a fact which some of us realised long ago, that the welfare of the worker is one of the most important questions in industry.

Much of the present report is concerned with the hours of labour. It is interesting to note that there is a marked tendency to reduce the number of working hours per week. It appears that Scotland is the pioneer in this direction; for as long as seven years ago the great Paisley cotton thread firms adopted the 8 a.m. start. Their experience has been that this change has resulted in the almost complete disappearance of bad time-keeping, whilst sickness amongst the girls has decreased, and the reduction in output is hardly noticeable where it depends upon the activity of the workers, and is not even in proportion to the loss of time where the output depends chiefly on machine hours. Lastly, better work is secured and maintained.

In other parts of the country there are also movements in favour of shorter hours. Thus in the Huddersfield district, some 30 firms have made an agreement to reduce the working hours from 53 to 50 per week for a period of one year as an experiment. No reduction in output has occurred and the loss through bad time-keeping has decreased. One of the leading firms in the slipper trade, in the Rossendale valley, has adopted a 48-hour week, and has found that the production and the wages paid have not been decreased in the least through this change, whilst indisposition amongst the workmen has been lessened by almost one half. The conditions of work at this factory are very good and the spell of four and a half hours in the morning and afternoon is broken by short pauses, when a cup of tea is given to each worker. The experiment met with a good deal of opposition at first from other manufacturers in the district, but owing to the successful results the whole of the slipper trade in the Valley have now abolished work before breakfast. It is also interesting to note that when the woollen manufacturers were compelled through restrictions to reduce their hours the majority adopted for their weaving sheds a 9-hours day, from 8 a.m. to 6 p.m., and both employers and the workpeople are almost unanimous as to the benefits resulting from the change.

It is very regrettable to notice that, although generally speaking, excessive hours are not found, there are bad cases from time to time of illegal hours, and also cases where young children are illegally employed. As an example, we may mention a case at Woolwich, where a boy of 16 years old was employed for 108 hours per week. He began work at 8 a.m. on Monday and worked till 8.30 p.m. on Tuesday, with two somewhat similar intervals, starting on the Wednesday and the Friday. In another case boys had been worked from 25 to 30 hours consecutively, except for intervals of four or five hours. Instances are mentioned of little girls of 8 to 10 or 11 years of age being employed at intervals between school hours, and two or three girls were in such health as to have been absent from school for long periods. It is cases of this kind which cause a bitter feeling on the part of the workers and which do much harm to the humane employer, because Labour naturally takes the view that all employers would adopt methods of this kind unless provision were made to render them impossible.

Another point on which the report lays emphasis is welfare work. There seems still to be a lack of appreciation of the fact that unnecessary fatigue is simply waste of energy which detracts from the output of the worker—probably in both quantity and quality. Take, for example, the question of seats for factory workers, more particularly women and girls. There is obviously no advantage in standing if the work can be done equally well by a person who is sitting; the advantage is all the other way, because more energy can then be put into the work. Yet it appears that overlookers are frequently averse to encouraging the girls to sit. It is clear that in many cases the provision of seats should be compulsory and not merely voluntary. The improvement of conditions, however, is a slow process. It has been going on for many years and it has been encouraged by the enlightened employer. But it has remained for the stress of war to give a long needed impulse to this very necessary movement.

Review.

Principles and Practice of Electrical Engineering. By ALEXANDER GRAY. 2nd Edition. (London: The Hill Publishing Co.) Pp. xxi.+431. 12s. 6d. net.

The first edition of this book was published in 1914 and the principal changes considered necessary in this edition are (according to the preface) the elimination of the left-hand rule for the direction of the force on a conductor in favour of the conception of strained lines of force, a change in the method of presenting the subject of direct current drum windings, a few additions to the chapters on alternating current circuits and the addition of a considerable number of problems without answers. The work is based on a lecture and laboratory course given to the senior civil, mechanical and mining students at McGill University.

Although such an enormous amount of information is compressed into a comparatively few pages, yet the whole makes good reading because of the exceptionally clear and concise way the author has of expressing his ideas. The book is not intended to give a working knowledge to those actually engaged in electrical work, but to give a broad idea of the principles and practice of electrical science to those who are studying or engaged on other branches of engineering. In this way, as the author states, such men can afterwards make intelligent use of the data contained in the electrical handbooks, or take up with advantage a further study of the special treatises on the subject. The author's method of explaining the theory and then immediately describing some practical applications make it very clear and easy to follow. A good example of this method occurs in the chapter on rheostats, which follows the chapter on electric circuits and resistance; and again in the chapter on solenoids and electromagnets, which comes immediately after that on magnetic circuits and magnetic properties of iron. We cannot leave this chapter on solenoids, however, without remarking on the absence of any figures obtained from tests, except for one set of curves.

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The design of such apparatus is not easy and is usually based on empirical formulæ rather than on the theoretical figures, and this fact might perhaps have been made more clear.

The first 26 chapters deal with direct currents, and include chapters on windings, commutation, motors, generators, controllers and batteries. Chapters 27 to 38 contain information on alternating-current work, chapter 39 deals with motor-generators and rotary converters, chapter 40 with traction, chapter 41 with transmission and distribution, chapter 42 with lighting, and chapter 43 gives a series of experiments suitable for a laboratory course. Two points occur to us which might be improved. The first is in the chapter on polyphase induction motors, where the leakage reactance of the stator winding is not kept distinct from the reactance; and the second is the explanation of the split-pole converter, which is decidedly rough-and-ready and can hardly be called accurate.

The book, on the whole, appears to fulfil admirably the object for which it was written. Perhaps it would be rather difficult for students to get the best out of it without outside aid, but the amount needed of such assistance has been reduced to a minimum by the logical arrangement and clear method of presenting the subject. R. G. J.

Resistance and Reactance of Iron Transmission Lines.

By A. PRESS.

At this time, when iron transmission lines are being introduced more and more into actual practice, a mathematical theory which will enable one to deal with circuits of variable permeability should prove of interest to engineers. The ordinary constant permeability mathematics is known not to be applicable to iron containing circuits, and that should be the more reason why a new mathematical operator method should be the more welcome.

The new views in dealing with variable permeability were first disclosed in a Paper by the author in THE ELECTRICIAN, of London, July 23, 1915. Since then a simple Harmonic Algebra has been evolved which enables one to solve for the harmonic components of voltage or current when either the simple sinusoidal current or voltage is given. Judging by the work of Messrs. Hague and Neville (*see* THE ELECTRICIAN, October 13, 1916), the working range for variable flux distributions is apparently 10,000 gauss, though some extension would be required to take account of magnetic saturation.

The differential equations connecting voltage and current will first be obtained; then, as an introduction, the ordinary solution for a copper wire will be derived, following which will come the work of the resistance and reactance of iron wires due to the simultaneous influence of hysteresis and variable permeability. The method of evaluation of the harmonic components, whether of voltage or current, will be gone into in a later paper.

In a circular iron conductor the current is assumed to flow axially along the wire in the direction z. The conductor being made of magnetic material, it is required to find the effective resistance of the wire as well as the reactance for a sinusoidally impressed E.M.F.

Let the current density of the wire be Δ; then the total volume current passing axially along the wire in the direction z in an elemental area, $drd\theta$, is $\Delta rdrd\theta$. In taking the line integral $\int Hdl$ around the elemental area it is necessary to note, by the nature of the problem, that there can be no radial or axial components of magnetic density, only one B tangential to the circles having the centre of the wire as an axis. The direction of B will be counterclockwise in the plane of r, θ. Thus, for the lower side AB of the figure, by the first law of electrodynamics, the line integral will be $-Hrd\theta$. For the top side of the rectangle it will be $(H+dH/dr \,.\, dr)(r+dr)d\theta$, and

$$\frac{4\pi}{10}drd\theta r\Delta = -Hrd\theta + \left(H+\frac{dH}{dr}dr\right)(r+dr)d\theta$$

$$= Hdrd\theta + \frac{dH}{dr}drd\theta r + \frac{dH}{dr}dr^2d\theta.$$

Dividing throughout by $drd\theta$, and neglecting higher orders of infinitesimals than the first, one has

$$\frac{4\pi}{10}\Delta = \frac{1}{r}H + \frac{dH}{dr} \quad \ldots\ldots\ldots\ldots \quad (1)$$

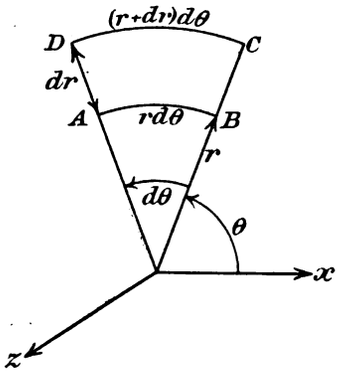

FIG. 1.

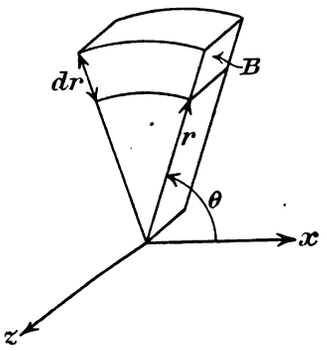

FIG. 2.

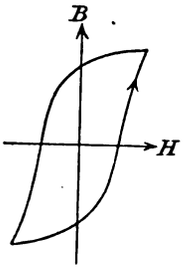

FIG. 3.

Taking now account of the second law of electrodynamics, one has per unit length axially of the conductor

$$-dr\frac{d\beta}{dt}10^{-8} = \Delta\rho - \left(\Delta+\frac{d\Delta}{dr}dr\right)\rho\frac{d\beta}{dt}10^{-8} = \frac{d\Delta}{dr}\rho \quad . \quad (2)$$

and by (1) and (2)

$$\frac{4\pi\mu}{10^9\rho}\frac{d\Delta}{dt} = \frac{1}{r}\frac{d\Delta}{dr} + \frac{d^2\Delta}{dr^2}$$

Be it noted that μ, the permeability, is usually taken as a constant. This limitation is not at all necessary, for one can look upon μ as a generalised permeability operator which will now be explained.

Consider the B-H loop relationship for iron due to a continued cyclic variation of either B or H (Fig. 3). Thus, let

$$H = \underline{H}\sin pt,$$

where H is the instantaneous value and $\underline{H}$ is the maximum value. If, then, H varies from + to −, it will follow that such values of B are to be taken as will correspond to the loop determination according to the direction of the arrow of the loop.

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Plotting in rectangular co-ordinates, one will have an irregular shaped B wave of magnetic density, whereas the corresponding H curve of magnetic force is necessarily sinusoidal by condition. If this B curve is analysed according to the harmonic analysis of Fourier, one will have

$$B=H\{a_1\sin pt+a_3\sin 3pt+a_5\sin 5pt+ \\ +b_1\cos pt+b_3\cos 3pt+b_5\cos 5pt+\},$$

where the a's and the b's are constants. Introducing a new mathematical operator, Q_m, defined by the relation

$$Q_m\sin pt=\sin mpt,$$

will enable one to express B more manageably from a mathematical point of view. The operator Q_m is to be so understood that it has the property of changing the function $\sin pt$ into $\sin mpt$, very much like the operator $1/p\,.\,d/dt$, acting on the operand $\sin pt$ by ordinary differentiation, changes it into $\cos pt$. As a matter of fact, Q_m can be expressed in terms of the differential operator $d/dt=t_1$ by a method kindly communicated to the author by Oliver Heaviside. (*See also* the latter's "Electromagnetic Theory," Vol. II., p. 109.)

By considering the operand as t^{dm}, one can show* that

$$\sin pt=p\,t_1\,.\,(1+p^2\,t^2_1)^{-1}t^{dm}=\left(1-\frac{p^2}{t_1^{\,2}}+\frac{p^4}{t_1^{\,4}}-\right)\frac{p}{t_1}\,t^{dm} \\ =pt-\frac{p^3t^3}{3}+\frac{p^5t^5}{5},$$

because $t_1^{\,m}t^n=\dfrac{n}{n-m}\,t^{n-m}$. Thus one can write

$$\sin mpt=\frac{mp}{t_1}(1+m^2p^2/t_1^{\,2})^{-1}t^{dm}=Q^m\sin pt\,;\ Q^m=m\,\frac{1+p^2\,t_1^{\,2}}{1+m^2p^2/t_1^{\,2}}$$

by substituting for $\sin pt$ its operational value. Thus, writing for B its equivalent

$$B=H\left\{a_1+b_1\frac{t_1}{p}+\left(a_3+b_3\frac{t_1}{3p}\right)\,Q_3+\right\}\sin pt\,;$$

since

$$\frac{t_1}{mp}\,Q_m\sin pt=\cos mpt.$$

Noting, therefore, that $H=H\sin pt$,

$$B=\mu H,$$

where, in fact, μ is now generalised and is a differential operator function given by

$$\mu=\left(a_1+b_1\frac{t_1}{p}\right)+\left(a_3+\frac{b_3t_1}{3p}\right)Q_3+\ \&c.$$

Since H is a cyclic function B must be likewise. The equation in Δ will now become $\dfrac{d^2\Delta}{dr^2}+\dfrac{1}{r}\dfrac{d\Delta}{dr}=q^2\Delta$, with the understanding that $q^2=\dfrac{4\pi\mu}{10^9\rho}\,t_1$ and μ is the generalised operator function just referred to.

To find a solution take tentatively

$$\Delta=1+ar+br^2+cr^3+dr^4+er^5+\ ;$$

then by proper substitution, differentiation and addition one will have

$$\frac{d^2\Delta}{dr^2}+\frac{1}{r}\frac{d\Delta}{dr}=q^2(1+ar+br^2+cr^3+dr^4+) \\ =\frac{a}{r}+4b+9cr+16dr^2+25er^3+.$$

If the above represents an identity it is necessary to have

$$a=0 \qquad b=0 \qquad e=0$$

$$b=\frac{q^2}{2^2},\qquad d=\frac{q^4}{2^2\,4^2},\qquad f=\frac{q^6}{2^2\,4^2\,6^2},\ \&c.$$

whence a possible form of solution is

$$\Delta=1+\frac{q^2r^2}{2^2}+\frac{q^4r^4}{2^2\,4^2}+\frac{q^6r^6}{2^2\,4^2\,6^2}+=J_0(qr).$$

This latter series is named the Zeroth Bessel function, with imaginary argument and the operator $J_0(\ )$ acting on the operand qr can be said to transform the expression qr into the series just derived. The proper solution for the problem at hand takes the form, therefore,

$$\Delta=\Delta_s\frac{J_0(qr)}{J_0(qR)}\sin(pt+\theta).$$

It must be noticed that in the operational equation

$$\frac{d^2\Delta}{dr^2}-\frac{1}{r}\frac{d\Delta}{dr}=q^2\Delta$$

the time as well as the operator q^2 are to be regarded as constants for the time being. The desired differential equation will not only thereby be satisfied, but also the boundary condition for $r=R$, that is, for the skin of the conductor where most generally one can set

$$\Delta=\Delta_s\sin(pt+\theta),$$

with an aggregate line current $i=\sqrt{2}I\sin pt$. However, the total line current of the conductor must be

$$\sqrt{2}\,I\sin pt=\int_0^R 2\pi r\Delta dr=\Delta_s\pi R^2\sin pt,$$

and $\Delta_0=\dfrac{\sqrt{2}I}{\pi R^2}$ represents the average maximum current density value in the conductor. Performing the integration indicated from the series development

$$\int_0^R rJ_0(qr)dr=\frac{R^2}{2}\left\{1+\frac{1}{2}\frac{q^2R^2}{2^2}+\frac{1}{3}\frac{q^4R^4}{2^2\,4^2}+\frac{1}{4}\frac{q^6R^6}{2^2\,4^2\,6^2}+\right\}.$$

It follows therefore

$$\Delta_s\sin pt=\Delta_s\left\{\frac{1+\frac{1}{2}\frac{q^2R^2}{2^2}+}{1+\frac{q^2R^2}{2^2}+}\right\}\sin(pt+\theta).$$

Note that the skin current is never in exact phase with the average line current. This is because there are circulating currents in the conductor that increase the apparent resistance. When $pt=\pi/2$ the total line current $\sqrt{2}I\sin pt$ will be a maximum or $\Delta_s\rho'=\Delta\rho\cos\theta$ with ρ' as the effective resistivity of the conductor against the direct current resistivity ρ. The ratio

$$K_c=\frac{\rho'}{\rho}=\frac{\Delta_s\cos\theta}{\Delta_s}$$

will give, therefore, the relation of the effective resistance of the conductor to the direct current resistivity. In other words it will be a measure of the "skin effect" resistance.

Operating on both sides with the inverse operator function gives

$$\Delta_s\left\{\frac{J_0(qR)}{1+\frac{1}{2}\frac{q^2R^2}{2^2}+}\right\}\sin pt=\Delta_s\sin(pt+\theta) \\ =\Delta_s\left\{1+\frac{1}{2}y-\frac{1}{12}y^2+\frac{1}{48}y^3-\frac{1}{180}y^4+\frac{13}{8640}y^5-\right\}\sin pt$$

by division and where for convenience there has been placed

$$y=\frac{q^2R^2}{2^2}=\frac{\pi R^2}{10^9\rho}\,.\,\mu t_1.$$

For a copper conductor where $\mu=1$ and there is neither variable permeability nor hysteresis loss $\dfrac{d}{dt}=t_1=pj$ and with $y=mj$ and $m=\dfrac{\pi R^2p}{10^9\rho}$. Thus for $pt=\pi/2$ one has

$$\Delta_s\left(1+\frac{1}{12}m^2-\frac{1}{180}m^4+\right)=\Delta_s\cos\theta$$

$$\frac{\rho'}{\rho}=K_c=1+\frac{1}{12}m^2-\frac{1}{180}m^4+.$$

If as in an iron transmission line one considers that μ is a differential operator determining in fact the hysteresis loop, then an exact solution should take into account the simultaneous effect of hysteresis and eddy current losses in the iron

* The quantity dm is here the infinitesimal part of an arbitrary parameter m as the latter approaches zero from plus values of m. It follows, therefore, that there can only be an imaginary branch to the left-hand side of the plot of $y=x^{dm}$, otherwise $y=1$ for $x>1$.

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conductor. These will now be investigated. For the fundamental component of voltage having its periodicity necessarily equal to that of the current of the line, it will be sufficient for finding the skin effect resistivity to take

$$B=a\sin pt-b\cos pt.$$ Thus when $H=H\sin pt$, it is possible to write

$$B=(a-bt_1/p)\sin pt\,;\quad B=\mu H\,;$$
$$\mu=a-bt_1/p,$$

because both current and voltage must have the same periodicity for a true energy loss to take place. Dealing, therefore, with a sinusoidal operand one can replace t_1 by pj, and, therefore

$$\mu=a-bj.$$

On introducing this value of μ it follows that

$$y=\frac{\pi R^2}{10^9\rho}(a-bj)pj=\frac{\pi R^2 p}{10^9\rho}(aj+b).$$

The new expression for y in the formula $\Delta_s\sin(pt+\theta)$ gives

$$\Delta_s\sin(pt+\theta)=\Delta_0[1+\tfrac{1}{2}m(aj+b)-1/12\,.\,m^2(a^2j^2+2abj+b^2)+1/48m^3(a^3j^3+3a^2bj^2+3ab^2j+b^3)-1/180\,.\,m^4(a^4j^4+4a^3j^3b+6a^2j^2b^2+4ajb^3+b^4)+13/8640\,.\,(a^5j^5+5a^4j^4b+10a^3j^3b^2+10a^2j^2b^3+5ajb^4+b^5)m^5]\sin pt.$$

Placing therefore $pt=\pi/2$ gives

$$\Delta_0\left\{1+\frac{1}{2}mb-\frac{1}{12}m^2(b^2-a^2)+\frac{1}{48}m^3(b^3-3a^2b)-\frac{1}{180}m^4(a^4-6a^2b^2+b^4)+\frac{13}{8640}m^5(5a^4b-10a^2b^3+b^5)-\right\}=\Delta_s\cos\theta$$

$$K_i=\frac{\rho'}{\rho}=1+\frac{1}{2}mb+\frac{1}{12}m^2(a^2-b^2)-\frac{1}{48}m^3b(3a^2-b^2)-\frac{m^4}{180}(a^4-6a^2b^2+b^4)+\frac{13}{8640}bm^5(5a^4-10a^2b^2+b^4)+$$

which will hold for all steady harmonic or simple harmonic waves of E.M.F.

Turning now to the reactance, if it is desired to find the reactance per centimetre length of a copper conductor for which the permeability is unity, it is sufficient to observe that at the moment when the aggregate line current $i=\sqrt{2}I\sin pt$ is zero, that is for $pt=0$, the total skin drop must be equivalent to the reactance drop of the line. Thus in

$$\Delta_0 f(q)\sin pt=\Delta_s\sin(pt+\theta)\text{ with }pt=0$$
$$\rho\Delta_s\sin\theta=\sqrt{2}Ix=\pi R^2\Delta_0$$

where the reactance x is in ohms, per centimetre length of conductor, and therefore

$$x=\frac{\rho\Delta_s\sin\theta}{\pi R^2\Delta_0}=\frac{\Delta_s\sin\theta}{\Delta_0}\cdot\frac{\rho}{\pi R^2}$$

Because one has

$$\Delta_0\left\{1+\frac{1}{2}y-\frac{1}{12}y^2+\text{ \&c.}\right\}\sin pt=\Delta_s\sin(pt+\theta),$$

whence with $y=mj$ and putting $pt=0$

$x_c=[1-m^2/24+13/4320\,.\,m^4-]p/(2\cdot10^9)$ for copper wires.

If now, as before, for iron wires a fundamental impressed E.M.F. alone is considered, one will have for y

$$y=m(aj+b),$$

and then one has by what has gone before

$$\Delta_0\left\{\frac{1}{2}ma-\frac{1}{6}m^2ab+\frac{1}{48}m^3(3ab^2-a^3)-\frac{m^4}{180}(4ab^3-4a^3b)+\frac{13m^5}{8640}(a^5-10a^3b^2+5ab^4)-\right\}=\Delta_0\sin\theta.$$

Thus the reactance per centimetre length of iron wires for the fundamental,

$$x_i=\frac{1}{2}\frac{pa}{10^9}\left\{1-\frac{1}{3}mb-\frac{m^2}{24}(a^2-3b^2)+\frac{4m^3b}{90}(a^2-b^2)+\frac{13m^4}{4320}(a^4-10a^2b^2+5b^4)-\right\}.$$

This equation reduces to the one given for copper on the understanding that $a=1$ and $b=0$ or no hysteresis loss. Of course, this reactance drop takes no account of the reactances due to the higher harmonics of current with a sinusoidally impressed E.M.F.

There remains finally to consider what must be the actual line current of an iron transmission line if the line drop is truly sinusoidal. In reality if the skin copper drop is a simple sinusoidal function of the time, which means that the impressed E.M.F. is such, then the aggregate current of the line cannot be a simple sinusoid. We have seen that

$$\rho\Delta_s\sin(pt+\theta)$$

represents the impressed E.M.F. per centimetre both in magnitude and phase (neglecting external reactance of the line,

$$\Delta_s\rho\sin(pt+\theta)=E\sin(pt+\theta)\,;\quad\Delta_s=E/\rho,$$

with E as the maximum total voltage drop per centimetre of line. On the other hand, the left hand side of the equation

$$\Delta_0(1+\frac{1}{2}y-\frac{1}{12}y^2+)\sin pt=\Delta_s\sin(pt+\theta)$$

should actually give the harmonic components of current, as at short circuit, where the impressed volts are represented by $E\sin(pt+\theta)$. However, it will be best to work with the equation in the form of partial fractions of the type $A/(\mu+k_n)$. This latter will also be conducive to obtaining a solution, because

$$y=mt_1\left\{a_1+b_1\frac{t_1}{p}+\left(a_3+\frac{b_3t_1}{3p}\right)Q_3+\right\},$$

then mathematically it will be necessary to evaluate the squares and other powers of the operators Q_m. Suffice it to say at this juncture that the new method involves equating all the coefficients of any term such as Q_m with $m>1$ to zero where one writes

$$\mu\times\frac{1}{\mu}=1$$

$$\text{and }\mu=\sum_{1,3,5}\left(a_m+\frac{b_mt_1}{mp}\right)Q_m\,;\quad\frac{1}{\mu}=\sum_{1,3,5}\left(A_m+\frac{B_mt_1}{mp}\right)Q_m,$$

and, therefore, it will be seen that it is in fact possible to obtain H in terms of B, given B in terms of H. This means that it is possible by means of the Q_m operators to obtain the harmonic developments of the one given the harmonic developments of the other whether for saturated or unsaturated iron.

Correspondence.

ELECTRICAL WORK FOR THE BLIND.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Sir Arthur Pearson and Mr. Hugo Hirst are to be congratulated on the way in which they have seized the opportunity of helping blind people in finding them work in the winding of electrical coils.

To anyone who has taken up work among the blind it is a very striking fact how few trades there are in which they have been employed, and I am writing this letter to ask electrical engineers and manufacturers to do their utmost to find new openings, so that there shall be as large a range of trades available where the blind could earn good wages.

The work of Mr. Hirst is particularly interesting in view of the fact that considerable numbers of blind people might be employed in connection with a steady trade, instead of having to depend on isolated jobs as piano tuners, music teachers or boot repairers.

It is probable that they could do a good deal of gauging work.

It must also be remembered that in many of the institutions there are numbers of persons with very defective sight who would be greatly benefited by having suitable trades open to them.

In addition to the large number of blind soldiers, there are great numbers of blind children growing up who will have to go out into the world and earn their living, and anyone who

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can find a new trade for them will have the gratification of knowing that they were doing extremely good work.

I enclose a very touching photograph of seven little blind entertainers.

A friend who is matron of a blind institution wrote me a few days ago that 10 blind babies had just been brought in. They will all want help in the future.—I am, &c.,

London, July 16. H. W. RAVENSHAW.

THE TERCENTENARY OF COMMON LOGARITHMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Dr. Russell, in the correspondence of your issue of July 19th, raises the question of the spelling of Napier's name. Perhaps the best justification of "Napier" is that it is the form used by his descendants. The old spellings are various—Napeir, Nepair, Nepeir, Neper, Nepper, Naper, Napare, Naipper—and several were used by the mathematician himself. Briggs also suffered in this respect. The notice of his baptism in the Halifax Parish Church Register gives Bridge as the surname. In the preface to Wright's translation of the Descriptio, which was written by Briggs, we have Brigs, Brigges and Briggs. Buergi appears as Jobst, Joost or Justus Byrg or Byrgius; also Speidell as Speidal.

Your correspondent states, in conclusion, that "those authors who write about Neperian logarithms are historically accurate." Even if "Neperian" is allowed, the system of logarithms to the base *e* cannot be directly attributed to Napier. His geometrical definition, which is essentially fluxional, covers all systems. He gave in the "Constructio" a "Short Table" of factors and numbers which is a little list of a few numbers and their natural logarithms. Napier used them as auxiliary to the logarithms that he had first calculated. In 1618 a small table of numbers and logarithms appeared in the second edition of the translation of the "Descriptio." These are natural logarithms, but, again, were used in connection with Napier's original system. The author is not known, but was probably Oughtred. Buergi published in 1620 a table of approximate natural antilogarithms. Speidell published in 1622 a considerable table of natural logarithms, "a new logarithmy." He is usually regarded as the originator. The theoretical importance of logarithms to the base *e* was not understood for many years afterwards.—I am, &c.,

Huddersfield, July 22. W. R. BOWER.

RIVERS-MOORE'S PATENT APPLICATION 4,862/15.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In order to remove misapprehensions will you kindly afford me space to point out that the arrangement referred to by Dr. Eccles on page 265 of his "Wireless Telegraphy and Telephony," second edition, in relation to Rivers-Moore's specification 4,862/15, is identical with Fig. 8 of my patent specification No. 13,755/13, when an auto-transformer is employed as described in lines 54 and 55, page 8 of my specification.

In view of this, the Comptroller of Patents, in his decision given on November 13, 1916, refused to grant a patent upon Rivers-Moore's Application No. 4,862/15.—I am, &c.,

Kingston, July 18. W. H. WILSON.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain of the Week.—Capt. E. G. Fleming.

Monday, July 29—Friday, August 2.—Drills as usual.

Friday, August 2.—Adjutant's technical lecture (earthworks), 6-30-7.30.

Saturday, August 3.—Annual Camp at Esher. Parade Waterloo Station 2.0. For further particulars see special orders.

Headquarters.—From August 3 to August 11 Headquarters will be transferred to the Camp at Esher.

Legal Intelligence.

Isaacs v. Hobhouse.

During the past week Mr. Justice Darling and a special jury have had this case before them. The plaintiff (Mr. Godfrey C. Isaacs) sued defendant (Sir Charles H. E. Hobhouse) for damages for an alleged libel with reference to Marconi contracts for wireless telegraphic stations. A statement was made by counsel for the Marconi Company (Sir E. Carson), during the hearing of a petition of right by the company, that Sir Charles Hobhouse had attempted to induce the Telefunken Company (of Berlin) to come to England and start in rivalry with the Marconi Company. In the House of Commons on March 19 Sir Charles Hobhouse said: "This statement, for which Mr. Godfrey Isaacs is responsible, is wholly false and without any foundation." On March 20 plaintiff wrote to defendant asking him to repeat that statement outside the House of Commons. On March 21 defendant published in the Press a letter in reply, saying that he had "stated the facts in the House of Commons fully and without reservation. It is for the public who read them to draw their own inference." In a further letter written by defendant to plaintiff, and published in the Press on March 22, defendant denied plaintiff's statement that he (defendant) had made an offer to the Telefunken Company, that he had recognised that as a Minister of the Crown he should not have made that offer, and he charged plaintiff with making other untrue statements.

The defence was that the words in their natural and ordinary meaning were true in substance and in fact.

Mr. Leslie Scott, K.C., Mr. J. A. Hawke, K.C., and Mr. Stuart Bevan appeared for plaintiff; Sir John Simon, K.C., Mr. Douglas Hogg, K.C., and Mr. Eustace Hills for defendant.

Mr. LESLIE SCOTT opened plaintiff's case at some length, and went into the details of the negotiations as to the contract for the erection of the six wireless telegraph stations, the effect of the war upon the contract, the recent Petition of Right, &c.

The plaintiff (Mr. G. C. ISAACS) gave evidence in support of counsel's statement as to negotiations with the Post Office, the interviews he had with defendant, and after a long cross-examination plaintiff's case closed.

On the 19th inst. the case for the defendant was opened by Sir John Simon, K.C. Sir Chas. Hobhouse gave evidence as to the negotiations with the Marconi Company, his visit to Berlin (with Sir H. Norman) and other incidents connected with the case. He denied certain statements made by plaintiff in his evidence.

Miss Hobhouse, Lady Hobhouse and Mr. Murray gave evidence for the defence.

The hearing of the case had not concluded when we went to press

Rio Tinto Co. v. A.E.G. Electric Co. and A.E.G. Electric Co. v. Rio Tinto Co.

Last week Mr. Muir Mackenzie, Official Referee, reserved judgment in these consolidated actions. He commenced hearing evidence in the actions on July 1, and several witnesses were examined.

Mr. Grant, K.C., appeared for the Rio Tinto Co., and Mr. Colefax, K.C., and Mr. Conway for the A.E.G. Co.

Mr. GRANT said his clients' action was for damages for the failure by the A.E.G. Co. to supply a turbo-blower which would do the work it was intended to do. Plaintiffs owned large copper mines at Rio Tinto. The ore contained valuable constituents, the chief of which were copper and iron. In some of the ore there was very little copper, and in some it ran up to 4 or 5 per cent. Normally it was about 3 per cent. It was never found pure, and therefore it was necessary to extract it with the other constituents from the ore. One of the processes used began in the blast furnaces, where they put the copper ore together with coke and another material, such as lime, in order to produce a flux. Then they had to create intense heat, the result of which was that the mixed mass in the furnace became fluid, the copper sinking to the bottom, and thereby producing copper of greater or less purity. The greater or less purity depended upon the intensity of the heat, and the intensity of the heat depended to a large extent upon the volume of air which could be blown into the furnaces. The greater the volume of air the greater the oxidation, and the greater the purity of the copper matte. The copper matte was taken in its liquid form into the converters, and was generally of about 40 per cent. of copper, and the Bessemer process did the rest. Everything depended upon the draught of air, a point which was material in the case because the machine ordered was for that process. The Rio Tinto Co. had at their works six blast furnaces air operated by turbo-blowers. In 1911 the company wanted to improve their works, and it was decided to put two converters alongside the six furnaces, and so increase their utility by doing the whole of the preliminary blast furnace operation there, and to carry the matte into the Bessemer converters. Owing to the failure of the machine supplied by defendants the output of copper fell off considerably, and the great question to be decided was whether such falling off was recoverable by way of damages. It was possible to found the case on the general ground that defendants, through their agents, must have known the purpose for which the blower was to be employed, but it became much stronger if he proved that defendants were aware of the exact situation of matters at plaintiffs' works, and of the particular use to which it was intended to put the machine. Counsel read a number of letters which had passed between the parties. In 1912 defendants (amongst others) were asked to tender for the blowers. The A.E.G. was a Berlin company, which had a subsidiary company in London (the defendants in the action) and another branch company in Spain. The A.E.G., although a branch of the Berlin company, was a limited company in England, and a Mr. Adler had all the dealings as to the

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blower for the blast furnaces. Mr. Clift, commercial manager of the Rio Tinto Co. in London, explained to Mr. Adler what was going to be done—how the Rio Tinto Co. was proposing to erect new converters side by side with the six furnaces. The question was discussed at great length of the supply of air—whether it should be supplied by steam power or by electricity. The matter was re-opened in June, went on until August, when defendants sent in a tender. Mr. Adler thoroughly understood what was being done at plaintiffs' works. After further consideration, in the light of information supplied by Mr. Adler, plaintiffs decided that they would not have turbo-blowers, but would induce the air by reciprocating engines, and accordingly those engines were ordered from the firm of Messrs. Fullerton, and they were installed. The next step was to get the new furnaces into active operation, and in the year 1913 plaintiffs took up the question of the new blower necessary in order to create a better draught of air. The Parsons turbine was to operate the one furnace, and defendants were to supply a new turbo-blower to operate the other furnace. At this stage Berlin asked London for details of the order. It was explained to Mr. Adler that the machine would have to work the five furnaces night and day, and that there was no other machine to do the work. They knew it was intended to dismantle the three old blowers and to retain the Parsons turbine, and that the new blower would have to create the draught for the five furnaces. The A.E.G. had never made a blower for so big a draught before. They wanted plaintiffs to pay the second instalment as a condition precedent to anything, but plaintiffs refused until proper tests had been made, which defendants declined to make. At the first trial the machine broke down, the shaft bent and it would not work. The A.E.G., owing to their German connection, could get no one to work for them. No British firm would have anything to do with defendants, and plaintiffs took up the provision of a new shaft to replace the defective one. There was a third trial, when the machine again broke down, but in the end an entirely new shaft was made and sent out by plaintiffs, and since then the machine had done its work. That being so, they made their claim on April 20th, 1916. The arbitrator had found that a serious error existed in the original plans, and that there was a defect in the design.

At this stage the Official Referee allowed plaintiffs to amend their pleadings.

Mr. A. S. CLIFT gave evidence and of the discussion he had with Mr. Adler as to the practicability of making turbines for the required pressure and volume which would have an efficient steam consumption. He also desired information about an alternative scheme for driving the blowers by electric motors. Witness was cross-examined at some length by Mr. Colefax as to the dates at which the various orders had been given. The claim for damages was based upon the actual production during 17 months from July, 1915, to December, 1916: the total amount of copper extracted from the ore during the 17 months was 10,161 tons. He gave details of the work done at various dates and particulars of the claim for £184,000 loss of profit consequent upon the failure of the machine.

At this stage a Mr. RONIE was called, and said that in 1915 he was employed by the A.E.G. Co. as an erector, and he was now employed by Dick, Kerr & Co. He went to Rio Tinto with Mr. Doughty in March, 1915, in connection with the trial of the turbine. The second attempt to start the turbine with the new shaft took place in February, 1916, and his expenses were paid by the A.E.G. Co. Before he went out he attended several times at Fraser & Chalmer's works, where the new shaft was being manufactured, and his charges for those attendances were paid by defendants. Dick, Kerr & Co. took over such business as the A.E.G. Co. had left in England, and he acted for them in connection with the Rio Tinto business.

Mr. CLIFT was recalled and further cross-examined upon the correspondence between the mines manager and the agents in London in reference to the delay in payment. The Rio Tinto Co. would have been willing to carry out the test if it was so desired, but they preferred that defendants should have a man there when the tests were made. It was originally intended that two engineers from Berlin should be present at the mines, bringing with them Pitot tubes to carry out tests as to the volume of air. A letter from defendants was read disclaiming all liability if the machine were put under test without overhauling by competent men, and witness said he was told by defendants that the company would prefer that their representative should be present at the tests. In further cross-examination, Mr. Clift said he was aware of what was being done in regard to the making of the new shaft. The shaft had been run for two hours on one occasion at 1,200 revolutions. It could not have been run up to the critical speed because it was not vibrating. When the machine was started they had never been told that there was a critical speed. As to the delay, he said there was no doubt that people did not like to work for the A.E.G. Co., and hence the difficulty experienced in getting the new shaft made.

Mr. ROBERT E. PALMER, formerly employed by the Rio Tinto Co., gave evidence as to the changes made in the plant and the substitution of the new plant, &c. At to the trials when the shaft bent, Mr. Kelton and Mr. Dufty were present for the A.E.G. Co.

Mr. COLEFAX, K.C. (for the defence), said that the case had been partly dealt with by the arbitrator. The agreement between the parties defined their position clearly, and it was that agreement which constrained the arbitrator to do what he did. Plaintiffs said that in July, 1914, the reason why the tests did not take place was because of the A.E.G.'s failure to deliver plans before Feb. 11, 1914. That was the issue between them. As to the position in July, 1914, he submitted that the A.E.G. had done everything that formed any part of their obligation—that so far as they were concerned the plant was erected, and all that remained was to carry out the tests. They were prevented from doing that, not through any shortcomings on their part, but entirely because it did not suit the convenience of plaintiffs. It was clear that the intention was that the people from Berlin should carry out the tests, which involved the starting up for the first time after the erection of the machine. Defendants had suffered great disadvantage, not from any fault of their own. Time went on until October, 1914, when defendants were entitled to be paid the second instalment, which he submitted had been deliberately held back. He contended that the breakdown was due to the Rio Tinto people having injured the machine in attempting to run it.

Mr. R. T. DURRAN, who prior to the outbreak of the war had been for 14 years in Berlin as manager of the foreign department of the A.E.G., and now managing director of the English company pending its dissolution, gave evidence as to the contract for the plant in the action.

Mr. JOHN WILLIAM FLOWER, formerly manager of the London branch of defendant company, and now with Dick, Kerr & Co., also gave evidence in relation to the transactions with the Rio Tinto Co. He said that he saw Mr. Clift on several occasions, and he never said anything as to the shortage of steam. There would have been no difficulty in carrying out the tests if the Rio Tinto people had wished to make them. Defendants repudiated any liability in respect of the second shaft, as plaintiffs had run the machine without anyone else being present. In August, 1914, Mr. Clift, who told him he had agreed to postpone the official test, was pressing for the starting of the engine without delay, and a proposal was made as to the payment of the second instalment of 25 per cent. in connection with the starting up. The Spanish erector was at the mines for three weeks, and in the end they had the statement from him that the plant was in order. It was necessary that the plant should have a detailed overhauling.

After the evidence had been heard, Mr. CONWAY, in summing up the case for defendants, submitted that the A.E.G. Co. were not liable for the defects which exhibited themselves in the machinery after it had been started up by the Rio Tinto Co. in the absence of any representative of the A.E.G. Co. Had that company, he said, been permitted to make the tests in the ordinary way before the plant was started, defendants would have been in a position to remedy any small defects which might have shown themselves, and so have prevented the failure of which plaintiffs complained. After dealing with the question of non-payment by plaintiff company, counsel discussed the matter of costs of the proceedings before the arbitrator.

Mr. GRANT, K.C., summed up the case for plaintiffs, and the Referee reserved his judgment.

Parliamentary Intelligence.

STATUTORY UNDERTAKINGS BILL.

On Monday the House of Commons went into Committee on the Statutory Undertakings (Temporary Increase of Charges) Bill.

The President of the Board of Trade (Sir A. STANLEY) said the Government had come to the conclusion that all public undertakings—gas, electricity, tramway and water—should be grouped together. All those statutory undertakings had been created with the assent of Parliament, and it was for the House to determine whether there should be any modification of those Acts of Parliament. The Committee which considered the matter were impressed by the case presented to them on behalf of the undertakings into which inquiry was made, that as matters stood there was a likelihood of the dividends being completely wiped out. On the other hand, the Committee thought that to release the undertakings from their statutory obligations with respect to charges would be unfair to consumers, but that the relief given should be borne equally by shareholders and consumers.

An amendment was moved by Mr. TENNANT that no modification should be authorised which was more than sufficient to enable a dividend to be paid at three-fourths of the standard or maximum rate of dividend.

This was carried, and the Bill as amended was ordered to be reported.

Commercial Topics.

British Electrical and Allied Manufacturers' Association.

The undermentioned firms have been elected members of the above Association. Unless otherwise stated, the address of the new members is in London.

Accumulators Limited, Arora Co. (Loughborough), Ashdowns (Gravesend), Associated Battery Co. (Penge), J. W. Barnard, Bastian Electric Co., Belling & Co., Bluemel Bros. (Wolston), Brompton & Kensington Accessories Co., Cable Accessories Co. (Tipton), Croggon & Co., Curtis Mfg. Co., Electric & Engineering Specialties Co. (Liverpool), Fuller Accumulator Co. (Chadwell Heath), Griffiths Bros. & Co., London (Ltd.), Jackson Electric Stove Co., Jeal & Co., Lithanode Limited, Joseph Lucas (Ltd.) (Birmingham), New Peto & Radford Accumulator Co., Randall Bros., Richford & Co., Rotax Motor Accessories Co., Rushmores Limited, Sun Electrical Co., Surrey Electrical Co., C. A. Vandervell & Co. and F. Wiggins & Sons.

* * * *

Government Control of Trade.

The London Chamber of Commerce has issued a memorandum giving particulars of the action taken by it on the subject of Government control of trade.

In October last, at a public meeting convened by the Chamber to

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consider the question of Government control of trade, resolutions were adopted supporting the protest of the Merchants' Committee of the Chamber against the methods adopted by departments of the Government in controlling and restricting trade, &c., and demanding that the Government should cease to act as a trading intermediary between producers and consumers, but should utilise to the fullest extent the services of the business community, and that control departments should in all cases be assisted or directed by business men nominated by their respective trades.

The recommendations of the Merchants' Committee were as follows :—

(*a*) That Government should cease to act as trading intermediary between producers and consumers, but should utilise to the fullest extent the services of the business community.

(*b*) That to this end merchants should be encouraged to carry or import stocks of commodities essential to this country.

(*c*) That so far as any control of imports and exports is concerned, the quantities allowed should, as far as possible, be based upon a fair allocation of quantities amongst merchants dealing in particular articles, after consultation with representative trade organisations. Permit should only be granted to British and Allied subjects who are legitimate merchants and importers to the trade involved.

(*d*) That the various control departments should be co-ordinated so as to secure uniform system on questions of principle and to obviate present delays in dealings with licences and permits.

(*e*) That control departments should in all cases be assisted by representative business men, nominated by their respective trades.

In due course the above resolutions were submitted to the Prime Minister, who, in a letter dated July 1, states that he is sympathetically disposed towards the various points raised in the memorandum forwarded, and that he is satisfied, after consulting the several departments, that those points of principle are being taken fully into account.

* * * *

Imperial News Service and Cable Facilities.

At a luncheon given last week by the Empire Press Union to representatives of the Press of Canada, the President (Mr. Robert Donald), in welcoming the Canadian journalists, said that the chief function of the Empire Press Union was to use the collective power and influence of the Press of the Empire to secure better facilities for the dissemination of news and to promote the common interests of the Empire in unofficial ways.

The Imperial War Conference had passed a resolution dealing with an Imperial news service, with the object of securing an adequate news service available in all parts of the Empire through British sources. The Government was preparing a scheme which would evidently provide for the setting up of an Imperial newsagency. If that meant better dissemination of true and impartial information during the war, he assumed that they were all in favour of it. If it meant improved facilities by cable and wireless after the war they welcomed it. If it meant that the Government intended to set up an official bureau with an official newsagency, subsidised and controlled, directly or indirectly, by Government officials, they on this side were dead against it. Let the Government confine itself to providing facilities. Newspapers would do the rest. An official news service would destroy the freedom and independence of the Press. The official news bureau could, and would, at the dictation of a political chief, suppress news which it ought to circulate, and circulate news which it should suppress. Let them beware, therefore, of a Germanised spoon-fed Press.

Mr. R. L. RICHARDSON, M.P. (Winnipeg), who returned thanks for the reception given to the Canadian delegation, said he was glad to hear the declaration that in no sense must the independence of the Press be interfered with by any arrangement that might be made for the subsidy of cable services for the dissemination of news.

A resolution was passed declaring that the Union should "use its influence to secure better, quicker and cheaper facilities for the dissemination of news throughout the Empire from British sources, and that such co-operation as Governments may give shall be limited to assisting in the provision of facilities."

* * * *

London University Commerce Degree.

At the Mansion House (London), on the 18th inst., there was an important meeting of gentlemen connected with city commercial and business interests in order to consider proposals of the authorities of the University of London to establish a degree in commerce.

The Lord Mayor presided, and the speakers included Mr. A. J. Balfour M.P., and Mr. R. C. Norman, chairman of the London County Council. In the course of his remarks, Mr. Balfour said that the scheme of conferring commercial degrees was favourably regarded by the Government. On the face of it, nothing could seem more natural than that the University of London should do all it could to further the great commercial, financial and industrial interest on which the greatness of London especially depended. They had, however, to guard against narrowing their academic standard by having too close a regard to its purely utilitarian aspects. They had to inculcate breadth of view, and he was clearly of the opinion that if that academic effort were taken up in the right spirit, as he believed it was, and if the teachers understood not merely the technical details of their subject, but also the place which that subject had in the circuit of human interests, nothing but good could be attained by any student who had the time and the means to take advantage of the course.

A resolution in favour of the University proposals was adopted, and an influential committee was appointed.

It is intended to found lectureships in commercial subjects in the colleges of the University, such as the London School of Economics; to organise a bureau to assist and advise students working by themselves; to create and subsidise a commercial literature suitable for the rising generation of business men; and to found and endow travelling fellowships and scholarships in commerce, with a view to promoting the study of commercial languages and foreign methods, &c.

* * * *

Some After-War Difficulties.

Sir Alfred Booth, chairman of the Cunard Steamship Co., made an interesting speech at the recent annual meeting of the company, in which he dealt with some of the industrial and economical difficulties to be encountered after the war.

Sir ALFRED pointed out that the company was not allowed to replace the ships it had lost. Meanwhile it would have to try to hold its trade together with a woefully inadequate plant, and the new ships built during the first years of peace would cost extravagant prices. He believed that prices and costs would come down much more rapidly after the war than most people imagined. The principal dangers were the difficulty of deflating currency and credit without destroying confidence, the tendency to maintain Government control, with all its deadening effect on enterprise, an attempt to place in the hands of some international authority the task of dividing up the raw materials of the world among all competing industries—the international jealousies engendered by such a system would be quite sufficient to kill any League of Nations they might have hoped to form—and labour unrest, due to the false hopes held out of a new heaven and a new earth after the war. The disillusionment would be very bitter when it came.

Electricity Supply.

General.

Acton.—The generating plant at the baths recently broke down, and it is proposed to obtain from the Metropolitan Electric Supply Co. a stand-by supply in case of emergency.

The Metropolitan Company will make the connection for about £75, but the cost of the service must be defrayed by the Council, and a minimum payment of £40 per annum be guaranteed, the guarantee only to operate in the event of the Council not taking electric energy to that value, such energy being charged for at 4d. per unit.

Ayr.—The salary of the borough electrical engineer (Mr. R. Marshall) has been increased by £100 per annum.

Ballymoney.—The Urban Council is pressing the local gas company for an explanation of the delay in carrying out the company's proposed electric lighting scheme.

Beckenham.—The new pumping station buildings at Shortlands is to be lighted electrically, and will be taken from the Council's mains.

Bexhill.—The gross profit on the past year's working of the electricity undertaking was £5,602 and the net profit was £197 (compared with £284 in previous year).

Brighton.—The accounts of the electric supply department were approved by the Council yesterday (Thursday), when the Lighting Committee reported that the surplus on the past year's working was £2,887.

The Finance Committee recommend that the surplus be carried forward. The total revenue increased from £109,059 to £119,003, but the abnormal price of coal and augmented wages considerably increased the expenditure. The total cost per unit (including loan charges) was 2·66d., and the average yield 2·63d. per unit.

Derby.—The salary of the borough electrical engineer (Mr. T. P. Wilmshurst, has been increased from £730 to £950 per annum, and that of the tramways manager (Mr. F. Harding) from £380 to £430.

Electrical Power Engineers' Association.—A meeting of the Divisional Council of the London Division was held on the 12th inst.

The report of the conference between the I.E.E., A.M.E.E., C.T.A.A. and E.P.E.A. was under discussion. Exception was taken to clause 5 of the report, and after discussion the following amendment was unanimously agreed upon :—

"Provided that the C.T.A.A. and the A.M.E.E. agree to the previous resolutions, these Associations may appoint two representatives who shall be members of the E.P.E.A.) to attend the meeting of the National Executive Council of the E.P.E.A. at Manchester on the July 27 to discuss and approve the draft constitution of the E.P.E.A. This draft in turn to be submitted to the I.E.E. The representatives of the two first-named Associations to remain as part of the National Executive Council of the E.P.E.A. for the current year.

We are informed that as a result of the meeting in Glasgow on the 29th ult., members of the staffs of the electric supply undertakings in Glasgow, Greenock, Perth, Dundee, Kilmarnock and Motherwell, have joined the Association. Particulars from Mr. J. H. Wright (the Interim Publicity Secretary for Scotland), 8, Garland-place, Dundee.

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Electricity Supply in the Midlands.—At a special meeting of Nottingham Corporation last week it was decided to urge upon the Government its claim for preferential treatment in the national scheme of electricity generation.

In December last a special committee was appointed to consider the Coal Conservation Sub-committee's report, and the committee now report pointing out that Nottinghamshire has all the essential factors required for a super-station—ample supply of water for condensing purposes, proximity of collieries, railway communication between collieries and suitable sites adjoining the River Trent, and large industries requiring electric power. Taking 40 miles as a radius over which electric power could be economically supplied, the following come into the area: Sheffield, Chesterfield, Mansfield, Newark, Retford, Lincoln, Nottingham, Loughborough, Leicester, Kettering, Burton-on-Trent, Derby and Ilkeston, and other smaller towns and numerous works in the various counties.

Consideration was, it was believed, being given to installing a similar power station in Yorkshire, in which some of the northern towns, such as Sheffield and Chesterfield, might prefer to link up. Each station should be a unit of the whole scheme, and a linking-up arrangement should be made so that surplus power can be supplied where a shortage exists. The site should be near the Trent, and four sites had been selected for their geographical position—one at Wilford, one in Meadow-lane, one at Colwick below the weir and one at Colwick sidings.

In moving the adoption of the report, Mr. A. R. ATKEY said the question was a very much wider one than the generation of electricity, whether for light or power. There was also the coal conservation question, and the matter of dealing satisfactorily with coal by-products. Hitherto every gallon of motor spirit used had been imported, but there was no reason why for the next 10 years they should not produce all they wanted at home. It was up to the Corporation to create the necessary driving force in presenting their case. The Committee asked for power to spend £500 or £1,000 in obtaining expert advice.

The report was adopted, and the following special committee was appointed to deal with the question: The Mayor (Mr. J. G. Small), the Sheriff (Mr. H. Offler), the chairman and vice-chairman of the Electricity and the Gas Committees, Ald. Sir J. T. McCraith, Ald. E. Huntsman, Mr. E. H. Lee, Major Walker and Mr. A. R. Atkey.

Electric Power Supply.—Hammersmith (London) Borough Council has addressed communications to the Board of Trade, London County Council and the Conference of Greater London Authorities urging the application of the scheme outlined in the recent report of Board of Trade Electric Power Supply Committee with the least possible delay.

Fulham-Hammersmith Linking-up Scheme.—In order to avoid unnecessary delay in proceeding with this linking-up scheme, it has been agreed that as soon as the draft agreement has been approved tenders for laying the connecting mains are to be invited.

The borough electrical engineer of Fulham (Mr. A. J. Fuller) has been appointed to prepare the necessary plans and specification, and to supervise the execution of the work; a nominal charge of 2½ per cent. on the total cost of the work will be added to the final account in respect of the duties to be performed by Mr. Fuller, such 2½ per cent. to be borne equally by the Battersea, Fulham and Hammersmith Councils.

Increased Charges for Electrical Energy.—The charges at the following places are being increased:—

At Batley, as from July 1, the price of current for heating and power has been increased 12½ per cent., making 40 per cent. over pre-war charges, and the lighting rate 5 per cent., making 20 per cent. in all.

At Shipley the lighting charge has been increased from 5d. to 6d. per unit.

Harrogate Council has increased its charges for current for lighting by 15 per cent., making a total increase of 25 per cent. on pre-war rates.

Bolton Electricity Committee is increasing its charges by 0·15d. per unit.

Todmorden Council has raised the price of current for power by 15 per cent.

Fleetwood Council increased its charges for current by 25 per cent. as from 1st inst.

Exeter Electricity Committee recommend an increase of 10 per cent. in the lighting charge (making the price 5½d. per unit) and 15 per cent. for power and traction.

Gloucester Electricity and Light Railways Committees is again increasing its charges for lighting and power by 50 per cent. (100 per cent. over pre-war rates).

Wolverhampton Corporation is increasing its charges by 10 per cent. (60 per cent. over pre-war charges).

Lincoln Corporation has decided to increase its charges for electricity to power consumers under agreements by 10 per cent., and to other consumers by 20 per cent.

At Burton-on-Trent the charges are being increased by 15 per cent. for lighting and 35 per cent. for power.

Bootle Corporation is increasing its charges by 17½ per cent. in addition to the increase of 12½ per cent. authorised in May, 1916. Consumers having agreements with coal clauses will be charged 12½ per cent. more.

Dromore Electric Light Co. is increasing its lighting charge from 6d. to 6½d. per unit.

Leighton Buzzard.—The Council is seeking information from Luton and Aylesbury Corporations as to the possibility of obtaining a supply of electric current.

Llandudno.—The charge for electric current has been increased by 1½d. per unit, making a flat rate of 7½d. a unit.

The long-standing dispute between the Council and the local electric railway company has been settled, the company agreeing to pay an increased rate of 0·035d. per unit for every increase in the price of coal of 1s. above 12s. per ton.

Mansfield.—On the past year's working of the electric supply department there was a loss of £161. 15s. 8d., compared with a net profit of £1,664 12 months ago.

Nenagh.—The local Gas Consumers Company recently decided to put down electricity generating plant.

Stoke-on-Trent.—Sir John Snell has been consulted as to the advisability of proceeding with the Electricity Committee's proposal to apply to the L.G. Board for sanction to the borrowing of £110,000 for the extension of the generating plant at the central power house in Hanley.

Wakefield.—The Corporation has been authorised to borrow £6,958 for extensions of the electric supply undertaking.

Westminster.—The Works Committee are negotiating with the Charing Cross, West End & City Electricity Supply Co. for the introduction of half-watt lamps in place of the public arc lamps lighted and maintained by the company.

Half-watt lamps have been substituted for arc lamps in the districts lighted by the Westminster Electric Supply Corpn., and as the altered lighting has been found to be sufficient, with a substantial saving in the cost, a provisional agreement has been made with the Charing Cross Company in respect of their area.

Willesden.—Negotiations are proceeding in regard to a new agreement for the supply of energy in bulk by the North Metropolitan Electric Power Supply Co.

For the year ended March 31 last the net surplus of the electricity undertaking was £1,200. 14s.

Electric Traction.

Blackpool.—The Corporation proposes to purchase the undertaking of the Blackpool & Fleetwood Tramroad Co.

At a special meeting of the General Purposes Committee of the Council last week the details of the purchase were discussed. The share capital of the company is £150,000, with debentures amounting to £35,000.

Derby.—The Board of Trade has extended by one year from Aug. 15, 1918, the times limited by the Derby Corporation Act, 1913, for the completion of tramways authorised by the Act.

Hull.—At a meeting of the Tramway Committee on Monday it was decided to abolish halfpenny fares.

Sunderland.—At March 31 the gross capital expenditure on the tramways was £307,120, of which £148,950 has been repaid.

The total amount of sinking fund being £169,959, while £117,832 has been set aside for reserve, &c., and £67,027 applied in reduction of rates. Revenue was £98,677, working expenses were £57,653, interest required £7,202, and repayment of capital £13,618, and the net balance was £20,204. Average traffic revenue per car-mile was 10·48d., and working expenses including power were 9·7d. Passengers carried were 25,041,160 (compared with 21,711,489 in previous year), and car-miles run 1,425,007 (1,463,281).

Telegraphy and Telephony.

Control of U.S.A. Telegraphs.—On July 31 the Government will take over the control of the telegraph and telephone cables and lines and the wireless stations for the duration of the war.

Hull Telephone Charges.—Hull Telephone Committee has increased its charges by 25 per cent. for business and residential services and 20 per cent. on "measured" services.

The present tariffs are £8 per annum for an unlimited service for business premises, and £5. 10s. per annum for unlimited service for private houses.

Wireless Telegraphy in Argentina.—Prior to the war the Marconi Company obtained a concession for the erection of a radio-telegraphy station to communicate with Europe, and it had commenced the erection of the plant when the war broke out.

Work was then suspended, but in 1915 the Argentine Government conceded to the Federal Holdings Co. (U.S.A.) the right to erect a Poulsen station to communicate with New York. As the Marconi Company holds the rights of the Poulsen system outside the United States, it was necessary to form a new company (the Pan-American Wireless Telegraph & Telephone Co.), composed of the American Marconi, the English Marconi and the Federal Holdings Co., the two first named, each taking three-eighths of the capital and control. It is stipulated that all the directors of the new company shall be citizens of the United States. The Federal Company, having transferred its concession to the Pan-American Company, has been bought out by the United States Government. The Pan-American Co. recently secured an amplified concession from the Argentine Government, admitting any wireless system, the establishment of communications with any part of the world, and 18 months' extension of the time limit for construction.

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Foreign Notes.

Chili.—Approval has been given to a project for constructing and working an electric or steam railway from the port of Quintero to San Pedro on the railway from Valpariaso to Santiago.

Electric Furnace Progress.—What is said to be the largest electric furnace for steel manufacture has been in satisfactory operation at Pittsburg for a year.

The "Mining and Scientific Press" (of San Francisco) states that the furnace, which is of the Heroult type, was built to hold 20 tons at a charge, but it regularly makes 25 tons, and has produced 30 tons at a time. There are now over 150 Heroult furnaces operating or under contract in Northern America. There are three more large furnaces in process of being erected at Gary, Indiana. Six heats are made every 24 hours in the furnace, and the charge is hot metal from large basic open-hearth furnaces near by. The steel is of the highest quality and is used for small gun-forgings, &c., by the Government. Two similar furnaces are operating at the plant at the Illinois Steel Co. (South Chicago), and a third is being installed.

Electro Metals (Ltd.) is putting in an extensive installation for the electric smelting of iron ore for Messrs. Ansaldo in Italy. In the first instance there are to be two plants of 4,000 H.P. each, and these will be followed by four more plants of the same size, bringing the total up to 24,000 H.P. The six plants together will be able to reduce 150,000 tons of ore annually. The current will be obtained from a three-phase high-tension supply through static transformers, three of which for each furnace will have a capacity of 1,200 k.v.a. each, and will be so arranged that the voltages on the secondaries can be varied between 35 and 70 volts in eight successive stages.

German Trade Methods in Spain.—According to the Board of Trade "Journal," Germany exported to Spain in 1913 goods of the value of less than 7½ millions sterling, and purchased Spanish goods valued at nearly 3 millions, but this comparatively insignificant trade was sedulously cultivated.

The A.E.G. and Siemens had a basis of profitable turnover in electrical accessories mainly manufactured in Spain and sold through their agencies. In the case of steam engines, pumps, &c., intercommunication of branches in France and Italy of German manufacturers with their agencies in Spain was the source of considerable indirect trade. In many cases (especially rubber and asbestos goods) the origin of the goods was British for introductory purposes, subsequent supplies being German. British, French and Italian addresses were used for the purpose of declaration, while the goods were German.

Uruguay.—According to recent cables from Monte Video, the Government of Uruguay propose to purchase the railways, tramways, electric light and other public works in the country owned by foreign capital.

Miscellaneous.

The Enemy Banks Bill.—The text of the Bill for winding-up enemy banks has been issued.

After empowering the Board of Trade to make Orders for winding-up companies "of enemy nationality or association," it provides against the carrying on of banking businesses in the United Kingdom by or for enemies or enemy-controlled corporations for five years after the war. Similar measures are enacted in the case of "clubs or other undertakings not being businesses carried on by or for the benefit of enemies." The Board of Trade may also vest in the custodian any patent or design belonging to an enemy company.

The Position of Called-up Apprentices.—During a discussion at a recent delegate meeting of the Electrical Trades Union in Manchester it was stated that there was no considered policy with regard to the treatment of apprentices on their return from the Army.

Some employers were agreeing to count time spent with the forces as part of the period of apprenticeship, while in other cases that time was not counted, and the Union decided to call upon trades and labour councils to urge upon the Government the payment of full district rates of wages to those men while they were completing their apprenticeships on their return to civil life.

Trading with the Enemy.—The "London Gazette" contains the following amongst other additions to the list of firms and persons with whom trading by firms or persons in the United Kingdom is prohibited:—

Guatemala.—Augusto Scharoch, agent for Allgemeine Electricitäts Gesellschaft (Guatemala City).

Netherlands.—Max Weinberger & Co., N.V., Electro Technische Magazijnen, v.h., N.Y. (Amsterdam).

Norway.—Elektrisk Union A./S. (Christiania), Elektrohm A./S. (Kristian IV.'s Gate, Christiania).

The "London Gazette" of July 12 also contains additions to the list, including the following: *Mexico:* Compania Mexicana de Electricidad S.A. (Mexico City). *Spain:* Industria Electrica de Cornella (Madrid and Barcelona).

Warwickshire R.E. (Volunteers).—The officers, N.C.O.'s and men of the Warwickshire R.E. (Volunteers) have recognised the services rendered to them by Capt. S. T. Pemberton, who acted as adjutant for nearly three years, by presenting him with a silver centre piece and side dishes on July 20.

The presentation was made at a full muster of officers and men by the Commanding Officer (Major D. Shanks), who referred to the ungrudging efforts made by Capt. Pemberton to maintain the membership and efficiency of the corps. Capt. Pemberton was one of the first to join the Volunteers shortly after war broke out, and has been associated with the Engineers ever since. He retains his position as captain of the Signal Company, and the corps will continue to have the benefit of his experience.

Mr. R. A. Chattock (hon. colonel) also testified to the good work done by Capt. Pemberton, and appreciative remarks were made by several officers who have been associated with him since the corps was raised.

Educational.

Manchester College of Technology.—The 1918-1919 session begins on Oct. 3. The matriculation and entrance examinations will be held in July and September, and matriculated students may enrol from Aug. 1.

There are complete courses in mechanical, electrical and sanitary engineering, the chemical and textile industries, mining, architecture, &c. The college possesses well equipped laboratories and workshops for demonstration and original research. Particulars of university course or of part-time courses may be obtained from the Principal.

University of Durham (Armstrong College).—In the department of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, &c., there are complete courses of instruction in preparation for degrees of the University of Durham. The next session commences on Sept. 23, and particulars of the courses may be obtained from the secretary (Mr. F. H. Pruen, M.A.), Armstrong College, Newcastle-on-Tyne.

Tenders Invited and Accepted.

Incandescent Electric Lamps.

The COMMISSIONERS of H.M. WORKS, &c., invite tenders (until 11 a.m. of July 31) for incandescent electric lamps. Forms of tender from Controller of Supplies, King Charles-street, Westminster, S.W.1.

Turbo-Alternators, Water-tube Boilers, Economisers, &c.

BELFAST Corporation invite tenders for the manufacture and erection of two 6,000 kw. Turbo-alternators and one 30 kw. Balancer Booster; four Water-tube Boilers, Fuel Economiser, &c.; two steel Chimneys with Fans; two electrically-driven boiler-feed Pumps, Accumulators; three 500 kw. and five 1,000 kw. Rotary Converters, with Transformers, &c.; and two 250 k.v.a., two 350 k.v.a. and six 1,250 k.v.a. Static Transformers. Specifications, &c., from the consulting engineers (Messrs. Preece, Cardew, Snell & Rider), 8, Queen Anne's-gate, Westminster, S.W. 1; or Mr. T. W. Bloxam, M.I.E.E., city electrical engineer, Belfast. Tenders to Town Clerk, City Hall, Belfast, by Aug. 16.

Transformers.

The VICTORIAN RAILWAY COMMISSIONERS invite tenders for the supply of 800 lighting transformers for signal system. (Contract No. 31,597). Specification from the Victorian Railway Commissioners, Spencer-street, Melbourne, to whom tenders by 11 a.m. Sept. 4. A copy of the specification, &c., may be seen at the Department of Overseas Trade, 73, Basinghall-street, London, E.C.

BATTERSEA (LONDON).—The Council has accepted the tender of the British Westinghouse Electric & Mfg. Co. for the supply and erection of a turbo alternator and condensing plant, and that of Price's Co. for oils.

NEWCASTLE-UNDER-LYME.—The Council has placed an order with the British Westinghouse Co. for a 150 kw. rotary converter and h.t. and l.t. switchgear, at £2,107.

Government Contracts.—The following tenders were accepted by the British Government Departments during June:—

War Office.—General Electric Co., Chatterton's compound: H. T. Boothroyd (Ltd.), City Electrical Co. (London) and General Electric Co., dynamos: Siemens Bros. & Co., rod and sheet ebonite: British Thomson-Houston Co., Electric Construction Co., General Electric Co. and Wright & Wood, motors, &c.; Harland Engineering Co., power plant: British Thomson-Houston Co., switchboards and spares; Brush Electrical Engineering Co., transformers.

H.M. Office of Works.—Vaughan Crane Co., generating set for fuel research station; North Metropolitan Electric Power Supply Co., electricity supply, converters, wiring, &c., at the late David Allen's premises, Harrow; Mawdsley's (Ltd.), motors of N.P.L., Teddington: Saml. Reed & Sons, wiring at N.P.L., Teddington; New Switchgear Construction Co., switchboards for N.P.L., Teddington.

Post Office.—Automatic Telephone Mfg. Co., Gent & Co., North British Rubber Co., Peel-Conner Telephone Works and Western Electric Co., telephone apparatus: British Insulated & Helsby Cables, Craigpark Electric Cable Co., Enfield Electric Cable Mfg. Co., General Electric Co., Hackbridge Cable Co., W. T. Henley's Telegraph Works Co. and Western Electric Co., telegraph and telephone cable; Albion Clay Co., ducts; Bullers Limited, F. W. Cotterill and Guest, Keen and Nettlefolds, insulator spindles.

India Office.—Callender's Cable & Construction Co., copper wire; Peel-Conner Telephone Works, telephone material.

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Appointments Vacant and Filled.

Oldham Corporation Electricity Committee require a shift engineer. Salary £2. 10s. and war wage of £1. 8s. 9d. per week. Applications to borough electrical engineer (Mr. Fred. L. Ogden) by Aug. 1. *See an advertisement.*

A Sheffield firm of tool steel manufacturers advertise for a man with a knowledge of engineering and tool making.

An assistant electrical engineer is required for the Metropolitan War Hospital, Whitchurch, near Cardiff. Applications to Officer-in-Charge. *See advertisement.*

An assistant mains engineer is required by the Calcutta Electric Supply Corpn. (Ltd.), 2, Broad Street-place, London, E.C 2. *See advertisement.*

A technical assistant, with knowledge of switchgear, &c., is required. *See advertisemen'.*

A designing engineer is wanted by a large electrical firm in Lancashire. *See advertisement.*

Electrical draughtsmen are required with experience in machine and control gear design, &c. Applications to Director of Electrical Engineers, Admiralty, Great George-street, London, S.W.1. *See advertisement.*

Experienced draughtsmen are required in Manchester district for h.t. and l.t. switchgear, &c. *See advertisement.*

An estimating engineer is required for control gear sales department of electrical engineering works on south coast. *See advertisement.*

An electrical engineer, with knowledge of d.c. machine design, is required by Messrs. Siemens Brothers Dynamo Works, Stafford.

Mr. E. C. Lazenby has been appointed shift engineer at Barnstaple at £156 per annum, plus 12½ per cent. war bonus.

Business Items.

We understand that Mr. C. S. Northcote, M.I.E.E., who will be best remembered as the deputy-chairman and moving spirit of the Olympia Electrical Exhibition of 1905, also the manager of the Manchester Exhibition, is obtaining his discharge in bankruptcy and shortly resuming business as "Wholesale Electric Traders," proprietors of "CSNsation" patents and the trade name "CSNsation."

Plant for Sale.—Derby Corporation have two B. & W. water-tube boilers for sale. Particulars from Borough Electrical Engineer, 9, Irongate, Derby.

Bankruptcies and Liquidations.

The discharge of Russell Ernest Connold, late electrician, 6A, The Parade, Canterbury, has been granted subject to debtor's assent to a judgment for £10.

A meeting will be held at 8, Bouveric-street, London, E.C. 4, on August 29 to receive the account of the winding-up of "The Electrician" Printing and Publishing Co., Ltd.

Municipal Accounts.

Brighton.—At March 31 the gross debt of the tramways department was £281,073, of which £91,119 has been paid off.

Year's revenue was £80,222 (compared with £64,819 in 1916-17) and working expenses were £45,927 (£37,960) and war allowances £2,472 (£3,538). Interest required £7,301 (£7,345), sinking fund £6,195 (£6,432) and income tax £2,042 (£1,644). Revenue per car mile was 16·71d. (13·75d.) and working expenses, including power, were 9·56d. (8·05d.). Passengers carried were 16,942,512 (13,678,251), car miles run 1,152,006 (1,131,201) and units used 1,907,537 (1,837,629).

Burnley.—The gross capital expended by the tramways department at March 31 was £232,996, of which £98,819 has been repaid.

Revenue was £97,480 (compared with £87,421 in previous year) and working expenses were £68,203 (£58,604). Interest required £6,590 (£6,402) and sinking fund £8,941 (£8,716), net profit being £11,753 (£0,488). £1,546 was paid as rent of lines owned by outside authorities and £3,818 as income tax, and £6,389 placed to reserve. Revenue per car-mile was 15·2d. (13·54d.) and working expenses, exclusive of power, were 7·61d. (6·29d.). Passengers carried were 17,796,016 (17,068,753) and car-miles run 1,538,471 (1,548,902).

Colchester.—At March 31 last the gross capital expenditure of the electric supply department was £98,641 (increase of £177 over 1917) of which £42,904 has been redeemed.

Year's revenue was £23,420 (against £21,083), and working and general expenses were £17,002 (£14,073), leaving gross profit £6,417 (£7,010). Interest required £2,070 (£1,981), and sinking fund and instalments of principal £4,232 (£4,113), and after providing £164 (£373) for reduction of suspense accounts, purchase of meters, &c., there was a deficit of £49 (against a profit of £541). Total costs were 2·031d. (1·802d.) per unit, and interest and redemption 0·752d. (0·781d.). Units sold were 2,008,826 (1,873,904). Maximum load was 1,048 kw. (958 kw.) and load factor 21·8 (22·3) per cent.

Huddersfield.—The income of the electricity department increased during the past year from £79,508 to £87,588.

After paying all working expenses the gross surplus is £23,637, from which has to be deducted £11,326 for interest and £9,213 for redemption of capital. £2,250 is being devoted to relief of rates and the balance (£847) is being placed to the depreciation fund.

Rochdale.—The tramway accounts for the year ended March 31 show total capital expenditure £367,652, of which £148,029 has been repaid or provided for repayment.

Revenue was £108,472 (compared with £90,812 in previous year), working expenses were £56,592 (£50,397), interest required £10,167 and sinking fund £9,575, leaving £32,138, of which £23,787 was required for rent of lines outside the borough, income tax, &c. The net profit (8,351, against £1,773) has been added to reserve. Revenue per car-mile was 15·875d. and working expenses, including power, were 8·453d. Passengers carried were 17,582,301, car-miles run 1,639,815 and units used 3,025,678.

Sunderland.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £504,778 (increase £10,709), of which £145,067 has been repaid, in additoin to £82,919 repaid for superseded plant and £1,987 value of lands repaid.

Revenue was £85,324 (compared with £78,291 in previous year), and total costs were £51,110 (£48,821), interest required £11,693 (£12,917) and sinking fund £17,937 (£17,421), and the net profit was £4,494 (against a deficit of £2,025). Total costs, including capital charges, &c., were 1·11d. (1·19d.) per kelvin sold. Kelvins generated were 21,247,270 and sold 17,320,791. Total maximum demand was 7,400 kw.

The report of the engineer and manager, Mr. A. S. Blackman, states that the current supplied for power increased by 14 per cent. Four additional power consumers' sub-stations (= 1,580 kw.) have been connected.

Wimbledon.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £268,734 (increase £1,057), of which £144,000 is outstanding.

Revenue was £41,988 (compared with £37,944 in previous year), working expenses were £27,586 (£22,423), sinking fund and repayment of loans required £12,531 (£11,703), and interest £6,090 (£6,343), and the net result was a deficit of £4,220 (£2,525). Average price obtained per unit was 2·647d. (2·361d.), and total cost, including capital charges, was 2·987d. (2·568d.). Total connections were equal to 10,895 kw. (10,406 kw.), and the maximum supply demanded was 2,040 kw. (2,208 kw.). Consumers increased from 7,337 to 7,419. Units generated were 5,079,485 (4,941,110) and sold 3,712,749 (3,781,744).

Companies' Meetings and Reports.

BRITISH THOMSON-HOUSTON CO. (LTD.)—Mr. H. C. Levis, who presided over the annual meeting last week, said he could not speak too highly of the loyal and efficient co-operation of their employees. Of those who had joined H.M. Forces, 180 had been killed in action or had died in service, 21 were missing and believed to have been killed, the wounded and prisoners of war making a total of 378 casualties. After consultation with the holders of a very large majority of the shares, the directors did not recommend payment of dividends. For several years they had heavily depreciated their goodwill, patents, &c., account. After careful consideration as to the value of the goodwill and patents it had been decided to reinstate the account at its original cost. The total amount written back was £157,958, and to that they had added £80,000 from the year's profit, so that the total capital reserve now stood at £237,958. On plant account they expended during the year £71,632, which, added to the figures appearing in last year's balance-sheet, brought the total to £936,632. From that they had written off £106,632, leaving £830,000. The securities which they held in lighting, traction and other companies had been depreciated by £7,465, bringing the total valuation down to £90,000. The profit for the year was £329,664, after making provision for the estimated war taxation for 1917. Provision had also been made for the unsettled balance of munitions levy and excess profits duty for 1916. The total amount to deal with was £343,586, out of which they had paid interest on debentures and loans, carried £80,000 to capital reserve account, depreciated the plant account by £106,632, depreciated shares and debentures account by £7,465, leaving £53,743 to be carried forward. Practically their entire output was directly or indirectly for Government requirements. When after the war they could speak freely, he was sure the shareholders would be very well satisfied with what had been accomplished. Many organisations were now engaged in considering matters relating to reconstruction after the war. Many of those were of great value in fostering particular industries, and thereby contributing in a marked degree to the welfare of the Empire as a whole, and already a great deal has been accomplished by the British Electrical and Allied Manufacturers' Association. It was to be hoped that there would be greater concentration of effort among the many associations which appeared to be pursuing the same ends, so that there would be less overlapping and dissipation of valuable energy.

CHILI TELEPHONE CO. (LTD.)—Mr. Chas. W. Parish, who presided over the 29th ordinary general meeting last week, stated that Chili had had a very prosperous time. It was to be expected that the prosperity of the country should be reflected in the progress of their company, and their local committee and general manager had been studying the developments of the territory in which the company operated that they

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might recommend what steps were becoming necessary to meet their increasing telephonic needs and also those of new centres which would benefit by being connected with the general system of the company. If the Chilian Government would grant them the necessary tenure which would justify such a large expenditure, they were inclined to erect in Valparaiso a full automatic plant, which would place that city in the first rank as regarded telephonic service, and they would doubtless eventually adopt that policy in other important towns. The gross revenue in the past year was £213,140, an increase of £60,958, while the net revenue increased by £24,368, or 41 per cent. The profits allowed them to propose the same final dividend as last year (5 per cent.), which with the interim dividend paid in January made 8 per cent. in all. They were also able to place £20,000 to a special reserve for renewal of plant and £7,000 to general reserve, bringing that account up to £145,000. The issued capital was £330,000, while their capital expenditure was £445,254. The directors therefore proposed to transfer £110,000 from reserve to capital account in the form of 22,000 fully-paid shares of £5 each, and to allot them to the present shareholders in the proportion of one new share to every three they now held. That would bring the paid-up capital to £440,000. The report and accounts were adopted, and resolutions were passed sanctioning the increase in the nominal capital and the distribution of bonus shares as recommended.

GREAT NORTHERN TELEGRAPH CO. (LTD.)—At the annual meeting held in Copenhagen on June 29, the chairman (Consul General W. Weimann), in rendering an account of the working during 1917, said the ever-increasing difficulties experienced by the company in the maintenance of its European cables had restricted their capacity for the transmission of the traffic to a considerable extent, and were felt more intensively now than at any previous time, with the result that several of their most important European cables were useless for the present. The cable steamer "H. C. Orsted" had been occupied for 161 days, and in the Far East the "Store Nordiske" and the "Pacific" had been occupied for 250 days, 128 of which being for other administrations. Owing to the circumstances prevailing in Russia, the Wladiwostock and Kiachta routes had taken only a very small share in the transmission of the traffic between Europe and the Far East. The office accommodation at Copenhagen and in London had been extended, and the board were erecting fireproof premises for their station and offices at Shanghai, which would be completed by the end of 1920. The new building would also accommodate the telegraph stations and offices of the Eastern Extension and Commercial Pacific Companies. In Peking the company has secured land for quarters for their Danish staff, and a new cable depot would be built on a leased plot of ground within the Free Harbour of Copenhagen, the harbour of Tuborg being too shallow for the new cable steamer to replace the "H. C. Orsted. An office has been opened at Stockholm for the preparation there of the traffic accounts between the Swedish administration and the company. He desired to express the board's sincere appreciation of the loyalty and perseverance of their employees, who had fulfilled their duties in circumstances which in many cases had been depressing and at times fraught with danger. Happily none had suffered bodily harm during the events of war or revolution. They had tried to remedy the food difficulties by granting liberal extra allowances, and, whenever necessary, by sending supplies of provisions from Denmark. The net result of the year's working was about £157,400 lower than that of the preceding year. That considerable decline was partly due to the great loss on exchange and partly to the heavy increase of expenses. The directors felt justified in proposing a total dividend and bonus of £22 per cent., or only 2 per cent. less than last year. The loss on exchange and the high working expenses would, doubtless, make themselves heavily felt during the current year; a considerable change had taken place in regard to the traffic transmitted by the company, the important telegraphic correspondence with Russia having been reduced to a minimum owing to the revolution, and the possible effects of the latter on the company's future position could not yet be foretold. On the other hand, the traffic in the Far East continued to develop satisfactorily. The loss on exchange showed an increase of approximately £90,800. The company collected the bulk of its receipts in foreign money, and the rate of exchange had generally moved in favour of the Danish crown during the past year. The increase in expenditure was about £87,200, chiefly for salaries and wages, &c. They were setting aside the same amount as last year for "extraordinary taxes" (£111,111). An increase of £83,000 in the item "participation in other telegraph undertakings" was chiefly due to having acquired further interests in several of the companies with which they co-operated. Recent Danish legislation had made it necessary to alter the articles of association on certain points, besides which the board had considered it advisable to propose other alterations.

City Notes.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—The directors have declared interim dividends on the 4½ per cent. preference shares and 6 per cent. second preference shares, and an interim dividend on the ordinary shares at rate of 5 per cent. per annum (less tax) for the half-year ended June 30.

BRUCE PEEBLES & CO. (LTD.)—In the First Session of the Court of Session last week authority was given to hold meetings of the members of the mortgage debenture holders and of the unsecured debenture holders, for ascertaining their wishes regarding a proposed scheme of arrangement with both classes of debenture holders. Both classes of debentures became due on July 1, 1918. Interest had been paid on the first debenture; interest amounting to £30,000 upon the unsecured debentures was unpaid, but debited in the annual accounts. The unsecured mortgages had no right to demand payment of interest until July 1, 1918. The object of the scheme was to convert the unsecured mortgagees into preference shareholders, with a right to at least 7½ per cent. cumulative dividend as from July 1, 1918, and to repayment of their capital in a winding up and to a bonus of 50 per cent. For these rights they were asked to surrender arrears of interest. The secured debenture holders agreed to defer for 15 years repayment of their capital, but they got 1 per cent. of additional interest. All the meetings were practically unanimous in approving of the scheme.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—An interim dividend of 2 per cent. per annum (1s. per share), less tax, has been declared on the ordinary shares.

NEW ROSS GAS & ELECTRICITY CO. (LTD.)—In the High Court, Dublin, last week Mr. Justice O'Connor sanctioned the alteration of the Company's name to the New Ross Gas & Electricity Supply Co., Ltd., and the increase of the capital to £10,000 by the creation of 1,000 new shares of £5 each, with authority to generate and supply electricity.

RICHARDSONS, WESTGARTH & CO. (LTD.)—It is announced that the committee of preference and ordinary shareholders have been unable to confirm the scheme for the rearrangement of the company's capital, agreed upon in April. The directors do not feel justified in dealing further with the reorganisation of the capital during the war, but they will propose at the next annual meeting that after providing for debenture interest, current depreciation and other charges, the surplus profits for 1917 shall be applied wholly in reduction of arrears of depreciation, and that out of the profits for 1918 one year's arrears of dividends on the preference shares, amounting to 6 per cent., shall be paid immediately, and that a second year's arrears shall be paid on Dec. 31 next. The accounts for 1917 are being completed.

ST JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The directors have declared an interim dividend at rate of 7 per cent. per annum on the ordinary shares for half-year ended June 30.

The Round Table.

By "kVA."

It is a recognised thing, I believe, for staff officers to take careful note of all munitions and war material shot over by the enemy or brought down by us at the front. The tendency seems to be to regard anything out of the way as an improvement, and to recommend its adoption by the Allies. Recently a magneto arrived at H.Q., with attention drawn to the fact that for part of its length the high-tension insulated conductor was a stranded *iron* wire. Will this lead to an instruction for similarly fitting our own magnetos I wonder!

* * * *

"Punch" always has a delightful way of hitting any and every situation. It deals thus with "The Great Coal Puzzle" in a cartoon which depicts Mr. and Mrs. Bull retired for the night.

MR. BULL (distracted by the Coal Ration Order): "I can't make up my mind whether to have a hot bath or a boiled egg in the morning."

MRS. BULL: "Well, if you don't put that light out soon you won't be able to have either."

* * * *

EVENT OF THE WEEK.—"The Tipperary Vindicator" states: "We have learned that at a recent meeting of the Nenagh Gas Consumers' Company it was decided to instal an electric lighting plant at an early date."

*

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, July 23, 1881.]

THE RESERVE SQUADRON.—On the occasion of the recent visit of the Reserve Squadron to Kiel, in Germany, a grand garden fête was given in honour of our officers. The garden at the Bellevue was illuminated by the Siemens electric light.

GERMANY AND THE ATLANTIC CABLES.—The United German Telegraphic Company have made an arrangement with the Anglo-American Company to secure the exclusive use of one of their Transatlantic cables. Connection is to be established with Valencia by a wire from Creetsiel, in East Friesland, passing through the Baltic, the Channel, and the West Coast of Ireland. Telegraphing to America from Germany will in consequence be as cheap henceforth as from England.

ELECTRICAL INSECTS.—Two fresh examples of insects capable of giving electrical shocks have just been brought to the notice of the Entomological Society. A letter from Lady de Grey, of Groby, described a shock caused by a beetle, one of the Elateridæ, the effect of which was felt as far as the elbow. The other case was that of a large hairy lepidopterous caterpillar, of South America. Capt. Blakeney, on touching this creature, received a shock so violent that he lost the use of his arm for a long time and his life was even considered in danger.

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CONTENTS.

NOTES 285
Measurement of Power Loss in Dielectrics of Three-Conductor High-Tension Cables. By F. M. Farmer. Illustrated 288
A 55-kw. Turbo-Alternator 289
Synchronising of Alternators. By E. Styff. Illustrated 290
The Future of Pure and Applied Chemistry. By Prof. W. J. Pope, F.R.S. 292
The Maximum Regulating Resistance and Maximum Shunt Resistance of Track Circuits. By W. J. Thorrowgood 292
Calculation of Performance of Induction Motors Working in Conjunction with Flywheels and Slip Regulators. By Herbert Vickers, M.Eng. Illustrated.—*Continued* 293
THE WELFARE (?) OF STATUTORY UNDERTAKINGS 296
REVIEW 296
Electrification of Steam Driven Three-High Merchant Mill at the Frodingham Iron and Steel Works. Illustrated 297
Electrical Power Engineers' Association 299
Volunteer Notices 299
LEGAL INTELLIGENCE 299
Commercial Topics 300
Electricity Supply 300
Educational 303
Tenders Invited and Accepted 303
Companies' Meetings and Reports 304

Notes.

Exhibition of British Scientific Products.

DURING part of the present month and during part of September there will be open an exhibition of British Scientific Products which has been arranged by the British Science Guild with the assent of the Ministry of Munitions and the approval of the Board of Trade. The object of this exhibition, which will be held at King's College, is chiefly to make clear the necessity for scientific research with respect to applications in the arts and industries, and to show how success has been achieved in this way since the outbreak of war. Exhibits will consist chiefly of products which were mainly imported from enemy countries before the war, but which are now made in this country, or products in the manufacture of which we excelled in this country before the war and exported to enemy countries, or products in the manufacture of which considerable developments have taken place during the war. We are glad to learn that more than 250 manufacturers are sending exhibits; also the Air Ministry will make a large display, as well as the Food Production Department. These exhibits will show that by the combination of science in industry we have done nearly as much in the four years of war as the Germans accomplished in the preceding forty. By this exhibition it should be possible to bring home to the public the fact that our scientific men and manufacturers can surpass German effort when the conditions of development are favourable, and that the independent position now achieved may be established for the future. It should have an educational value for both the technically educated man and for those who have a more general interest in such matters. We hope that the result will be to bring about a better appreciation of the position of affairs, and to assist that support which should be given to our manufacturers, without which the independent position of this country cannot be maintained.

The Future of Pure and Applied Science.

THE recent address of Prof. W. J. POPE before the Chemical Society voiced in an apt way the feelings of many of those interested in pure and applied science. Many examples were quoted to show the fundamental influence of scientific discovery on the welfare and development of nations—an influence which, strange to say, is habitually ignored by historians, doubtless because of their unfamiliarity with scientific subjects Prof. POPE also alluded to one crying need in scientific development, the training of a nucleus of workers to meet the requirements of the future. This is a point to which we have repeatedly drawn attention, and there is a real danger that the urgency of the immediate demands of the war may lead us into courses which will have a permanent prejudicial effect on our scientific future—an effect from which it may be difficult to recover for generations. Prof. POPE commented on the changing public view as to the utility of science. The more enlightened regard for scientific achievement which is slowly coming about is gratifying up to a point, and may yet act as a preventive to the danger referred to above. Nevertheless, we agree that even this change of attitude is not without its dangers. There is too much tendency to value science merely for its immediate industrial advantages, or for its direct application in the war. The emphasis placed thereon leads to a somewhat short-sighted utilitarian view, and may carry with it a neglect of all forms of investigation which, to the uninstructed public, are of no immediate commercial benefit. We hope, however, that this is only a transition stage. It is something that the value of direct industrial research should be appreciated. The recognition of the ultimate value of all forms of scientific investigation can only be brought about as a result of further educational effort, and may be of much slower growth.

Rockets and Illuminating Shells Used in War.

AMONG the many special applications of light in the present war, the design of illuminating rockets and star shells, and the evaluation of their candle-power, is of considerable interest to the illuminating engineer. We notice in a recent issue of the "Transactions" of the Illuminating Engineering Society in the United States a Paper on this subject by Mr. A. BERGMAN, in which some data on star shells, &c., are given. In view of the fluctuating light from such shells, and also the fact that their candle-power can be varied within wide limits according to the speed of the composition and consequent period of burning, a mere statement of candle-power alone does not constitute a proper method of rating. In these experiments the shells investigated were rated in "candle-power seconds per cubic inch of composition" burned. It is interesting to note that a composition can be "slowed" within wide limits without greatly altering the illuminating value on the above rating. In other words, one can, generally speaking, always increase the candle-power by shortening the time of burning, and vice versa. In a series of samples tested, the candle-power varied from 79,000 to 269,000, the candle-power seconds per cubic inch being on the average 480,000. These figures give some idea of the very high illuminating value of such devices as

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compared with ordinary artificial illuminants. It is conjectured that the light-giving area is in the form of a flame, and that the candle-power at different angles will be substantially the same. The Paper affords an instance of the frankness with which data of this kind are published in the United States. We understand that the Illuminating Engineering Society in this country have been for some time conducting tests on flares, parachute lights, &c., for a Government Department, and it would be very interesting at a favourable opportunity to hear something of their experience of the physical problems involved. No doubt there are some general aspects of the matter which could be referred to without disclosing any confidential information.

The General Electric Company.

It is not usual to find a company with a share capital of £3,000,000, nor is it a common occurrence to see advertised the issue of shares aggregating nearly £1,000,000. We are glad to note that the General Electric Co. has reached a stage of its existence in which such an event can take place. The present day is undoubtedly one for expansion and combination, and the growth of this company is only one instance of the present tendency and of a policy which is adopted to meet foreign competition after the war. The General Electric Co. will now be in a position to carry out practically any manufacturing operations in electrical engineering and kindred branches. As was pointed out by Mr. Hirst at the recent annual general meeting of the Company, average electrical contracts only bring in, as a rule, 10 or 15 per cent. of the work into purely electrical shops; the remaining 85 to 90 per cent. goes into shops which are concerned with ordinary engineering or other industries. By having such allied companies as the Conner-Magneto & Ignition (Ltd.), Chamberlain & Hookham, and by acquiring the works of Fraser & Chalmers, the Company has obviously strengthened its position, and we must congratulate Mr. Hirst upon a notable achievement

A Drop in Electrical Exports from the United States.—The entrance of the United States into the war is at length having an influence on the export of electrical goods. We observe that for February, 1918, the total ($3,446,000) was approximately $100,000 less than in the corresponding month in 1917. This is stated to be the first time for many months that the export of electrical goods has fallen below $4,000,000, the diminution being specially marked in the case of exports of wires and cables.

Institute of Chemistry.—Part IV. of the "Proceedings" of the Institute of Chemistry is devoted mainly to the discussion that has been proceeding on the conditions of membership, a series of resolutions embodying important modifications in procedure being passed. Under the new conditions suitable qualifications are to be accepted in lieu of the entrance examination, but further requirements are needed before admission to Fellowship in the Institution. Other matters dealt with included the formation of local sections and their efficient representation on the Council of the Institute.

Efficiency of the Moore Light.—A contribution by Dr. M. Wolfke to the "Bulletin" of the Association Suisse des Electriciens refers to some tests carried out on a Moore tube installation using carbon dioxide gas. Figures for the consumption varying from 4·7–6·0 watts per hefner-candle are given, and it is shown that the former was apparently a minimum when the installation consumed about 2,000 watts. In the case of tubes filled with nitrogen the efficiency is much better, about 1·2 watts per hefner being recorded, while the Neon tube operates at less than 1 watt per hefner. It is known also that the efficiency of the CO_2 Moore tube can be materially improved by introducing a choker in the primary circuit with a view to producing a modification in the form of the wave.

Rivetless Ships.—On Thursday last there was a special meeting of the Technical Committee of Lloyd's Register of Shipping in order to consider the application of electric welding to ship-building.

The Committee of Lloyd's have recently carried out a series of experiments to determine, as far as can be done by means of tests and analysis, the general trustworthiness of structural connections effected by electric welding and their capacity to stand the strains to which they would be subjected in practice. The Committee had before them a report from the society's Chief Ship Surveyor on the results of these experiments, and to assist them in their deliberations a demonstration was given at the society's offices. After careful consideration, the Technical Committee decided to recommend to the General Committee for approval certain recommendations put forward by the Chief Ship Surveyor as to the conditions on which, as a tentative measure, welding might be adopted instead of riveting in the construction of vessels intended for classification in Lloyd's Register Book.

National Electrical Safety Code.—We have received a new publication of the Bureau of Standards, Circular No. 72, entitled "The Scope and Application of the National Electrical Safety Code." This Circular is intended to aid those to whose attention the Safety Code has been called and those who are contemplating its adoption or use in acquiring the necessary familiarity with intent and scope. The need for the Code is explained, and examples of personal injuries by electricity are given, most of them avoidable by observance of the rules. A short summary is given of the provisions of each of the four principal parts of the Code. As the Code is being adopted on trial by many administrative bodies and public utility companies, it is expected that this Circular (which may be obtained on application to the Bureau) will facilitate its introduction.

Institution of Electrical Engineers.—A.M.I.E.E. Examination.—In view of the practical impossibility while the war continues of holding the A.M.I.E.E. Examination and of candidates having the requisite time to prepare for or undergo examination, the Council of the Institution of Electrical Engineers have decided to suspend temporarily the Institution rules in regard to examinations. The greatest care will nevertheless be exercised by the Council to ensure that only candidates possessing the qualifications laid down in the Articles in respect of training and experience are admitted to Associate Membership. Candidates who have been informed that they have been approved for Associate Membership subject to their passing the examination and who desire their applications to be reconsidered by the Council are requested to communicate with the Secretary, at 1, Albemarle-st., W. 1.

Enemy Members of the Royal Society.—A special general meeting of the Royal Society was called on July 31 to consider the advisability of expelling enemy foreign members. The following motion was submitted to the meeting by Sir George Beilby and Dr. M. O. Forster:—

That, in view of the war having continued during nearly four years without any indication that the scientific men of Germany are unsympathetic towards the abominable malpractices of their Government and their fellow-countrymen, and having regard to the representative character of the Royal Society among British scientific bodies, as recognised by the patronage of His Majesty the King, the council forthwith take the steps necessary for removing all enemy aliens from the foreign membership of the Society.

On July 4 the council had the question of expelling the enemy foreign members under consideration and considered that, if possible, unity of action between the Allied nations should be secured. In view of the fact that a conference between representatives of Allied academies for the purpose of discussing the future of scientific work hitherto carried out by international organisations will take place next October, the question was referred to that conference.

In the meantime the opinion of the Fellows of the Society on the subject has been expressed by the adoption of the above resolution.

Photo electric Sensitivity of Bismuthinite and Various other Substances.—A Scientific Paper (No. 322) issued by the Bureau of Standards (Washington) summarises the results of an investigation by Dr. W. W. Coblentz on various substances in regard to (1) the increase in electrical conductivity caused by the action of light upon them, and (2) the photo-electrical activity ensuing when they are charged to a negative potential in an evacuated chamber and exposed to light. Of the various

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substances examined none were found which are as sensitive to light as the selenium cell, and the potassium photo-electric cell. Experiments are described in which some of these substances are used as photophones, the substances being joined through a battery to the grid circuit of an audion amplifier and telephone, and an interruption of light obtained by the rotation of a sector-disc. Crystals of bismuthinite and molybdenite altered appreciably in conductivity, causing a musical note to be emitted in the telephone. It is curious to observe that in some crystals, *e.g.*, bismuthinite, the effect is confined to quite narrow regions along the length of the crystal, while in the case of molybdenite the change of conductivity appears to be a function of the thickness of the lamina used.

"Variance" of Measuring Instruments.—In a contribution to the "Journal" of the Washington Academy of Science, Mr. F. J. Schlink, of the Bureau of Standards, draws attention to some distinctions not generally appreciated in the use of terms applied to measuring instruments. Accuracy and inaccuracy are apt to be loosely defined, and sensitivity and immediacy of response, two distinct qualities, are apt to be confused one with another. The common statement of sensitivity in terms of the change in the value of a measured quantity producing the smallest perceptible response in the indication of an instrument is not entirely happy. This definition disregards the factor of sluggishness or passiveness in instrument performance. In this connection Mr. Schlink discusses another quantity the "variance" of an instrument. This is the range at any given value of the measured quantity of the variation in reading which may be exhibited by the instrument under repeated application of the same value of the quantity being measured, after a steady reading has been attained. This quantity thus represents "the range of uncertainty" of the instrument. An example of variance is the hysteresis loop observed by plotting upward and downward readings in many direct reading instruments. Such a loop is plotted for a typical automatic weighing scale. Backlash is a common cause of variance, while in some instruments the variance is irregular, *i.e.*, the hysteresis loops vary in size under apparently similar conditions.

Patents in 1917.—The report for 1917 of the Comptroller-General of Patents, Designs and Trade Marks has been issued.

During the year 223 applications were made for the avoidance of suspension of patent rights, and in 178 cases licences have been granted and in three cases the patents have been suspended in favour of the applicants. Under sec. 6 of the Trading with the Enemy Amendment Act, 1916, orders have been made vesting in the custodian the benefit of over 2,000 applications for patents made by or on behalf of enemy subjects, and patents have been sealed to the custodian of these applications. Ninety-one applications for the grant of licences under such patents were received. Six of these applications were abandoned, and in the remaining cases licences have been or will be granted.

During the year notifications and documents relating to foreign patents, designs and trade marks were made in 346 cases, against 290 in 1916, and the fees received amounted to £43. 5s.

As regards the general business of the office, there was a further improvement in the number of applications and specifications filed in 1917, the total applications numbering 19,285, an increase of 683 over 1916. The number of complete specifications filed was 11,539, compared with 10,700, an increase of 839.

The applications received from women inventors numbered 253, as compared with 238 in 1916. The applications made by way of communication from abroad numbered 927, compared with 835 in 1916. Under the provisions of the International Convention for the Protection of Industrial Property, 1,661 applications were made, against 1,400 in 1916. There are now six patents in force which have been prolonged beyond the normal period of 14 years.

The number of applications to register designs was 13,208, including 290 sets, in 1917, compared with 15,399, including 295 sets, in 1916. The number of applications made in 1917 for the registration of trade marks was 5,502, as compared with 5,837 in 1916.

The total fees received were £318,149, against £292,731 in 1916. The surplus of receipts over expenditure was £124,427.

A Device Illustrating the Properties of the Polyphase Commutator Motor.—Teachers of electrical engineering are well aware of the difficulties in presenting problems connected with alternating-current motors to students and an ingenious device, the "secomor" described by Prof. V. Karapetoff before the American Institute of Electrical Engineers, seems to deserve attention. The name is an abbreviation of the words "series commutator motor," the properties of which it is intended to illustrate. The device consists of four bars of adjustable length and with adjustable angle, which are set in combination to represent the vector diagram of voltages in a motor with any desired constants. By moving the bars to vary the load the chief characteristics of the motor (speed, torque, power factor, &c.) can be studied, and an additional device termed an "impedometer" enables the impedance drop in the machine to be also taken into account. An adjustable saturation curve is also used to enable the effect of saturation to be investigated. The author has applied similar methods to other problems. For example, the "shucomor" is a kinematic device imitating the behaviour of a shunt wound polyphase commutator motor, and the ordinary induction motor has been similarly treated. The usefulness of such apparatus is not limited to alternating-current machinery, but may apply to direct-current machinery in special cases. Thus the author has built a kinematic device to imitate the operation of the Entz electromagnetic clutch used in some motor-cars, at different engine speeds and with any setting of the regulating resistances. Naturally, such devices can no more replace human intelligence than can a vector diagram. But they are claimed to be valuable as a guide to the engineer's judgment and as a preliminary to electrical design.

The Organisation of Industry.—A meeting of the Industrial Reconstruction Council was held at the Institute of Journalists last week, when Mr. Arthur Greenwood (Secretary to the Whitley Committee) opened a discussion on "The Organisation of Industry."

Mr. GREENWOOD remarked that the Whitley scheme had only been adopted by the Government after acceptance by responsible organisations. Dr. Addison had found that when he wished to call representatives of industry into consultation no representative bodies, as a rule, were in existence. It was, therefore, necessary to create them. Such bodies would be particularly important during the reconstruction period for reconstruction must be carried out by the rank and file if it was to be satisfactory. Schemes could not be evolved by a Government department to suit every industry: this must be done by the industry itself in most cases. With regard to joint industrial councils, more headway had been made than was apparent. In one case of this kind it had been necessary to bring nearly 40 employers' associations and 40 trade unions into line. Thus progress was not easy. Nevertheless, by the end of the year, probably about a score of councils would be in existence. Even so, time was moving on rather rapidly, and therefore interim committees had been formed, and about a score of these were in view. Mr. Greenwood expressed the opinion that no hard and fast lines should be drawn as to the questions that should be considered by a council. Hitherto industry had been regarded too much as a money grubbing pursuit. Broader views should now be taken, and a patriotic spirit should be infused into it, so that there would be industrial patriotism.

A very lengthy discussion followed, to which we are not able to devote adequate space. It is of interest, however, to note the views expressed by Mr. Naylor (secretary of the London Society of Compositors). Mr. Naylor remarked that the success of the movement would depend very much on the spirit with which the subject was approached. So far, the way of progress was not clear. It was necessary to remove the inherent suspicion of workmen towards schemes which were ostensibly suggested for their welfare, but which might possibly deprive them of a means which had hitherto been effective for their good. Although the strike weapon might not be abolished, there was the idea that it might become useless and out of date through a movement of this kind. Provided they were not asked to deprive themselves of the strike as a last resource, much good might result. It should be made clear that this weapon still remained. The confidence of some trade union representatives had recently been shaken in negotiations in which he had himself taken place in forming a council. If employers, who were organising themselves, were not prepared to allow the men to organise, there would certainly be difficulties.

Personal.

Sir Joseph Larmor has been awarded the Poncelet mathematica prize by the French Academy of Science.

Dr. G. N. Watson has been appointed professor of mathematics at Birmingham University in succession to Dr. R. S. Heath.

WAR HONOURS.—Two members of the staff of the heating department of Simplex Conduits (Ltd.) have figured in the recent honours list.

Sergeant-Major J. M. Surrall was awarded a Meritorious Service Medal and Sergeant-Major Cutts obtained a Distinguished Conduct Medal. Both of them voluntarily joined up early in the war.

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Measurement of Power Loss in Dielectrics of Three-Conductor High-Tension Cables.*

By F. M. FARMER.

Summary.—This Paper describes the method used at the electrical testing laboratories for measuring the dielectric power losses in 10 ft. samples of three-conductor cables subjected to three-phase potential. The difficulties encountered and the methods employed to overcome them are discussed. Results are given for two specimens of cable, one having a low and the other a high power loss in the dielectric.

The carrying capacity of a cable is determined by the temperature at the hottest part at which the dielectric strength becomes dangerously low. Formerly the only factors which had been given serious consideration in determining the temperature of the cable were the I^2R losses in the conductor and the thermal conductivity of the surrounding media. However, investigations of cable failures, for which there was no obvious explanation, revealed local hot spots which were not due to any outside cause. Attention was then drawn to the possibility of power losses in the insulation being responsible for abnormal temperature rises.

This Paper describes the methods used at the electrical testing laboratories for determining the power loss in the dielectric of samples of paper-insulated lead-covered cables 10 ft. long, the loss being measured at various voltages and various temperatures.

The power loss in the dielectric of three-conductor cables is usually determined by making single-phase measurements, and computing the corresponding three-phase loss. The loss in the dielectric between the conductors (conductor loss) and the loss between the conductors and the sheath (belt loss), is measured with single-phase potential at the appropriate Y or delta voltage. It is assumed that these two losses are the same with three-phase potential as with single-phase potential, and that their sum is the total loss—an assumption which is open to question. Thus the author shows that there may be points not at the same potential and a tangential electrical stress in the insulation between the conductors leading to a power loss, which does not exist when making single-phase measurements.

Insulation between conductors may become charred although the insulation between the conductors and sheath is uninjured. The power loss in most insulations increases rapidly with temperature, whence it may be suspected that in such cases the heat generated in the insulation between conductors increases faster than it can be dissipated.

Method of Test.—The method used in these tests was the simple three-wattmeter method for measuring three-phase power. The cable was Y-connected, with the sheath as the neutral, and a wattmeter was connected to each phase in turn. The algebraic sum of the three quantities thus obtained is the total power dissipated. The high potential applied to the cable was obtained with three 15,000-volt 200-watt potential transformers connected in Y. The wattmeter was a reflecting dynamometer instrument, the current circuit being connected between the grounded neutral point and the high-tension winding of the transformer in the phase being measured, while the potential circuit was connected to the low-tension winding of a step-down potential transformer connected across the same phase. Now, the power factor is as low as 4 or 5 per cent. at moderate temperatures, and the effect of inductance in the potential circuit of the wattmeter would produce serious errors. Moreover, losses through paths in parallel with the cable are likely to be large and must be eliminated.

The effect of the inductance in the potential circuit of the wattmeter and the phase angle of the potential transformer was eliminated by the usual method of shunting a variable portion of the series resistance with a condenser. Thus, the resultant equivalent inductance of the circuit is compensated for by the introduction of a proper amount of capacitance.

In order to avoid the inclusion of power lost through leakage paths a guard circuit was provided for each of the three phases. This guard circuit consisted of a metallic connection between each of the following:—

(*a*) A piece of tin or tinfoil inserted between ground and each insulator supporting the high-tension circuit. (*b*) A few turns of fine bare copper wire around the insulation of the conductor 2 in. or 3 in. from the end, which served to pick up any leakage current over the surface of the insulation. (*c*) The iron cases of the step-up power transformer and the step-down potential transformer, the transformers being insulated from ground. (*d*) The low-tension windings of the transformers. (*e*) A point *between the wattmeter and the grounded end* of the step-up power transformer.

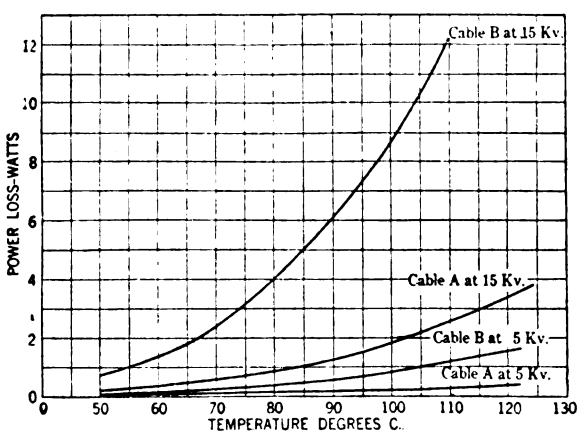

FIG. 1.—RELATION BETWEEN AVERAGE WATTS AND TEMPERATURE.

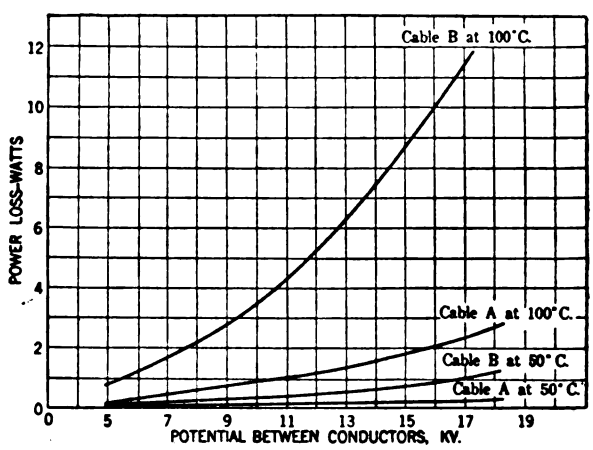

FIG. 2.—RELATION BETWEEN AVERAGE WATTS AND VOLTAGE.

This guard circuit arrangement theoretically eliminates any current from the wattmeter current circuit that does not pass through the insulation of the cable except that directly through the air due to corona. In these tests potentials were always below the corona value.

A special smooth-core generator was used in these tests, the wave of which was substantially a sine curve under all conditions. The power in each phase was measured as already indicated, the total power to the test circuits and the cable being taken as the algebraic sum of these three measurements. The cable was then disconnected from the high-tension leads, leaving all of the rest of the test circuits exactly the same, and the measurements repeated. The latter gave the "leakage" loss. The difference between these two quantities was taken as the power loss in the dielectric of the cable. The power factor was obtained by measuring the reactive volt-amperes—*i.e.*, by simply shifting the voltage circuit of the wattmeter through 90 deg. by connecting to the proper delta voltage instead of the Y voltage. The resistance between the various combinations of conductors and lead sheath was measured in the usual manner with a sensitive reflecting galvanometer at 700 to 800 volts.

Heating of Cable.—The heating of a section of cable 10 ft. long to a temperature as high as 125° C. uniformly throughout its length is not a simple problem. A simple oven was ultimately constructed consisting of a wood box lined with asbestos of such a size that the cable when bent in the form of a U having about 2·5 ft. radius could be mounted in the box in a vertical position. Heat was provided by large incandescent lamps located experimentally to give the most uniform temperature, two fans being installed to assist in attaining

* Abstract of a Pape read before the American Institute of Electrical Engineers.

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this condition. Switches outside the box controlled the amount of heat supplied. The temperature of the cable was measured by seven thermocouples soldered to the lead sheath.

These thermocouples agreed within 3°C. at a temperature of 100°C. One of the couples was connected to a curve-drawing instrument for the purpose of conveniently showing when a cable had reached constant temperature with any given condition of heating. The final test of thermal equilibrium was the wattmeter indication, the power loss in the dielectric being very sensitive to temperature. Final loss measurements were not taken until the wattmeter indication had been constant for at least 30 minutes.

Results.—The author presents in the original Paper a series of diagrams, of which Figs. 1, 2 and 3 give a summary. From these curves he deduces that the relation between the chief variables may be expressed by the equations :—

$$W = kT^{n_t} \text{ and } W = kT^{n_e},$$

where W=power loss of dielectric in watts, T=temperature in degrees Centigrade, E=potential in volts, n_t and n_e=exponents and k=constant.

The exponents for cables A and B and also for two other cables are given in the following table. The power loss in the dielectric per foot at 80°C. and 15,000 volts is given for purposes of comparison :—

Cable.	n_t.	n_e.	W.
A	3·36	2·07	0·85
B	3·54	2·34	3·85
C	3·77	2·01	1·76
D	4·26	2·16	2·62

n_t=exponent for temperature change, n_e=exponent for voltage change, W=power loss in the dielectric per foot in watts.

Single-phase measurements were made on a number of specimens in addition to the three-phase measurements. These single-phase measurements included the following, all measured at Y voltage :—

(*a*) R_1, R_2, R_3=power loss in the dielectric between each conductor and the other two conductors connected to lead sheath, $R_1 = W_1 + W_4 + W_5$, $R_2 = W_2 + W_4 + W_6$ and $R_3 = W_3 + W_5 + W_6$.

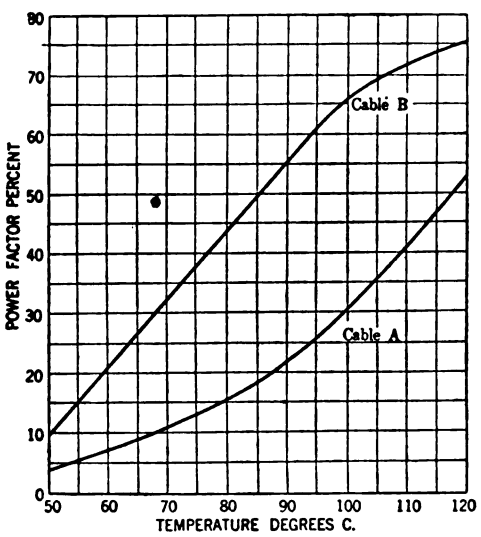

Fig. 3.—Average Power Factor and Temperature.

(*b*) R_4=power loss in the dielectric between all three conductors connected together and the lead sheath, $R_4 = W_1 + W_2 + W_3$.

If it is assumed that the conditions with three-phase potential are the same as in these single-phase tests, a value for three-phase loss can be computed from the relation

$$W \text{ (total watts)} = \frac{3(R_1 + R_2 + R_3) - R_4}{2}.$$

The three-phase loss corresponding to single-phase conditions has been calculated on this basis for a number of cables. Values for the ratio of the measured three-phase loss to computed loss do not appear to settle definitely the question of the relation of measured and calculated losses.

The most significant thing is that the measured value is frequently *lower* than the calculated value. This suggests that the theory of a greater power loss in the dielectric between conductors with three-phase potential is not substantiated. This question should be investigated further, although it is probable that, for all practical purposes, the power loss may be determined from two single-phase measurements without serious error. The question of what are the actual temperature conditions in practice is very important and in order to get data under approximate working conditions, tests are now being made with a length of cable 20 ft. long installed in a concrete conduit in the laboratory. The dielectric power losses will be measured from time to time whilst the cable is carrying its rated current and rated voltage until constant thermal conditions have been reached. Various temperatures will be measured, including the copper by increase in resistance, and the lead by thermocouples

The following conclusions are deduced from the preceding discussion :—

(*a*) The power loss in the dielectric of a three-conductor cable under actual three-phase conditions can be readily measured in the laboratory with specimens 10 ft. long.

(*b*) No special apparatus is necessary for such measurements other than a reflecting high-sensitivity wattmeter.

(*c*) The power loss in the dielectric cannot in all cases be accurately calculated from data obtained in single-phase tests, but it is probable that for practical purposes the discrepancy would not be serious. The method of determining power losses in the dielectric directly by three-phase measurements involves more preparation and time, but the results are conclusive.

The precision obtained in these measurements was probably not over 5 per cent., but this was sufficient for the purpose (namely, to determine the approximate power loss in the dielectric of the samples at various temperatures), and is capable of improvement.

A 55-kw. Turbo-Alternator.*

The first turbo-alternator of 60,000 k.v.a. capacity has recently been completed in the A.E.G. works. The output of the machine is 55,000 kw., at a speed of 1,000 revs. per min. It gives 7,000 volts., three-phase, with excitation at 220 volts. The turbines work at a super-heat of 326°C., and with cooling water at 27°. The weight of the turbine is 250 tons, of which the turbine rotor is responsible for 49 tons ; the total weight of the alternator is 225 volts and of its rotor 106 tons. The entire weigh of the machine, turbine and alternator, is thus 475 tons. The machine utilises two condensers, each of 3,000 sq. metre superficial area, and weighing 100 tons. The outlets leading to the turbines are 2,400 mm. in diameter.

The turbine utilises 10 radial arms of 3,400-3,800 mm. diameter. This corresponds with a peripheral speed of 180-200 metres per sec. The blades must be made of steel without any nickel content, and the arms must, therefore, be worked entire. The alternator-rotor has an outer diameter of about 2,200 mm., which corresponds with a peripheral speed of 115 meters per sec. It was not necessary to construct the rotor, which, apart from the bearing, has a total length of 9 metres, out of one single piece, but it was built up by the assembly of a large number of plates from the same metal.

The speed of rotation at which the rotor was tested in the works was 50 per cent. above working speed, *i.e.*, 1,500 revs. per min With single plates tests were even made at 2,000-2,400 revs per min. The bearings of the machine have a diameter of 600 mm., which corresponds to a peripheral speed of about 47 metres per sec. In testing the machine at 50 per cent. above working speed great pains were taken, and likewise in a prolonged test of the turbine, designed to secure that the safety-regulator on the turbine shall forbid any possible excess of speed when the machine is in continuous use.

In accordance with the standard practice of the A.E.G. the machine is provided with three bearings, the centre bearing being a double one, in view of the size of the parts. Between the two inner bearings is the flanged coupling connecting the turbine-rotor to the alternator-rotor. The turbine house has no pedestal, but rests on the bearings on either side of it. It can thus expand, unhindered, to differences in temperature. Apart from mechanical strength, the design of the whole machine was so contrived, as a result of experiments on models, to give an imposing and constructive appearance, the round form of the turbine, indicating its function, being strongly emphasised. The machine, although the first of its kind, gives an impression of complete harmony in design.

This machine, together with a second one of similar size and output, also designed by B. Goldenburg, will be installed in the Rheinisch-Westfälisches Elektricitätswerke power station, located on the site of the coal fields at the foot of the hills near Cologne. The total installation at this station (named after the designer, the "Goldenburg-works") will consist ultimately of six turbo-alternators from 15,000 kw. each up to about 200,000 kw.

* Abstract of an article in the "Elektrotechnische Zeitschrift."

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Synchronising of Alternators.*

By E. STYFF.

If two alternators are to be connected in parallel, the correct moment for closing the switch of the incoming machine may be determined by the connections of Fig 1 (designated as connection II. below) by selecting the moment of minimum voltage as indicated on the voltmeter or phase lamp. It is also possible to reverse one of the potential transformers and synchronise with the phase lamp bright (designated as connection I. below) instead of dark. The method with reversed transformer has the drawback that the potential transformers cannot be permanently earthed if there are more than two generators, and the method of Fig. 1 is nearly universally employed in consequence. In the "mixed connection" shown in Fig. 2 the voltmeter indicates the line voltage when the generators are in phase, and the advantage of synchronising with the lamp bright is combined with the possibility of permanently earthing the transformers.

The sensitiveness k of the adjustment of phase may be defined as the ratio of the reading A of the phase-indicating instrument to the magnitude φ of the phase difference between the machines. We have, therefore,

$$k=\left[\frac{dA}{d\varphi}\right]_{\varphi=0}=\left[\frac{dA}{dV}\right]_{\varphi=0}\times\left[\frac{dV}{d\varphi}\right]_{\varphi=0}=f\times g. \text{ (say)}$$

It will be noted that the factor f depends on the type of phase indicator used, and g on the method of connection employed.

If two three-phase alternators are connected in star connection, and E_p and E_l are the phase and line voltages respectively, and V is the voltage on the phase indicator, then, with the connection I., we have $V=2E\cos\frac{\varphi}{2}$ and $g\cong E.\frac{\Delta\varphi}{2}$, in which $E=E_p$ or E_l, according as the neutral point or one phase of the transformers is earthed.

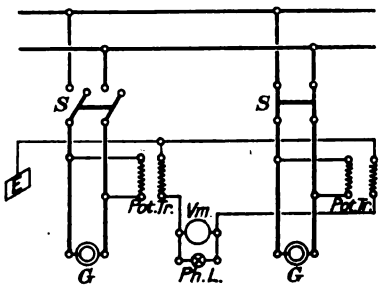

FIG. 1.

If the method of synchronising with dark lamp (connection II) is used, we have $V=2E\sin\frac{\varphi}{2}$ and $g=E_p$ or E_l in the two cases referred to.

In the mixed connection of Fig. 2 we have $V=2E_p\sin\frac{120-\varphi}{2}$ and $g=E_p\times\frac{1}{2}$, if the neutral point is earthed, and $V=2E_l\sin\frac{60-\varphi}{2}$ and $g=E_l\times\frac{\sqrt{3}}{2}$, if one phase is earthed.

The dependence of the indication of the phase indicator on the voltage impressed upon it varies according to the type of indicator used. If we call A_1 and V_1 the maximum values of these quantities, and assume that they occur simultaneously, we have $A=CV$ if the scale of the instrument is uniform, C being a constant. Furthermore, $A_1=CV_1$, whence $A=\frac{A_1}{V_1}V$ and $f=\frac{dA}{dV}=\frac{A_1}{V_1}$. For non-uniform scales we may write

$$A=A_1\Psi\left(\frac{V}{V_1}\right) \text{ and } f=\frac{dA}{dV}=\frac{A_1}{V_1}\Psi'\left(\frac{V}{V_1}\right)=\frac{A_1}{V_1}\rho,$$

where $\rho=\Psi'\left(\frac{V}{V_1}\right)$ the first derivative of the function Ψ with respect to $\frac{V}{V_1}$. If we attach to ρ the suffixes b, d and m for the cases in which the synchronising is done with the lamp bright, dark and for the mixed connection respectively, and in the mixed connection attach a further suffix, n or p, according as the neutral point or one phase is earthed, we obtain the relations,

$\rho_b=[\rho]_{V=V_1}$, $\rho_d=[\rho]_{V=0}$, $\rho_{mn}=[\rho]_{V=V_1\frac{\sqrt{3}}{2}}$ and $\rho_{mp}=[\rho]_{V=\frac{V_1}{2}}$.

From the above considerations Table I. may be drawn up.

* Abstract of an article in the "Electrotechnische Zeitschrift.

Table I.

Synchronising with	Neutral point earthed.	Phase earthed.
I. Lamp bright.....	$f=\frac{A_1}{2E_p}\cdot\rho_b$; $g=E_p\cdot\frac{\Delta\varphi}{2}$ $k=A_1\rho_b\cdot\frac{\Delta\varphi}{4}$	$f=\frac{A_1}{2E_l}\cdot\rho_b$; $g=E_l\cdot\frac{\Delta\varphi}{2}$ $k=A_1\cdot\rho_b\cdot\frac{\Delta\varphi}{4}$
I. Lamp dark	$f=\frac{A_1}{2E_p}\cdot\rho_d$; $g=E_p$ $k=A_1\cdot\rho_d\cdot\frac{1}{2}$	$f=\frac{A_1}{2E_l}\cdot\rho_d$; $g=E_l$ $k=A_1\cdot\rho_d\cdot\frac{1}{2}$
III. Mixed connection	$f=\frac{A_1}{2E_p}\cdot\rho_{mn}$; $g=E_p\cdot\frac{1}{2}$ $k=A_1\cdot\rho_{mn}\cdot\frac{1}{4}$	$f=\frac{A_1}{2E_l}\cdot\rho_{mp}$; $g=E_l\cdot\frac{\sqrt{3}}{4}$ $k=A_1\cdot\rho_{mp}\cdot\frac{\sqrt{3}}{4}$

This table shows that with the methods I. and II. the mode of earthing is immaterial as regards the sensitiveness obtained, and that

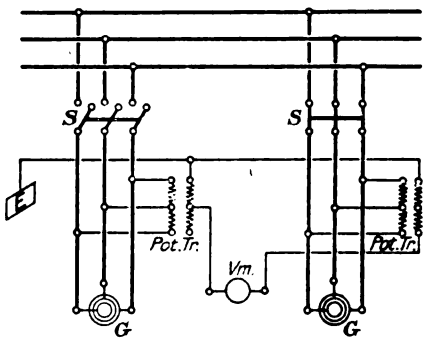

FIG. 2.

with the method III., if we may put $\rho_{mn}=\rho_{mp}$, the sensitiveness with a phase earthed is about 70 per cent. greater than with the neutral earthed.

If the scale of the phase indicator is uniform, we have over the whole scale $\rho=1$., *i.e.*, $\rho_b=\rho_d=\rho_m=1$, giving for case I. $k=A_1.\Delta\varphi/4$, for case II., $k=A_1.\frac{1}{2}$, and for case III., $k=A_1.\frac{\sqrt{3}}{4}$.

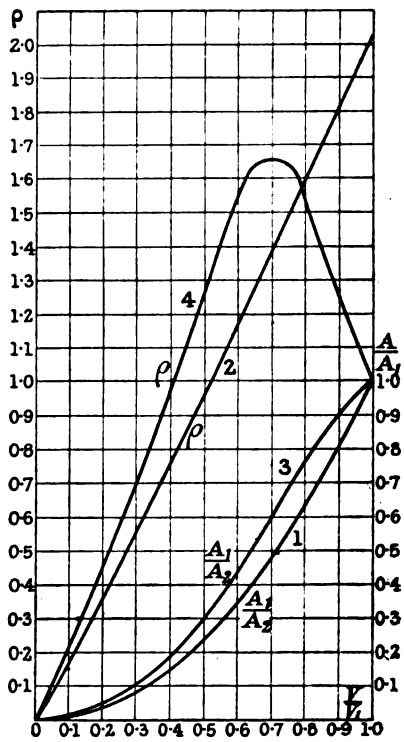

FIG. 3.

Thus, in case I., it will be seen that $k=0$ when the machines are in phase, so that the moment for synchronising is not obtainable *from a reading* of the instrument. On this account the method is inferior to the other two. The difference between the sensitiveness of the methods II. and III. is small and about 14 per cent.

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The relation between ΔA and $\Delta\varphi$ is shown in Table II., on the assumption that the phase-indicating instrument has a diameter of about 250 mm. with a scale A_1=125 mm

Table II.

Deflection of instrument ΔA.	Phase displacement $\Delta\varphi$		
	I. Lamp bright.	II. Lamp dark.	III. Mixed connection.
1·0 mm.	15°	0·9°	1·1°
1·5 mm.	18°	1·4°	1·6°
2·5 mm.	23°	2·3°	2·5°

If the scale of the phase-indicator is uneven, ρ is obtainable as the tangent of the inclination of the curve A/A_1 plotted as a function of V/V_1—*i.e.*, of the curve denoted by $\frac{A}{A_1}=\Psi\left(\frac{V}{V_1}\right)$. Thus, $\rho=\Psi'\left(\frac{V}{V_1}\right)$. Characteristic curves of this nature are given in Fig. 3, in which the curves 1 and 2 refer to Ferraris instruments and the curves 3 and 4 refer to hot-wire and soft-iron instruments.

It appears that ρ_d, and therefore k_d, are zero for all types of instruments, so that the coincidence of phase is not obtainable from an instrument reading with the connection I. The same applies to the connection II., for which $\Delta\varphi=0$, $k_l=0$. The value of k only differs

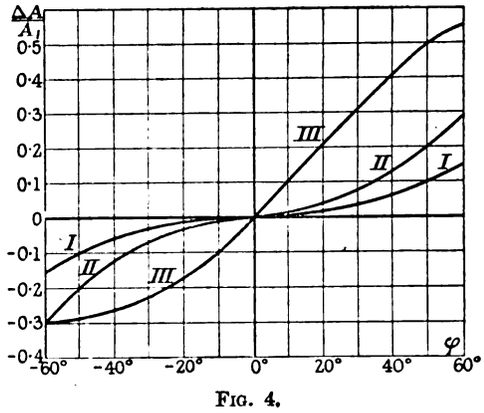

FIG. 4.

from 0 in the mixed connection III. Corresponding to the value $V_1/V_2=0{\cdot}5$, we obtain from Fig. 3, $\rho_m=1{\cdot}25$ for soft-iron or hot-wire instruments, and $\rho_m=0{\cdot}95$ for Ferraris instruments. In the first case we thus have $k_m=A_1 \cdot 1{\cdot}25 \cdot \frac{\sqrt{3}}{4}=0{\cdot}54\,A_1$; and in the second case $k_m=A_1 \cdot 0{\cdot}95 \cdot \frac{\sqrt{3}}{2}=0{\cdot}41\,A_1$. On this account the mixed connection is the only one suitable for use with instruments with uneven scales. In some cases it is desirable to instal the cheap soft-iron instruments under conditions that preclude the use of the mixed connection III. In this event a choice between the other two connections, I. and II., depends on the law of variation of A with φ, as φ increases from 0. Fig. 4 shows this relation for the instrument corresponding to curve 3, Fig. 3, the curves being numbered I., II. and III. to denote the type of connection to which they apply. It will be seen that the connection II. is about twice as sensitive as the connection I., and that the superiority of I. would become more marked with greater rate of increase of the curve 3, Fig. 3, from $V=0$. The curve III. for the mixed connection is drawn to show the great advantage gained by using this connection. Table III. is drawn up for the instruments with uneven scale under the same assumptions made in Table II., that applies to instruments with even scales.

Table III

Deflection of instrument ΔA.	Phase displacement $\Delta\varphi$.		
	I. Lamp bright.	II Lamp dark.	III. Mixed connection.
10 mm.	14°	10°	0·8°
1·5 mm.	17°	12°	1·2°
2·5 mm.	22°	15°	2·0°

When incandescent lamps are used for synchronising we may take the candle-power $I_c=C_1V_1^6$ for carbon filament lamps and $I_m=C_2V^4$ for metal filament lamps, and the factor f is given by $f=\left[\frac{dI}{dV}\right]_{\varphi=0}$.

If we denote the maximum candle-powers at the maximum voltage V_1 by I_{c1} and I_{m1} respectively, we obtain

$$f_c=6\frac{I_{c1}}{V_1} \text{ for carbon lamps}$$

and

$$f_m=4\frac{I_{m1}}{V_1} \text{ for metal filament lamps.}$$

Hence, *with connection I.*, the carbon filament lamp is about 50 per cent. more sensitive than the metal filament lamp.

In order to test the effect on the eye, two 220-volt Osram lamps of 10 c.p. were varied in brightness by making small variations in the voltage around its nominal value of 220 volts, and the variations in brightness were classified roughly as weak, plain and strong. The average results obtained are given in Table IV., in which ΔV represents the change of voltage measured, and $\Delta\varphi$ the corresponding change calculated for the phase angle between the generators.

Table IV.

	Carbon filament.		Metal filament.	
	ΔV.	$\Delta\varphi$.	ΔV.	$\Delta\varphi$.
Weak change	4·0	22°	5·0	25°
Plain change.....	5·5	26°	8·0	31°
Strong change	9·0	33°	12·0	38°

The superiority of the carbon filament lamp is, therefore, not as great as the value obtained above under the assumption that $\varphi=0$, but it is great enough to render the carbon lamp preferable.

If connection II. is used, it must be remembered that the lamps cease to glow at a certain voltage. The same lamps were examined for the purpose of determining this extinction voltage V_e, and the corresponding phase displacements $\Delta\varphi$ between the generators for the connection in question were calculated.

The results are given in Table V.

Table V.

	Carbon filament.		Metal filament.	
	V_e.	$\Delta\varphi$.	V_e.	$\Delta\varphi$.
Lamp quite dark	55	29°	28	15°
Weak glow	62	33°	41	22°
Plain glow.....	75	40°	53	28°
Strong glow	98	53°	73	39°

As might have been expected, the metal filament lamp is superior with connection II.—*i.e.*, in synchronising with the lamp dark. Nevertheless, the sensitiveness with the lamps bright or dark is so poor that phase lamps alone do not fix the moment for synchronising sufficiently accurately for use except in unimportant installations.

To sum up, the best phase indication is given by the mixed connection III. with soft iron, hot-wire, electro-dynamic and Ferraris instruments, or by the connection II. (lamps dark) with instruments having a uniform scale. The use of soft-iron or hot-wire instruments in this latter connection is not to be recommended. All the other combinations of instruments, lamps and mode of connection that have been discussed should be avoided.

The article concludes with a number of diagrams of modes of paralleling three-phase alternators using single and duplicate systems of 'bus-bars.

Electric Welding with Various Metals.—In a recent issue of the " Revue Générale de l'Electricite " Mr. J. Guerner compares the various methods of uniting metals, such as soldering and brazing with electrical processes, comprising welding, mixed welding and resistance welding. The electrical methods are now giving promising results, but the best method of treatment varies according to the metals dealt with. Iron may be welded by almost any of the typical electrical welding processes, a number of which are described. Copper sometimes presents difficulties owing to its low resistance and high thermic conductivity ; it has also the inconvenient quality of passing from the solid to the liquid state without any marked intermediate pasty condition. Aluminium is particularly difficult to weld owing to the tendency to form oxide layers, and requires special skill on the part of the workman. Experience has shown that the joint formed in electric arc welding is harder than the original metal : in resistance welding, on the other hand, there appears to be little difference. One interesting development is the filling up of small cracks in shell cases.

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The Future of Pure and Applied Chemistry.*

By Prof. W. J. POPE, F.R.S.

For three years past pure chemical research has been dormant the whole world over. Our mental point of view and our outlook are entirely different from those of four years ago; yet the future gives promise of brilliant and rapid developments in natural science in general and in chemistry in particular. The statement has been made that chemistry, and particularly applied organic chemistry, is a subject in which the British nation can never excel: That minute attention to detail, coupled with the power of organisation and co-operation, entails something antipathetic to the British character. The events of the last three years have sufficed to dissipate this fallacy for ever. Great Britain, which in the autumn of 1914, possessed scarcely any equipment for the manufacture of fine organic chemicals, has rapidly become a larger producer of explosive, pharmaceutical, photographic and other essential chemicals than Germany. Many people would contend that the battle of Trafalgar was the most pregnant event of the first quarter of the nineteenth century, but a brief moment of reflection would lead us to correct this hasty statement. Sodium was discovered by Davy in 1807, benzene by Faraday in 1823. From sodium we obtain sodamide, the prime agent in making artificial indigo; the separation of benzene from coal-tar led to the production of Perkin's mauve and thousands of other synthetic colouring matters, and to the manufacture of synthetic alizarin, involving ultimately the ruin of the Turkey-red or madder industry. The first practical process for making aluminium depended on the use of Davy's sodium, and with the aid of Davy's safety lamp 250,000,000 tons of coal are mined annually. Faraday's investigations on magnetic induction led to the invention of the dynamo, and, through Clerk Maxwell, to the introduction of wireless telegraphy. Cavendish's early production of nitric acid by the passage of an electric spark through air, reproduced on an enormously larger scale, is now furnishing Central Europe with the nitric acid, without which no explosives could be manufactured.

The modern historian is apt to take a false point of view, being in general unacquainted with physical science. The whole history of Europe for the last century has been made within a few hundred yards of Burlington House in our scientific laboratories. The nation now recognises that science is the only real maker of history The whole Empire is one vast chemical and engineering laboratory. Chemistry, with physics, engineering, preventive medicine and others of the natural sciences, which previously had no imperialistic position, because powerless to make or break a Government, have become the pivot on which turn all our hopes of retaining an independent national existence; it has been suddenly realised that supremacy in these branches of knowledge is vital to our country.

The time is approaching, however, when neglect of the natural sciences will no longer put us in danger of *sudden* extinction, but to our slow, certain downfall as a nation. Scientific men must ensure that the old order is not re-established, that science makes her voice heard in our national councils, and that policies of drift are for ever abandoned. In the past century all educational interests passed into the hands of a particular caste. Illustrations of the stultifying effect of a purely classical education are laid before us every day. Every scientific man realises that an innate appreciation for fine literature, for great thoughts nobly expressed, and for the appropriate delineation of our greatest aspirations, are among the most sublime instincts of humanity. No one asks for the abolition of classical literary learning, but that the young should be provided with an education which includes an insight into our present-day knowledge of the Universe. The petty disputes which rage about this matter of classical and scientific education are one-sided; the scientific man generally knows something of both aspects of the subject, whilst his classical compeer rarely has any acquaintance with science. Practically all the superior positions in the Civil and Diplomatic Services are filled by men of classical instincts. It is significant that branches of the administrative services such as the home Army Medical Service, have practically never been charged with inefficiency. The department named is staffed by men who have had, at least, the rudiments of a scientific education.

Meantime, one educational problem calls loudly for attention. For several years past our teaching staffs have been depleted, and but a small fraction of the normal number of young men have been able to present themselves for training in chemistry. If hostilities were to cease to-morrow, five years would be needed before our colleges and universities could begin to supply the large numbers of young chemists required for the development of the future great fine chemical industry of this country. Surely this is a matter which should engage the serious attention of the country. The adoption of some scheme by which a sufficient number of juniors can be provided to help in the great developments which the future has in store for the scientific industries of the country is of the utmost importance. Notwithstanding that, during the past 40 years, much has been done to facilitate the entrance of talented and promising young men into the scientific professions, far more progress must be made in this direction if we are to regain for Great Britain the paramount position she once held in scientific discovery. If science is to retain in its service such a proportion of the most powerful intellectual and creative talent of the Empire as will suffice for our progress as a nation, some method must be devised for securing to its followers appropriate emoluments commensurate with those now allocated to the non-productive professions.

A great danger exists at present, and will grow in the future, that the enormous productiveness of experimental science will overshadow the importance of scientific work of less immediate utility. It would be a great calamity if pure science were neglected in favour of the cultivation only of natural knowledge which gave immediate promise of beneficial material results.

At the present time, physics and chemistry are merging into one; we forsee that the near future will furnish us with still broader views of the Universe and will mark a new development more illuminating even than the great advances which followed Dalton's atomic theory and all its nineteenth century sequences.

* Abstract of a Presidential Address delivered at the annual general meeting of the Chemical Society.

The Maximum Regulating Resistance and Maximum Shunt Resistance of Track Circuits.*

By W. J. THORROWGOOD.

The maximum shunt resistance of a track circuit is that resistance which, if placed across the positive and negative rails of a track-circuited section, will cause sufficient additional current to pass through the regulating resistance (including internal resistance of battery) to increase the D.O.P. on the regulating resistance, so that the D.O.P. on the terminals of the relay falls to the "drop-away" voltage This is generally spoken of as the "shunt resistance," as it is thought to shunt the current from the relay.

It is of the utmost importance when designing or laying out a track circuit that the maximum shunt resistance should be as high as possible, to allow of any slight variations due to weather, and for light vehicles, sand, or rust, not interfering with the operation of the track circuit, and to make it more certain that even a slightly dirty rail or wheel will not result in a false clear signal being given. The maximum shunt resistance aimed at in general practice is about 2 ohms, but there are many track circuits in work to-day that have a much lower maximum shunt resistance than this.

The maximum shunt resistance depends upon:—

1. The E.M.F. used in the track circuit.
2. The pick-up and drop-away current of the relay.
3. The resistance of the relay.
4. The regulating resistance in series with the battery, both (*a*) ordinary regulating resistance and (*b*) added regulating resistance.
5. The insulation resistance of the track circuit (or the resistance of the leak path).
6. Indirectly to the strength of the stray currents.

The author, in the original Paper, discusses the influence of these various factors in detail, illustrating his contentions by practical examples. A series of curves of maximum shunt resistances for track-circuit relays to meet various requirements is presented.

In conclusion, the author states his convictions regarding the conditions desirable to obtain maximum shunt effect on track circuits, as follows:—

1. It is advantageous to use maximum value of regulation resistance.
2. Increasing the E.M.F. when the max mum regulation resistance is used, increases the maximum shunt resistance.
3. It is necessary that the insulation resistance of the track circuit shall be as high as possible.
4. The 4·5-ohm track circuit relay gives the highest results as regards maximum shunt resistance of track circuits.
5. The maximum shunt resistance of track circuits can be easily improved by one or other of the methods discussed, and the best results are obtained (1) by inserting additional regulating resistance at the battery end of track, or (2) by adding resistance between the rail and track circuit relay in series with the relay after the relay has started to pick up.

* Abstract of a Paper read before the Institution of Railway Signal Engineers.

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Calculation of Performance of Induction Motors Working in Conjunction with Flywheels and Slip Regulators.

By HERBERT VICKERS, M.Eng.

(Continued from p. 271.)

Summary.—The author deals with the subject mathematically, taking the two cases of continuous slip regulator and intermittent slip regulator; also the automatic slip regulator and the Ward Leonard system. Numerical examples are given.

The Case of the Automatic Slip Regulator.

We will now consider the case of a rolling mill cycle, in which an automatic slip regulator is introduced at a predetermined value of the load. An induction motor of the slip-ring type, whose stator is excited from the secondary circuit of a series transformer, the primary of which is inserted in the leads to the motor, is used for operating the electrodes. The movement of the rotor is resisted by means of a spring. As the current in the leads to the stator of the main motor increases, the current in the induction motor of the slip regulator increases. The torque varies as the square of the current, so the displacement of the rotor will vary as the square of the current. A lever attached to the rotor of the induction motor moves the blades of the liquid resistance switch in and out of the liquid, thus varying the resistance in the main motor circuit. An increase in load causes the blades to leave the liquid partially, and thus to increase the resistance and slip of the main motor. We will investigate shortly the law according to which such regulators should be designed to meet the objects in view.

Unlike the case of permanent resistance, the torque of the induction motor remains constant, or at least this is the condition to be aimed at since the current to the motor remains constant if this condition is fulfilled.

Taking the case of a continuous mill with constant total torque in the pass, our torque equation is

$$T-I\frac{d\omega}{dt}=T_3. \quad \ldots\ldots\ldots \quad (17)$$

T_3=constant total torque in the pass, and the other symbols have the same significance as before.

$$\frac{d\omega}{dt}=\frac{T-T_3}{I}.$$

$$\therefore \quad \omega=\left(\frac{T-T_3}{I}\right)t+G,$$

where G is the constant of integration.

When $t=t_1$ the time when the slip regulator comes into action, let $\omega=\omega_1$.

$$\therefore \quad \omega_1=\left(\frac{T-T_3}{I}\right)t_1+G,$$

$$\therefore \quad G=\omega_1-\left(\frac{T-T_3}{I}\right)t_1.$$

$$\therefore \quad \omega=\omega_1+\frac{T-T_3}{I}(t-t_1). \quad \ldots\ldots \quad (18)$$

It may be remarked that ω_1 is easily determined, for it is simply the angular speed in radians per second when the regulator comes in. In other words, it will be the full-load speed of the motor without external resistance if the regulator is set to operate at the full load of the motor.

It will be seen, in this case, that the speed time curve in the pass is a straight line. This can otherwise be seen to be true since the torque of the motor remains constant in value, the torque exerted by the flywheel is constant, since the total torque in the pass is constant.

The torque exerted by the flywheel $=I\frac{d\omega}{dt}$,

i.e., $$I\frac{d\omega}{dt}=\text{a constant.}$$

$$\therefore \quad \frac{dw}{dt}=\text{constant,}$$

i.e., the angular speed varies uniformly with time.

In the interval between passes, our torque equation is

$$T-I\frac{dw}{dt}=T_0.$$

Where T_0=friction torque, here $d\omega/dt$ is positive.

The solution is

$$\omega=\left(\frac{T-T_0}{I}\right)t+F.$$

When $t=t_2$ the time to the end of the first pass $\omega=\omega_2$

$$\therefore \quad \omega_2=\left(\frac{T-T_0}{I}\right)t_2+F.$$

$$\therefore \quad F=\omega_2-\left(\frac{T-T_0}{I}\right)t_2.$$

$\therefore$ ω in the interval

$$=\omega_2+\frac{T-T_0}{I}(t-t_2). \quad \ldots\ldots \quad (19)$$

The speed, therefore, rises according to a linear law in the intervals.

The power of the motor at any time during the pass with the regulator in

$$=T\omega=T\omega_1+\frac{T\{T-T_3\}(t-t_1)}{I}. \quad \ldots\ldots \quad (20)$$

The average speed in the pass during the time the regulator is in action $=\frac{1}{2}(\omega_1+\omega_2)$, where ω_1=angular speed at entrance of regulator, ω_2=angular speed at end of pass.

$$=\tfrac{1}{2}\{\omega_1+\omega_1+(T-T_3)(t_2-t_1)\div I\},$$

$$=\omega_1+\frac{T-T_3}{I}\frac{(t_2-t_1)}{2}. \quad \ldots\ldots \quad (21)$$

In the interval, the torque equation is

$$T-I\frac{d\omega}{dt}=T_0,$$

where T_0=frictional torque. $d\omega/dt$ is positive in the interval between passes.

It is interesting to inquire what values of rotor resistance are required in order that the torque of the motor shall remain constant.

Referring to equation (2) we have the torque in synchronous watts=input to rotor—*i.e.*, torque×synchronous speed (expressed in watts)

$$=\frac{mE^2Rs}{R^2+s^2L^2\omega_e^2}.$$

Let T=torque exerted by the motor in kilogrammetres, then $T\omega_0$ 9·81=torque in synchronous watts.

$$\therefore \quad T\omega_0 9{\cdot}81=\frac{mE^2Rs}{R^2+s^2L^2\omega_e^2}. \quad \ldots \quad (22)$$

m=number of rotor phases; s=slip$=\frac{\omega_0-\omega}{\omega_0}$; $L\omega_e=L\times 2\pi\times$frequency=reactance of rotor per phase at standstill; R=rotor resistance per phase+external resistance per phase.

$$\therefore \quad T\omega_0 9{\cdot}81R^2-mE^2Rs+T\omega_0 9{\cdot}81s^2L^2\omega_e^2=0.$$

From this

$$R=\frac{mE^2 \pm \sqrt{(m^2E^4-386T^2\omega_0{}^2\omega_e{}^2s^2L^2)}}{19{\cdot}62T\omega_0}.$$

$$\therefore \quad R=\frac{mE^2 \pm s\sqrt{(m^2E^4-386T^2\omega_0{}^2\omega_e{}^2L^2)}}{19{\cdot}62T\omega_0}.$$

$$\therefore \quad \frac{R}{s}=\frac{mE^2 \pm \sqrt{(m^2E^4-386T^2\omega_0{}^2\omega_e{}^2L^2)}}{19{\cdot}62T\omega_0}$$

$$=\frac{mE^2 \pm \sqrt{(m^2E^4-15200T^2\omega_0{}^2\times f^2\times L^2)}}{19{\cdot}62T\omega_0}. \quad \ldots \quad (23).$$

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$\omega_0 = 2\pi \times \text{frequency} = 2\pi \times f$ must not be confused with ω the angular velocity of the machine.

We have shown the relation between resistance and slip. We shall go now a step further, and get the relation between resistance and time.

$$R = s\left\{\frac{mE^2 \pm \sqrt{(m^2E^4 - 15200T^2\omega_0{}^2 \times f^2 \times L^2)}}{19{\cdot}62T\omega_0}\right\},$$

and $$s = \frac{\omega_0 - \omega}{\omega_0}.$$

$$\therefore \quad R = \frac{\omega_0 - \omega}{\omega_0}\left\{\frac{mE^2 \pm \sqrt{(m^2E^4 - 15200T^2\omega_0{}^2 \times f^2 \times L^2)}}{19{\cdot}62T\omega_0}\right\}$$

in the pass. $\therefore$

$$R = \frac{\omega_1 - \left(\frac{T - T_3}{I}\right)(t - t_1) + \omega_0}{\omega_0}\left\{\frac{mE^2 \pm \sqrt{(m^2E^4 - 15200T^2\omega_0{}^2 f^2 L^2)}}{19{\cdot}62T\omega_0}\right\} \qquad (24)$$

It will be noticed that in equation (23) the right-hand side of the equation is constant—assuming a constant coefficient of self-induction for the rotor.

$$\therefore \quad R = KS,$$

i.e., the resistance should be directly proportional to the slip for constant torque.

We shall next take the case of the continuous mill with an automatic slip regulator and constant output during the pass. Our power equation is

$$T\omega - I\frac{d\omega}{dt}\omega = W.$$

Where W = constant output during the pass,

$$\frac{I\omega d\omega}{T\omega - W} = dt.$$

$$\frac{I\omega d\omega}{W\left(\frac{T}{W}\omega - 1\right)} = dt.$$

$$\therefore \quad \frac{I}{W}\left\{\frac{W}{T}\left(\frac{1}{\frac{T}{W}\omega - 1} + 1\right)\right\} d\omega = dt.$$

Integrating, we have—

$$C + \frac{IW}{T^2}\log\left(\frac{T}{W}\omega - 1\right) + \frac{I}{T}\omega = t$$

To determine C, put $t = t_1$, then $\omega = \omega_1$, the speed at time t_1, when the regulator comes in,

then $$C + \frac{IW}{T^2}\log\left(\frac{T}{W}\omega_1 - 1\right) + \frac{I}{T}\omega_1 = t_1$$

$$\therefore \quad C = -\frac{IW}{T^2}\log\left(\frac{T}{W}\omega_1 - 1\right) - \frac{I}{T}\omega_1 + t_1.$$

$$\therefore \quad t = \frac{IW}{T^2}\log\frac{\left(\frac{T}{W}\omega - 1\right)}{\left(\frac{T}{W}\omega_1 - 1\right)} + \frac{I}{T}(\omega - \omega_1) + t_1 \quad . \quad (25)$$

$$\therefore \quad t = \frac{IW}{T^2}\log\left\{1 + \frac{\frac{T}{W}(\omega - \omega_1)}{\left(\frac{T}{W}\omega_1 - 1\right)}\right\} + \frac{I}{T}(\omega - \omega_1) + t_1.$$

Expanding the logarithm, we have

$$\log\left\{1 + \frac{\frac{T}{W}(\omega - \omega_1)}{\frac{T}{W}\omega_1 - 1}\right\} = \frac{\frac{T}{W}(\omega - \omega_1)}{\frac{T}{W}\omega_1 - 1} - \frac{1}{2}\left\{\frac{\frac{T}{W}(\omega - \omega_1)}{\frac{T}{W}\omega_1 - 1}\right\}^2.$$

The second and higher powers are negligibly small.

$$\therefore \quad t = \frac{IW}{T^2}\left\{\frac{\frac{T}{W}(\omega - \omega_1)}{\frac{T}{W}\omega_1 - 1}\right\} + \frac{I}{T}(\omega - \omega_1) + t_1.$$

$$\therefore \quad t - t_1 = \frac{I}{T}\left\{\frac{\omega - \omega_1}{\frac{T}{W}\omega_1 - 1} + \omega - \omega_1\right\}.$$

$$\therefore \quad t - t_1 = \frac{I}{T}\frac{\left\{\omega - \omega_1 + \frac{T}{W}\omega_1\omega - \frac{T}{W}\omega_1{}^2 - \omega + \omega_1\right\}}{\frac{T}{W}\omega_1 - 1}$$

$$= \frac{I}{T}\frac{\left\{\frac{T}{W}\omega_1(\omega - \omega_1)\right\}}{\frac{T}{W}\omega_1 - 1}$$

$$\therefore \quad (t - t_1)\left(\frac{T}{W}\omega_1 - 1\right) = \frac{I}{W}\omega_1\omega - \frac{I}{W}\omega_1{}^2.$$

$$\therefore \quad \omega = \frac{\left(\frac{T}{W}\omega_1 - 1\right)(t - t_1) + \frac{I}{W}\omega_1{}^2.}{\frac{I}{W}\omega_1}$$

$$\omega = \omega_1 + \left(\frac{T}{I} - \frac{W}{I\omega_1}\right)(t - t_1). \quad . \quad . \quad . \quad . \quad . \quad (26)$$

If, as is sometimes the case, $\frac{IW}{I^2}$ is fairly large, it will be necessary to take the second or even the third power of the expansion of the logarithm, and these will give a quadratic and a cubic equation in ω which can be solved by the usual methods.

We will take as an example for the automatic slip regulator a steel tube mill. This is an admirable case for such an application for the passes, and intervals are relatively long.

The cycle consists of 1 pass of 45 seconds and one interval of 75 seconds.

The total torque required in the pass = 26,000 lb.-ft.

The friction torque = 2,100 lb.-ft.

The speed of the mill is 150 revs. per min.

The motor is geared to the mill shaft, and the reduction ratio = 3·23.

The total torque-time in lb.-ft. seconds = $26{,}000 \times 45 + 2{,}100 \times 75$

$= 1{\cdot}17 \times 10^6 + 1{\cdot}575 \times 10^5 = 1{\cdot}327 \times 10^6$.

Average torque in the cycle $= \frac{1{\cdot}327 \times 10^6}{120} = 11{\cdot}05 \times 10^3$

$= 11{,}050$ lb.-ft.

To find the size of the flywheel we proceed as follows :—

Let I = moment of inertia of the flywheel in lb. (ft.)^2.

ω_1 = angular velocity in radians per second at the beginning of the pass.

ω_2 = angular velocity in radians per second at the end of the pass.

The energy given out by the wheel in the pass $= \frac{1}{2}I(\omega_1{}^2 - \omega_2{}^2)$.

$\omega_1 = 51{\cdot}8$ radians per second $= 495$ revs. per min.

$\omega_2 = 2\pi \times \frac{450}{60} = 47{\cdot}1$ radians per second.

The torque given out by the flywheel in the pass

$$= \frac{(26{,}000 - 11{,}050)}{3{\cdot}23} = \frac{14{,}950}{3{\cdot}23} = 4{,}640.$$

The torque of the flywheel in lb.-ft. × average angular velocity in radians per second in the pass × time of pass in seconds = energy given out by flywheel in the pass.

$$\therefore \quad \tfrac{1}{2}I(51{\cdot}8^2 - 47{\cdot}1^2) = 4{,}640 \times 2\pi \times \frac{474}{60} \times 45.$$

$$\therefore \quad I \text{ in lb.(ft.)}^2 = \frac{2 \times 4{,}640 \times 2\pi}{460} \times \frac{474}{60} \times 45$$

$$= 45{,}000 \text{ lb.(ft.)}^2.$$

Average horse-power of the motor

$$= \frac{11{,}050 \times 2\pi \times 474}{3{\cdot}23 \times 550 \times 60 \times 0{\cdot}95} = 326 \text{ H.P.}$$

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This, of course, will not be the rating of the motor. The motor will be required to be put in for the R.M.S. brake-horse-power over the cycle. We have seen that the speed line is a straight line after the regulator comes in. Before its introduction, however, the motor is working with permanent resistance in its circuit—viz., its own rotor resistance. Our speed and torque equations (3) and (9).

We will apply equation (3).

$$\omega=\frac{c}{a}+\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t}.$$

$$\frac{-c}{a}=\omega_0-\frac{T_3}{a};\ \omega_0=500\times\frac{2\pi}{60}=52{\cdot}4 \text{ radians per second.}$$

$$T_3=\frac{26{,}000}{3{\cdot}23}=8{,}050.$$

$$a=\frac{T_F}{\omega_0-\omega_F}=\frac{11{,}050}{3{\cdot}23\times2\pi\times\frac{15}{60}}=\frac{11{,}050\times60}{3{\cdot}23\times2\pi\times15}=2{,}180$$

natural slip at full-load=3 per cent.

$$\frac{c}{a}=52{\cdot}4-\frac{8{,}050}{2{,}180}=52{\cdot}4-3{\cdot}69=48{\cdot}71$$

$$\frac{a}{I}=\frac{2{,}180}{45{,}000}=0{\cdot}0485.$$

$\therefore$ at the end of pass

$$\omega=51{\cdot}8+\frac{(3{,}390-8{,}050)}{45{,}000}\times37{\cdot}5,$$

$$=51{\cdot}8-3{\cdot}89=47{\cdot}91.$$

In the interval the speed rises in a *st* line, the torque remaining constant, till the natural torque slip curve of the motor is reached. This is seen from Fig. 1. Any further increase in speed beyond that corresponding to the natural slip of the motor results in a reduction in torque, and our speed and torque equations are, from this point, simply those for permanent resistance (viz., the resistance of the rotor windings)—namely (6) and (12).

We must find the time taken to reach the natural torque slip curve—*i.e.*, the torque-slip curve corresponding to no external resistance in the rotor circuits.

In the interval the speed rises in a *st* line, while the regulator is in, according to equation (19), viz.,

$$\omega=\omega_2+\frac{T-T_0}{I}(t-t_2).$$

$$\therefore\quad\frac{d\omega}{dt}=\frac{T-T_0}{I}$$

$$=\frac{3{,}390-650}{45{,}000}=\frac{2{,}740}{45{,}000}=0{\cdot}061.$$

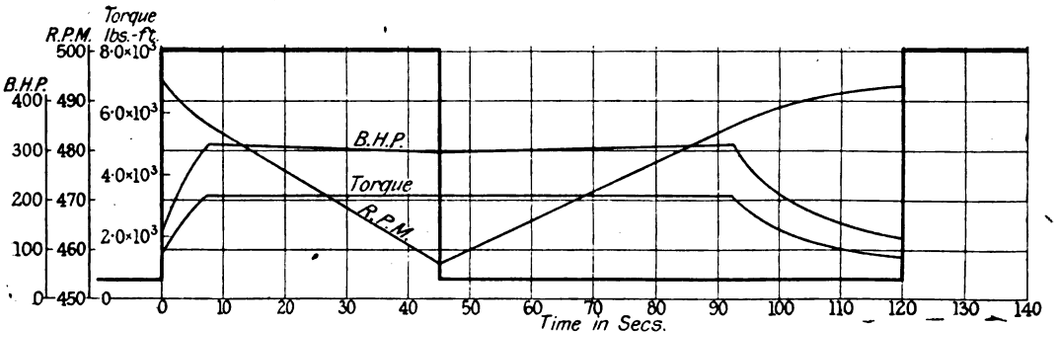

FIG. 3.—DIAGRAM SHOWING PERFORMANCE OF INDUCTION MOTOR OPERATING WITH FLYWHEEL AND AUTOMATIC SLIP REGULATOR.

The time to reach full-load torque is given by

$$50{\cdot}85=48{\cdot}71+3{\cdot}09e^{-\frac{a}{I}t}$$

$$\therefore\quad e^{-0{\cdot}0485t}=\frac{2{\cdot}14}{3{\cdot}09}=0{\cdot}692$$

$$0{\cdot}0485t=0{\cdot}368,$$

$$\therefore\quad t=7{\cdot}6 \text{ seconds.}$$

The torque equation for the beginning of the pass up to the point that the regulator comes in is

$$T=T_3-a\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t}$$

$$=8{,}050-2{,}180(51{\cdot}8-48{\cdot}71)e^{-\frac{a}{I}t}$$

$$=8{,}050-6{,}745e^{-\frac{a}{I}t}.$$

We will tabulate the results for the pass.

Time in seconds.	ω.	R.P.M.	$e^{-0{\cdot}0485t}$	Torque (lb.-ft.).	H.P. of motor.
0	51·8	495·0	1	1,305	122·7
2	51·51	492·0	0·905	1,950	182·5
4	51·25	490·0	0·822	2,520	235·1
6	51·01	487·5	0·746	3,025	284·1
7·5	50·84	485·0	0·692	3,390	311·0
Reg. comes in 45	47·91	457·0	...	3,390	295·0
End of Pass.					

From the points *K* to *H*—*i.e.*, when the regulator is in action the speed falls in a *st* line, as shown in equation (18)

$$\omega=\omega_1+\frac{T-T_3}{I}(t-t_1).$$

The speed of the motor at full-load torque $=2\pi\times\frac{485}{60}=50{\cdot}84$

increase in speed from end of pass $=50{\cdot}84-47{\cdot}91=2{\cdot}93$.

$\therefore$ time to reach the natural slip-curve $=\frac{2{\cdot}93}{0{\cdot}061}$ seconds $=48$ seconds.

The remaining 27 seconds is taken up on the permanent resistance of the rotor.

Equation (6) applies to this period.

viz., $$\omega=f/a+(\omega_2-f/a)e^{\frac{a}{I}(t_2-t)}$$

$$f/a=\omega_0-\frac{T_0}{a}=52{\cdot}25-\frac{650}{2{,}180}=52{\cdot}25-0{\cdot}296=51{\cdot}954,$$

$$\omega_2=50{\cdot}84\ ;\ \omega_2-f/a=-1{\cdot}114.$$

Tabulating the results for the 27 seconds in the interval, we have :—

Time from 48 seconds in interval.	ω.	R.P.M.	$e^{-0{\cdot}0485t}$	Torque.	H.P.
2	51·95	486	0·905	2,850	263·5
4	51·024	488	0·822	2,650	246
6	51·117	489	0·746	2,460	229
10	51·27	490	0·61	2,130	198·5
14	51·38	490·3	0·51	1,890	176·5
17	51·465	491	0·433	1,700	158·5
27	51·648	493	0·275	1,318	124

The corresponding torque

$$T=T_0-a(\omega_2-f/a)e^{\frac{a}{I}(t_2-t)} \quad \text{(equation 12).}$$

$$T=650-2{,}180(-1{\cdot}114)e^{\frac{a}{I}(t_2-t)}$$

$$=650+2{,}430e^{\cdot0485(t_2-t)}$$

These results are plotted in Fig. 3.

(To be concluded.)

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The Welfare (?) of Statutory Undertakings.

We have seldom read such foolish talk as that which took place in the House of Commons last week on the subject of statutory undertakings. We have already made reference in these columns to the Bill which is entitled "Statutory Undertakings (Temporary Increase of Charges) Bill," according to which it was proposed, among other things, that the charges might be so raised as to permit payment of a dividend on such undertakings at the rate of half the statutory or maximum rate of dividend, or of the pre-war dividend, whichever was the lower. We pointed out, when the Bill was brought forward, that such a basis was totally inadequate. This proposal was made by a Select Committee, but last week it was modified by the House of Commons, the half being raised to three-quarters. This is certainly a step in the right direction, but the occasion was marked by a great deal of wild talk showing that many members of the House of Commons have no true idea of the basis on which the commercial prosperity of this country depends. They start out with the absurd notion that the shareholders should be wholly neglected, and even sacrificed, for the supposed benefit of the consumer. In other words, the shareholder is a mere parasite. The sentiments expressed by Mr. John Burns, who we had thought was more level-headed than his utterances appear to show, illustrate this point, and similar views were expressed by Col. Wedgwood. The latter, for example, spoke of "putting money into the pockets of the shareholders at the expense of the silent mass of the community," and Mr. Burns spoke of "financial Bolshevists who, with disorderly intent and revolutionary and confiscatory measures robbed other people." In his view they were now face to face with a vicious extension of Government liability for the benefit of speculators and others who were taking advantage of the war to obtain preferential privileged consideration. The step contemplated was, in his opinion, unjust to the consumer and to the ratepayer. Mr. MacCurdie stated that they were being asked to compensate financial interests at the expense of the public. We would ask why those who have invested their savings in such undertakings should have their modest dividends, which are supposed to be reasonably secure, reduced at a time when the cost of living is abnormally high?

By way of illustration, the attack in Parliament was made on the gas companies, but any statutory undertaking would have served equally well, except perhaps from the point of view of catching votes. To those who know nothing about the subject, the impression given by some of the remarks would be that the cost of working such undertakings had not increased materially during the war, and that any increase in the charges was merely an effort at profiteering. In the words of Mr. Burns, the gas companies had "exploited the war by increasing the price of gas." The annual returns show very clearly that this is not so. In the case of the Gas Light & Coke Co. the net cost of gas sold has increased by 7·98d. in the period 1914–17, and the price has been raised by 9d. In the case of the South Metropolitan Gas Co. the increase in cost has been 8·41d. and the increase in price 8½d. The standard dividend in both cases is 4 per cent. In 1914 the Gas Light & Coke Co. paid £5. 1s. 4d. per cent. and in 1917 a dividend of £3. 14s. 8d. The corresponding dividends by the South Metropolitan Gas Co. were £5. 6s. 8d. and £4 per cent. respectively. These have both been reduced so far in 1918. And yet our enlightened politicians consider that 2 per cent. is sufficient!

It seems to be entirely forgotten that commercial undertakings cannot exist and give an efficient service without earning dividends, and not only must dividends be paid but they must be adequate. Such undertakings are often limited in the extent of their dividends, and it will be quite impossible for them to maintain their position and to attract the capital that is necessary for extensions if these dividends are not maintained. If a local authority undertakes work of this kind it raises a loan and pays interest upon this loan. Mr. Burns will, no doubt, consider this class of undertaking as one which is run for the benefit of the ratepayers. We wonder whether he would suggest that the interest on such loans should be reduced to half the pre-war rate, so that the cost of gas, electricity or water, as the case might be, could be reduced? We presume that he would be sufficiently logical to accept this extension. If this line of policy is equitable for private undertakings it is equally so for those which are operated by municipalities, but no one with any knowledge of such matters would propose such a course for either type of enterprise.

If the dividends which have been paid in pre-war days have been high, then a step that might be taken at the present time would be to limit the dividend to such a figure as might be considered commercially reasonable, but so to limit the charges that the dividends may be wholly inadequate and may endanger the financial stability of the undertakings is foolish, to say the least of it. Possibly sentiments such as those to which we have referred are expressed at the present moment for electioneering purposes, but even if the speakers are sufficiently irresponsible to put forward such ideas for the sole purpose of winning an election, we feel great misgivings for the future prosperity of this country, when talk of this kind takes place freely in what is supposed to be the most responsible assembly of the United Kingdom. The prosperity of the country must inevitably depend upon the financial stability of the undertakings, statutory and otherwise, on which the industry of this country depends, and it is high time that politicians learned that there is no iniquity in paying a dividend—that, on the contrary, if all dividends in this country are reduced to a nominal figure, such as socialistic dreamers desire, the commercial importance of this country would vanish and we should become bankrupt among the nations of the world.

Review.

Steam Power. By C. F. Hirshfield and T. C. Ulbricht. (London: Chapman & Hall, Ltd.) Pp. viii.+420. 9s. 6d. net.

This volume on steam power and the elements of steam engineering is one of the widely known Wiley Technical Series, and is evidently written to meet the needs of civil engineering students at American colleges. A very useful and indeed a very necessary feature of the technical training of students at colleges, or apprentices in classes held at local institutes, is to make trade terms and idioms familiar to them. Now, the volume under review is full of American terms which are not in the everyday language of the British engineer. For instance, we say "dry back," whereas on page 347 it is termed

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"continental"; also hand-governed in place of "manual" on page 214, "expansion valve" instead of riding cut off valve on page 185. The term Brake Horse Power is more usual with us than Developed H. P., as given on page 137, and a surface condenser seems misnamed when referred to as a non-contact condenser. These examples show that this text-book, however excellent in its get up, is written in a foreign language, considered from the standpoint of our terminology.

The book is divided into 19 chapters, of which the first three deal with units, the physical properties of steam, and the elements of a steam power plant. Three chapters follow dealing with the ideal steam engine and with this a description of the temperature-entropy chart. Chapters VI. to XII. deal with the actual steam engine, indicator diagrams, compounding and the valve-gears in general use, governors, &c. A short chapter on the large topic of steam turbines includes such an intricate subject as nozzle design; this seems out of place in an elementary work. It is not sufficiently advanced in explanation to be useful to a student and yet too much so for a reader whose knowledge is to be aided by such elementary chapters as Nos. I. and II. Chapter XIV. deals with condensers, and in this chapter too much prominence is given to types of condensers which are comparatively rarely used in Britain. The remaining chapters deal with boiler-house equipment and combustion of fuels, &c.

In dealing with steam raising and power plant engineering it seems a good plan to write a text-book which follows step by step the generation, flow and utilisation of the steam in the engine, and its exhaust and condensation. This book does not follow this systematic plan, and is hardly so suitable for students on this side of the water as many elementary text-books written and published in England. There are 232 figures and diagrams which are very clearly printed and these will be found very useful by students.

A description of an automatic flue gas analyser for CO_2 would be of utility, and would certainly be an improvement if substituted for paragraph 131, which deals with temperature of combustion. The percentage of CO_2 gas is a very practical direct indicator of the efficiency of a steam raising plant, and as such it should receive a careful description in any text-book on steam.

A. J. M.

Electrification of Steam Driven Three-High Merchant Mill at the Frodingham Iron and Steel Works.

Running at the Frodingham Iron and Steel Works, Scunthorpe, Lincolnshire, was a 14-in. three high non-reversing merchant mill driven through a gearing by single-cylinder engine with cylinder dimensions 36¾ in. diameter by 36 in. stroke running at 100 revs. per min. and operating at a nominal steam pressure of 90 lb. to the square inch, but often falling to a much lower figure.

The engine was equipped with a 12-ft. 6-in. flywheel having a rim weighing 21,000 lb., and power was transmitted to the mill through gearing with two speed changes. When rolling heavy sections the speed was reduced in the ratio of 29 to 16, but for lighter work where a higher speed could be used it was reduced in the ratio of 23 to 22 by changing the gears.

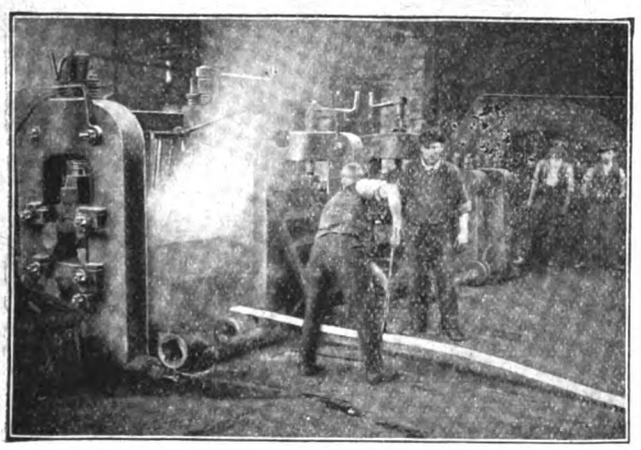

FIG. 1.—VIEW OF THE ROLLING-MILL MOTOR AT WORK.

The management decided to electrify the mill, with a view to obtaining an increased output, and the conversion affords an interesting example of the problems which often have to be solved by the electrical manufacturer.

In formulating the electrical scheme it was desired to supply the mill with sufficient power to roll the heavier sections and to obtain a wider range of speed variation by means of shunt regulation on the motor without the intervention of the gearing. Moreover, it was wished to include a flywheel sufficiently heavy to reduce the peak loads to below 900 H.P., commensurate with the limited amount of power available. This power was to be obtained from gas engines incapable of overload, and with only 900 H.P. to spare.

Some account of the way the problems were solved may be of interest.

To avoid the complications of gearing it was decided that the mill should be driven direct by the motor, the full-load speed of which would in consequence range from 72 revs. per min. for the heavy sections to 150 revs. per min. for the light sections.

The first portion of the problem was to settle the size of the flywheel, and for this purpose a number of tests were made upon the steam mill. A difficulty was introduced in making these tests by the inability of the engine to develop adequate power for the output required, so that indicator diagrams alone did not afford the requisite information, The following tests were therefore taken:—

1. The instantaneous drop in speed of the engine and flywheel was measured many times for the heaviest passes in the roughing rolls, and the time of the pass was also taken. From the known weights of the flywheel, the time of pass, and the drop in speed it

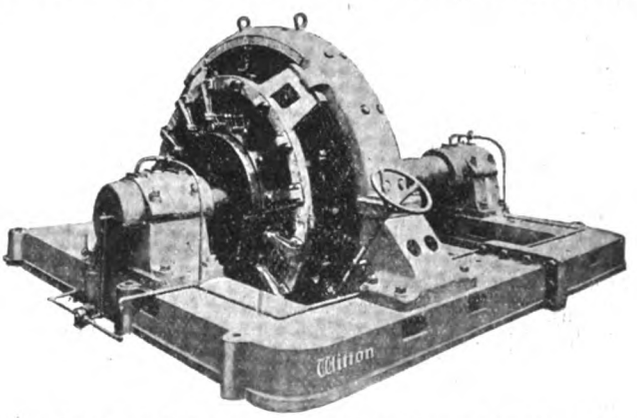

FIG. 2.—750-H.P. "WITTON" ROLLING-MILL MOTOR SUPPLIED TO THE FRODINGHAM IRON AND STEEL WORKS, LTD.

was therefore possible to calculate fairly closely the power required by each roughing pass.

2. Continuous indicator diagrams were taken for all the passes, but particularly for the long finishing pass, occupying 10 or more seconds. During this pass the energy given by the flywheel was only a small portion of the total and the engine had to exert a torque sufficient to roll out the section without assistance from the flywheel. The horse-power required to do this was obtained from the continuous indicator diagrams taken in conjunction with the speed figures and time figures.

The tests on the finishing and roughing rolls were taken separately, so that the heaviest loads of each pass could be taken independently and combined together to give the conditions under which the motor would have worked when rolling sections in both sets of rolls

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at the same time. Very frequently the engine pulled up under such conditions, so that a reliable estimate of the power needed could only be calculated by combining the results of individual tests.

Having obtained the figures for the existing flywheel and engine, it was possible to calculate the amount of compounding and the size of the flywheels that would be required on the motor.

The weight of the flywheel had to be such that it would give out the additional energy required if the heaviest roughing pass occurred during the period of the heaviest finishing pass, with a suitable drop in speed so that the load on the motor did not exceed the stipulated 900 H.P mentioned. In making the calculations allowance had also to be made for the extra power given out by the motor as it slowed up. Very careful calculations were made with a number of different sizes of flywheel, and it was eventually decided that to keep the

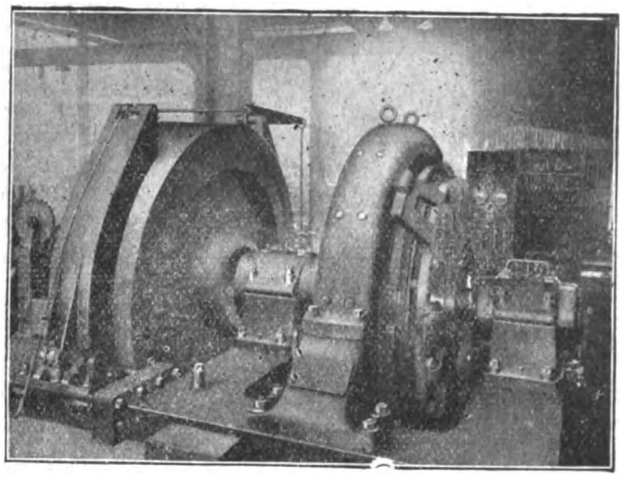

Fig. 3.—View of the Rolling-Mill Motor at Work.

maximum horse-power down to about 900 it would be desirable to instal a flywheel having a stored energy equivalent to that of a weight of 35 tons revolving on a radius of gyration of 5 ft It is interesting to note that the calculated figures agree very closely with the results obtained when the mill was set to work, and as in making calculations a margin was allowed for contingencies, the maximum horse-power required was actually about 10 per cent. below the calculated figures.

It was eventually decided to instal a continuous current compound wound, interpolar "Witton" motor, capable of developing 750 B.H.P. as a normal continuous load with a temperature rise not exceeding 72°F. after 6 hours run at 72 revs. per min. The motor was so compounded that it had a drop of 20 per cent. between no load and full-load. Thus the light load speed, corresponding to the 72 revs. per min. was about 90 revs. per min. A diverter was provided so that the amount of compounding (and consequently the drop in speed) could be instantaneously adjusted on the switchboard to suit the best conditions of rolling. Further, the motor was so designed that the speed could be increased by shunt regulation up to 180 revs. per min. at light load. When running at this higher speed the load on the motor is usually comparatively low as lighter sections are being rolled, and as also the stored energy in the flywheel increases proportionately to the square of the speed, the amount of compounding required at this higher speed is only slight and can be adjusted on the diverter, as already mentioned, to suit actual conditions.

The motor was coupled to a flywheel having a total weight of about 45 tons and approximately 12 ft. 8 in. diameter. To give additional strength, this flywheel, which is of the disc type, had an additional cast-steel rim about 12 in. deep shrunk over the outer periphery, bringing up the weight to the figure mentioned above. The motor and flywheel were combined into a three-bearing set, the centre bearing being extra large so as to take the combined weight of the armature and the flywheel.

The bearings, which were lined with special white metal, had oil-ring lubrication, and, in addition, overload flood lubrication from a small pump belt driven from the motor shaft. Either system of lubrication alone would be sufficient, so that with the two systems there is no likelihood of bearing trouble.

The flywheel shaft ran in the two outer bearings at one end and was connected to the motor by means of a solid coupling, forged with the shaft and bolted to a coupling forming a portion of the armature spider. It was then possible to remove the armature, should this ever be necessary, without disturbing the flywheel or its bearings.

It is unusual to instal a three-bearing set where a motor and heavy flywheel are required, the most common practice favouring four bearings with a flexible coupling between the motor and the flywheel, or, alternatively, a very stiff shaft with only two bearings, and with armature and flywheel mounted in the centre side by side. This arrangement has considerable disadvantages if any repairs are ever necessary to the armature.

In this case, however, there were reasons why the three-bearing set was chosen. It was desired to make the change from steam to electrical drive in as short a time as possible, so as to avoid stopping the mill, except for the August holidays, and as a matter of fact the engine was dismantled and the mill re-started, driven by the electric motor, with a total stoppage of only 11 days, an extremely satisfactory result.

To reduce the time required for stoppage to a minimum it was proposed to utilise as far as possible the existing engine foundations and the bed of the motor was so designed that a number of the existing engine foundation bolts were used for bolting down the motor. The shape of the existing foundation was such that very little alteration was required to make it suitable for taking a three-bearing motor and flywheel, whereas the foundations would not have been suitable for either a two- or four-bearing set. One of the reasons why a two- or four-bearing set is usually chosen for a drive of this nature is the difficulty of getting reliable foundations that will not sink, but as the engine foundations had been in existence for many years they formed a perfectly reliable support for the motor, so that no trouble due to sinking or settling of a portion of the bearings was anticipated, and no such trouble has actually resulted.

The amount of stored energy of the combined armature power and flywheel, amounting to about 3,650,000 lb. at 100 revs. per min. would keep the set running for very long periods after current was cut off. This would, of course, cause considerable delay where adjustments were required to the rolls, where rolls had to be changed, or in cases where breakages of rolls or portions of the mill had occurred. The set was therefore provided with a mechanical disconnecting trip coupling, so that the mill could be instantly stopped while the motor and flywheel continued running. In addition to this a water-cooled post-brake with powerful hand-wheel was fitted on the combination bed-plate, the brake being arranged to press on the turned surface of the flywheel. The ratio of leverage was so adjusted that too much pressure could not be applied to cause dangerous stresses, but the set could be pulled up in between one and two minutes.

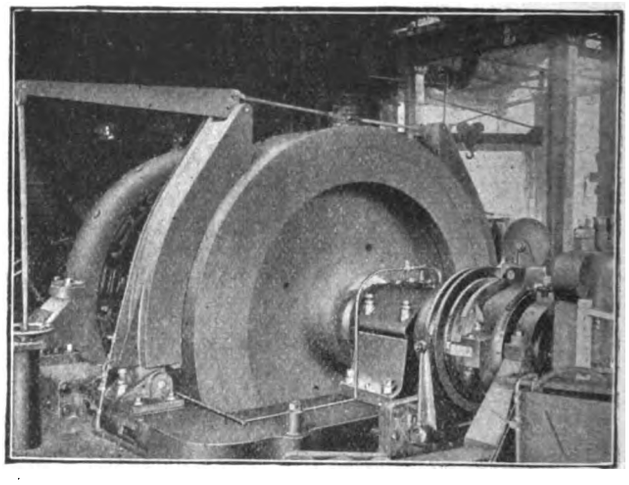

Fig. 4.—View of the Rolling-Mill Motor.

The switchgear for controlling the motor consists of enamelled slate panels with the usual side screens and lock-up door, supplied with ammeter, voltmeter, shunt regulator for varying the speed within the two to one limits of the motor, a double-pole main switch, overload and no voltage circuit breaker. A switch was also provided for reversing the direction of rotation at a slow speed for emergency use. On the board is mounted a multiple knife switch diverter for the series windings. Each switch diverts a certain amount of current from the series turns, and thus alters the compounding. When all the switches are closed the machine practically acts as a shunt-wound machine with only about 5 per cent. drop in speed between no load and full load, instead of the 20 per cent. which can be obtained with the full current passing through the series turns.

The starter for the motor was also mounted on the board and

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consisted of a multiple-switch starter with interlock, so that the switches must be closed in the right order.

In addition to the considerable friction of the rest of the set there is the friction of the mill to be overcome, and during the starting period the whole of the energy in the flywheel has to be imparted to it. This stored energy, even at a minimum speed, forms a very large proportion of the starting power needed, and as the stored energy increased in proportion to the square of the speed, an interlock was provided between the starter and the shunt regulator, so that the motor could only be started with full field at the slowest speed. After the motor had attained the minimum full speed the speed could be increased up to the maximum by the shunt regulator as required, but only when the starting resistance had been cut out of circuit. The starting resistance itself consists of heavy cast-iron grids, liberally rated, and capable of starting the motor against 750 H.P. for a period of 2 min., or a proportionately greater power for a shorter period. Additional interlocks were provided between the breaker and the starter so that the breaker could not be closed unless the starter was in the "off" position.

A view of the motor taken before erection is given in Fig. 1, and the other illustrations depict the motor at work.

The installation at the Frodingham Iron and Steel Works also includes a large 750 kw. "Witton" motor-generator used for the purpose of coupling together two portions of the works operating at different voltages. The machine converts into continuous power from 460 to 230 volts, the low-voltage side having a continuous capacity of 7,500 amperes.

The whole of the installation was supplied by the General Electric Co., Ltd., of Birmingham.

Indebtedness must be expressed to the Frodingham Iron and Steel Works for permission to take the photographs and to publish this description.

Electrical Power Engineers Association.

A meeting of the National Executive Council of this Association was held at Manchester on the 27th ult.

The following were present:—Messrs. Annett, Atkinson, Spurr, Lunn and Thomas (Northern Division); Porter and Vernier (North Eastern); Mason, Bowser and Burgess (Midland); Bostel, Healy, Christmas and Law (Southern Division); G. G. Bell (A.M.E.E. Greater London), Parker and Young (C.T.A.A.) and W. A. Jones, Hon. Sec. of E.P.E.A. Mr. C. H. Wordingham (President I.E.E.) attended the meeting in an advisory capacity.

Mr. Lunn was elected chairman of the meeting, and the Hon. Sec. reported that as a result of ballot of members as to representation on the National Executive Council there was a large majority in favour of proportional representation. The drafts of rules were submitted and a final draft agreed upon, subject to legal approval and that of the Registrar before final submission to the members. The development in connection with the A.M.E.E. and C.T.A.A. since the last meeting was reported upon, and it was unanimously agreed that it was necessary to safeguard representation of the various grades, namely: (1) Chief Engineers, (2) Departmental Chiefs, and (3) the remaining members—on the Sectional and Divisional Committees, and National Executive Council. The following scheme was adopted for the basis of representation: 10 per cent. to be elected by Grade 1, 2 per cent. by Grade 2, and 70 per cent. by Grade 3. Provided that there shall be not less than one representative of each of the three grades on any committee.

The following officers were elected for the current year:—*President*, Mr. A. L. Lunn; *Vice-Presidents*, Messrs. R. C. Atkinson and H. Parker; *Treasurer*, Mr. G. C. Law; and *Hon. Sec.*, Mr. W. Arthur Jones.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Saturday, August 3, to Sunday, August 11.—Annual Camp at Esher, Surrey. The party will parade at Waterloo Station, opposite No. 10 platform, at 2.0 p.m., on Saturday, August 3. Dress: Full Marching order. Billets are provided at Sandown Park (Fire Station entrances.

Headquarters.—During the period August 3 to August 11 the Headquarters at Balderton-street, will be closed, Headquarters being transferred to Sandown Park, Esher.

Legal Intelligence.

Isaacs v. Hobhouse.

The hearing of this case was concluded late on Thursday last.

Sir HENRY NORMAN, who was called for the defence, said he had taken a great interest in wireless research. He was chairman of the War Office Secret Committee on the utilisation of wireless telegraphy for the British Army: and he was a member of every wireless research society in England and America. He had a private wireless station which he had used for the Admiralty at the beginning of the war. He had always taken a scientific interest in the subject, but never a commercial interest. In 1914 he went to Berlin at the invitation of Sir Charles Hobhouse. He knew then that there was a working arrangement between the Marconi Co. and the Telefunken Co. which prevented them from competing. While in Berlin he visited von Lepel and saw his laboratory. Sir Charles Hobhouse was not with him on that occasion. Von Lepel was engaged on what he believed to be an invention of very great value. He encouraged him in the sense of offering to bring him into touch with British experts. On March 2 he went with Sir Charles Hobhouse to the Telefunken works. He did not make any offer to the Telefunken Co. that they should start in keen competition with the Marconi Co., or suggest that they could rely on Government support. Sir Charles Hobhouse did not make such an offer in his hearing. He would not have had any authority whatever to make such an offer.

Mr. Justice DARLING: Can you say positively whether Sir Charles Hobhouse said anything to that effect?—I am quite positive that he did not.

The witness, continuing, said that on March 3 von Lepel came to the railway station. A short time before the train left he (witness) introduced von Lepel to Sir Charles Hobhouse, but only one or two purely formal words were spoken. Von Lepel came to England and witness placed his workshop at his disposal on condition that no commercial friend should come with him. He did not see Mr. Hurd in Berlin nor did he approach Mr. Beit on the subject. When he first heard of the suggestion that an offer had been made to the Telefunken Co. he replied that it was ridiculously untrue.

In cross-examination witness said that he had always been an opponent of anything like monopoly in wireless telegraphy. He was an opponent of the Government so far as it had made a contract with the Marconi Co. He regarded the contract made in 1912 when Mr. Samuel was Postmaster-General as the worst contract for a national and scientific undertaking that had ever come to his notice. Down to the outbreak of war he was not certain that the Marconi system was the best. He approached him as he had approached every inventor, with the object of seeing what stage he had reached. He took it that the Telefunken Co. would be far too well informed as to von Lepel's invention to imagine for a moment that he could have been a competitor with Marconi for the wireless chain service for a very long time.

Mr. Justice DARLING: Your attitude was that the State should not employ any company, but should ascertain which was the best system and then adopt it?—Yes, it should combine several systems.

The witness, continuing, said that his view was that the State should examine inventions possessed and worked by any commercial company and should take advantage of its powers under sec. 29 of the Patents Act to use those inventions in its own stations.

Mr. R. MCKENNA said he was appointed in the Cabinet to co-operate with Sir Charles Hobhouse in endeavouring to get some settlement of the difficulties which had arisen between the Marconi Co. and the Post Office. He went fully into the matter. Undoubtedly the draft of the letter of Jan. 21 was approved of by him in the first instance. When Sir Charles Hobhouse and he had agreed upon the draft it was then reported to the Cabinet and the Cabinet's approval was given to it. The draft afterwards became the letter of Jan. 21, 1915. His impression at that time was that Sir Charles Hobhouse was inclined to a settlement more favourable to the Marconi Co. than the rest of the Cabinet believed the facts to warrant.

Sir Charles Hobhouse and Mr. Hurd were recalled. The latter produced a letter (dated July 21, 1914) from the directors of the Telefunken Co. to Mr. Isaacs.

After speeches by counsel his Lordship summed up, and in doing so, said he was afraid that the case had degenerated at times almost into an inquiry whether the Marconi Co. had a grievance against the Government. Many documents had been read, and much evidence had been given which did not seem to have the remotest bearing on the issue. It had been suggested that the petition of right was brought to a close in order to protect Sir Charles Hobhouse. As a matter of fact it was settled after a consultation between the Law Officers of the Crown and Mr. Illingworth, and the Attorney-General had sworn that Sir Charles Hobhouse was never consulted and would not have been consulted in the circumstances. Sir Charles Hobhouse was subpœnaed by both sides, but neither called him.

Then there was the charge that Sir Charles Hobhouse's draft of his speech was a wicked invention which he palmed off on the House of Commons. Mr. Leslie Scott said that his memorandum was a fabricated document, though he said that it was not a forgery. Forgery, according to the 1913 Forgery Act, was the making of a false document in order that it might be used as genuine. Forgery of certain specified documents, if committed with intent to deceive, was a felony. Among the documents specified was any document, or copy of a document, used, or intended to be used, in evidence in any Court of Record. Sir Charles Hobhouse's document had been used in a Court of Record, and if it was fabricated,

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as Mr. Scott had said, it must have been used with intent to deceive. Sir Charles Hobhouse said that it was genuine. Seeing that forgery had been already mentioned in the case, he was bound to see whether the Telefunken letter was genuine. Forgery had been suggested by Mr. Isaacs himself. He said that he suspected a document of Sir Charles Hobhouse's to be a forgery. He sent it to an expert; he had had it treated with chemicals. Why were they to accept as obviously genuine a document which had "Berlin" at the head of it and at the same time to suspect as a forgery a document by the Postmaster-General of that date?

Having reviewed the evidence he said the stories told by the two parties to the action were hopelessly in conflict, and it was the duty of the jury to say which party was telling the truth.

The jury returned a verdict for defendant. Judgment was entered accordingly, but a stay of execution was granted on the usual terms.

Rio Tinto v. A.E.G. Electric Co.

On Tuesday Mr. Muir Mackenzie, O.R., delivered judgment in these cross actions, which were reported in our last issue. He decided defendants had supplied a defective blower, which would not do the work required of it, and plaintiffs were entitled to damages to be assessed hereafter; but defendants were entitled to £1,757 on their counterclaim. Costs would be plaintiffs except on the issues they had failed.

A stay was granted pending any application for appeal.

Re Edison Swan Electric Co. (Ltd.)—On Tuesday Mr. Justice Astbury granted the petition for the reduction of the capital of this company. Mr. Jenkins, K.C., said reduction was a term involved in a scheme of arrangement between the company and its debenture stockholders and its members. The real reason for that scheme was to enable the company to raise £100,000 capital, which was wanted for important works.

Commercial Topics.

Imperial Preference.

The Secretary of State for the Colonies (Mr. Walter Long) has announced that the Committee appointed by the War Cabinet to consider the question of trade within the Empire after the war has decided on a scheme adopting preference within the Empire which had met with the approval of the War Cabinet.

The Imperial War Conference was the most remarkable gathering that had taken place in the history of the world. Last year it was decided that there must be a system of imperial preference for the benefit of the Empire. He had presided over a Committee to draft schemes by which that could be put into effect, and the Committee had produced a clearly worked-out scheme for the adoption of preference within the Empire, which had the approval of the Government, and, he believed, would have the approval of the Empire as a whole. The Committee had dealt with the question of raw materials so as to secure them, in the first instance, for the Empire, and a whole series of reports had been approved by the Imperial War Conference and by the War Cabinet.

* * * * *

Industrial Council for the Electric Supply Industry.

On Tuesday Mr. W. C. Bridgeman, M.P., Parliamentary Secretary to the Ministry of Labour, received representatives of various trade union organisations concerned in the electricity supply industry for the purpose of considering proposals for establishing an Industrial Council on the lines recommended in the Whitley Report.

The setting up of a Council had previously been agreed upon, but on Tuesday the workers' representatives consented to nominate members for appointment on a sub-committee, which, with an equal number of employers' representatives, is to draw up a draft scheme for acceptance by both parties in the industry and by the Ministry. The employers will shortly nominate representatives on the drafting sub committee. It is intended that the scheme shall embrace all undertakings (private and municipal) engaged in the generation and supply of electricity, whether for power, lighting or traction.

* * * *

Allocation of Raw Materials.

Yesterday (Thursday) the Minister of Reconstruction (Dr. Addison) met a number of leading representatives of trade, commerce and industry, and of industrial organisations, established under the Whitley scheme, in private conference, in order to hear the Government's proposals with regard to a system of priority and allocation of raw materials during the transitional period after the war.

This important question was referred by the Minister of Reconstruction early in the year to Section Two of his Advisory Council, which is presided over by Sir Henry Birchenough. This Committee drew up an outline of a scheme based upon its recommendations, and it has been approved by the Government. Before issuing any announcement, Dr. Addison desired to meet representatives of the interests chiefly affected in order to explain the proposals in detail.

* * * *

Imperial Mineral Resources Bureau.

At the Imperial War Conference last year it was agreed that it was desirable to take steps to set up an Imperial Mineral Resources Bureau for collecting information from the appropriate departments of the Governments concerned and from other sources regarding the mineral resources and metal requirements of the Empire, &c.

A special committee under the chairmanship of Sir Jas. Stevenson, Bart., was appointed in order to examine the proposal and to report upon the duties and administrative responsibilities of the proposed bureau. The Committee defined the duties of the Bureau as follows:—

(*a*) To collect, co-ordinate and disseminate information as to resources, production, treatment, consumption and requirements of every mineral and metal of economic value; (*b*) to ascertain the scope of the existing agencies with a view ultimately to avoid any unnecessary overlapping; (*c*) to devise means whereby the existing agencies can (if necessary) be assisted and improved in the accomplishment of their respective tasks; (*d*) to supplement those agencies (if necessary) in order to obtain any information not now collected which may be required for the Bureau; and (*e*) to advise on the development of the mineral resource of the Empire or of particular parts thereof, in order that such resources may be made available for Imperial defence or industry.

After consideration of the report of the Committee, the Government instructed the Minister of Reconstruction (in consultation with the Secretaries of State for the Colonies and India) to take the necessary action to give effect to the recommendations of the Imperial Conference and the findings of the Committee. Detailed proposals were submitted to the Dominion and Indian Governments, who nominated their representatives on the governing body of the Bureau, and the general scheme of the Bureau has now been finally ratified by the Imperial Conference. The Bureau will be incorporated by Royal Charter, and the governing body, which will be under the presidency of the Lord President of the Council, will consist of the following gentlemen:—

Sir Richard Redmayne, K.C.B. (chairman), Dr. Willet G. Miller (nominated by Canadian Government), Mr. W. S. Robinson (Commonwealth of Australia), Mr. T. H. Hamer (New Zealand), Right Hon. W. P. Schreiner, C.M.G. (Union of S. Africa), Lord Morris, K.C.M.G. (Newfoundland), Mr. R. D. Oldham, F.R.S. (India), Mr. J. W. Evans, D.Sc., LL.B. (Secretary of State for the Colonies), and the following nominated by the Ministry of Reconstruction (in consultation with the Institution of Mining and Metallurgy, the Institution of Metals, the Iron and Steel Institute and the Institution of Mining Engineers):—

Messrs. W. Forster Brown, Prof. H. C. H. Carpenter, Dr. F. H. Hatch, Sir Lionel Phillips, Bart., Edgar Taylor and Wallace Thorneycroft.

Dr. Arnold D. McNair has been appointed secretary, and all communications regarding the Bureau should be addressed to the secretary, Imperial Mineral Resources Bureau, Holborn Viaduct Hotel, London, E.C.

Electricity Supply.

Extensions.

Birmingham.—At the meeting of the Corporation on Tuesday the Electric Supply Committee reported in favour of the extension of the generating station at Nechells, the erection of a new permanent station having at length been agreed to by the Board of Trade.

The report states that in May, 1913, the Electric Supply Committee obtained the sanction of the Council to the erection of a new generating station at Nechells with a capacity of 100,000 kw., the first instalment being 25,000 kw., the actual plant capacity being 15,000 kw. The erection of the station was in progress when war broke out, and as it seemed unlikely that it could be completed in time to meet the urgent needs of the city, a temporary station was sanctioned by the Council in January, 1915. It becoming obvious towards the end of that year that the requirements of factories in the city would not be met by the provision thus made, and further plant was installed at the temporary station in 1916. Even these additions were found to be insufficient to meet the requirements of the department, and arrangements were made to obtain a supply from the private generating station of the Dunlop Rubber Co., who installed more plant than it was their intention to use at the time so as to enable them to be in a position to supply current to the Corporation, and subsequently they agreed to instal, in addition to two 2,000 kw. sets which they purchased themselves, two 5,000 kw. sets, the money for which was being provided by the Government. Both the smaller sets have been installed and current delivered therefrom to the Corporation for some time past, and one of the larger sets was put into commission some weeks ago, the other being due for completion in a few months. The additional plant provided since the outbreak of war has been found from time to time to be inadequate, and special provision has been necessary in order to meet the demands of the city. The Committee has frequently urged upon the Government the necessity of allowing them to proceed with the Nechells permanent station, but for various reasons they declined to permit this course to be adopted, the principal being that the station would take too long to erect to be of use during the war, and the materials and labour required were more urgently needed elsewhere.

It, however, became abundantly clear some time ago that further provision for the electric supply in Birmingham and the districts outside Birmingham was necessary, and in November, 1917, the Director of Electric Power Supply of the Ministry of Munitions conferred with the Committee upon the subject. He suggested, among other things, that a joint scheme of supply to Birmingham and to the neighbouring area of the Shropshire, Worcestershire and Staffordshire Electric Power Co. should be created, and that a large power station should be erected upon

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an economic site to deal with the supply to both areas jointly. On examining this proposal it was ascertained that the preliminary steps necessary to secure a suitable site would take so much time that it was extremely unlikely the station contemplated could be available for service within a reasonable period, and, bearing in mind that they had carried out a certain amount of work on the Nechells site, the Committee urged upon the Ministry the necessity of permitting them to complete this station forthwith. Simultaneously, the Power Company prepared a scheme for erecting a generating station on a site in their area, and both proposals were submitted to Mr. C. P. Sparks, M.I.E.E., with instructions to express his opinion as to whether it was more expedient to proceed with the two independent schemes or with a joint scheme, as suggested by the Ministry. His report was in favour of the two separate schemes, and, after a further conference with the Ministry of Munitions, the Director of Electric Power Supply recognised that the urgency of the situation would be more speedily met by the completion of the two schemes, for which estimates and plans were more or less in existence, and he recommended the Committee to proceed with the work at Nechells. That was the position reached in January last; but before the scheme could be submitted for sanction, the Ministry put forward entirely new proposals, which in the opinion of the Committee were objectionable in principle, and such as they could not recommend without fundamental modification. This led to further prolonged negotiations: but after consideration by various Government departments, authority has been given to proceed at once with the Nechells permanent station, subject to the provision of a linking-up main.

It was intended at the present stage to make provision for 45,000 kw. of plant as soon as possible, but the Ministry will only agree to 30,000 kw. being installed for the present, and make it a condition that an interlinking main should be laid, connecting the main station of the Corporation with the station of the Power Company at Smethwick, so that any surplus current may be interchanged between the two undertakings on terms to be arranged. The expenditure sanctioned by the Council in 1913 upon the permanent station, which provided for land for the ultimate capacity of the works—100,000 kw., buildings, railway and canal wharfage, for 25,000kw., and plant and machnery for 15,000 kw., was £288,500. The total amount which has been expended, exclusive of plant, is £58,260, principally on land and foundations, all of which, with the plant purchased, will be employed in the works when ultimately erected. The cost of the buildings (consisting of ferro-concrete foundations and steel superstructure, with brickwork filling-in, and comprising boiler house, engine house, offices, workshop and battery room, switch-house, cooling reservoir and foundations for cooling towers, &c., including architects' fees) is estimated at £266,880; engine-house equipment (two 15,000 kw. turbo-alternators with surface condensing plants, two 1,500 kw. d.c. turbo-generators with surface condensing plant, 100 ton overhead electric travelling crane) £238,500; boiler-house equipment (18 water-tube boilers, complete with mechanical stokers, superheaters, economisers, forced and induced draught fans and chimneys, ash handling plant, comprising overhead electrically operated telphers with unloading cranes on the jetty, water-softening plant, feed pumps and tanks, pipework, &c.), £388,200; cooling-tower equipment (18 tooling towers), £89,100; switchgear equipment for controlling the generating plant and the trunk and distributing cables, with all cabling inside the station, and the provision of a storage battery, also transformers for stepping up from 5,000 volts to 30,000 volts, £80,860; and workshop and sundries, £3,500, with 20 per cent. for contingencies and possible increases in wages granted by Government (£213,410). The total cost of the new work is £1,280,450, and with £58,260 already spent the total cost of power station will be £1,338,710.

The cost of the linking up main between Nechells and Smethwick, and of the mains and sub-stations equipment is £287,140. The 30,000-volt main transmission system, comprising 10,000 kw. link main from Nechells via Summer-lane to Smethwick boundary, with step-down transformers and switchgear at Summer-lane, also 10,000 kw. capacity main from Nechells to Selly Oak district with step-down transformer and switchgear and the necessary building would cost £110,300; and the 5,000-volt and l.t. mains, two years' requirements, £64,000; and extensions and equipment of sub-stations, £65,250, making, with 20 per cent. for contingencies and possible increases in wages granted by Government (47,880), a total estimated cost outside power station of £287,430, or a total combined cost of £1,626,140.

The Committee points out that the cost of the various items of expenditure is very materially higher owing to the present abnormal cost of labour and materials than would have been the case had the extension proceeded without interruption in 1914-15, though it must be borne in mind that the plant now to be installed is coniderably greater than that previously contemplated. Negotiations are now proceeding with a view to endeavouring to obtain some assistance form the Government to meet this extra cost. Though the scheme involves such a considerable sum of money, the Committee feels the position is one of extreme urgency, and that it is necessary to proceed if a repetition of the breakdown in the supply of power in the city such as was experienced in the winter of 1916 is to be avoided. The Committee therefore recommends that the amended scheme for the permanent generating station at Nechells, for the mains and sub-station equipment, and for the provision of a linking-up main between Nechells station and Smethwick boundary be approved, that they be authorised to proceed with the several works, and that, subject to appropriate agreements with the Ministry of Munitions, the Treasury and the Shropshire, Worcestershire & Staffordshire Electric Power Co., the Finance Committee be instructed to take all steps necessary for raising the moneys.

The report and recommendations were approved.

Huddersfield.—At the last meeting of the Corporation it was reported that, owing to the increasing demands for electric power, there was an immediate necessity for extensions of the generation and mains estimated to cost £90,000.

The Electricity Committee is prepared to spend the money conditionally upon the Government authority concerned making a grant of a portion of the excess capital expenditure due to war conditions.

London County Council.—At the meeting of the L.C.C. last week sanction was given to Poplar Borough Council to borrow £16,696 for its electricity undertaking. Of the loan, £1,000 is for buildings, £10,196 for mains and £5,500 for plant.

Redditch.—At its last meeting the Council accepted tenders for further extensions of the generating plant. During the last few years the electricity supply undertaking has made considerable progress.

Early in 1914, when the present consulting engineers (Messrs. Handcock, Dykes & Trotter) were first called in, the station was making a loss of about £3,000 per annum, the maximum demand was 640 kw., the system of supply single phase (75 periods), the units sold being 1,433,666. On their advice, a sum of about £40,000 was expended in bringing the station up to date by the addition of two 1,000 kw. Parsons turbo-alternators and condensing plant, two motor alternators to transform from three phase 50 periods to single phase 75 periods, or vice versa, condensing plant, new cooling tower, additional boiler power, extension of engine room and a system of three-phase mains. The new plant was first put into commission towards the end of 1916, and at the beginning of this year the maximum load on the station had increased to 1,340 kw. The units sold for last year were 2,643,007, and, notwithstanding that wages had more than doubled and the rise in the price of coal, the reduction in generating costs was such that the station has now turned the corner and shows a profit after paying running costs, interest and sinking fund charges.

In a further report given to the Council at the beginning of the year, the consulting engineers recommended additional extensions at an estimated cost of £54,000, which were approved by the Council, and, the general approval of the Director-General of Electric Power Supply having been given to the scheme, the Council has now placed contracts for part of this extension scheme. Since the original installation of the new three-phase plant, one, the biggest works in Redditch, has shut down its own plant and relies entirely on the Corporation station, and the majority of the other large works in Redditch are now taking a supply.

Walsall.—The Corporation has applied to the L.G. Board for sanction to borrow £6,304 for the electric supply department.

General.

Brighton.—The Corporation has increased the salary of the engineer and manager of the electricity department (Mr. John Christie) from £1,000 to £1,100 as from Jan. 1 last.

Colne.—At the Council meeting last week, Councillor J. Thompson, chairman of the Electrical Committee, referred to the resignation of the borough electrical engineer (Mr. A. G. Cooper), who had accepted a Government appointment, and said Mr. Cooper had been with them since the inception of the municipal electricity undertaking 18 years ago. The Council decided to place on record its appreciation of his long services.

Electric Power Supply.—Last week Wallasey Corporation adopted a report of its Finance Committee criticising the proposal that the State should purchase electric generating stations.

The Committee protested against the embodiment in legislation of the recommendations of the terms of purchase by the State of generating stations and main transmission lines as recommended by the Board of Trade Electric Power Supply Committee, on the ground that the adoption of such terms would penalise prudently managed undertakings and place a premium on undertakings which have failed to create depreciation and reserve funds.

The Committee also protested against the recommendation to confiscate sinking funds (accumulated for the redemption of loans), and then to require municipal authorities to discharge their loan obligations in respect of such undertakings.

In the event of a Bill being introduced embodying the recommendations of the Board of Trade Committee, the Parliamentary Committee of the Council should be requested to take vigorous steps to oppose such Bill.

Silsden.—The Electrical Distribution of Yorkshire has notified the Council that it will apply for a provisional order for the district, but the Council will oppose the application.

Stepney (London).—The Board of Trade has approved the agreement extending the period for the supply of electricity in bulk to Shoreditch until Sept. 30 next, or until a new turbine which Shoreditch Council has on order is completed.

The question of entering into a new linking-up agreement with Shoreditch Council at the termination of the period referred to, as well as with Poplar Council (with whom there is also an agreement), has been considered by the electrical engineers of the authorities concerned, and the Electricity Supply Committee recommends the Council to enter into a new agreement with Poplar and Shoreditch Borough Councils upon the basis of a draft agreement submitted and prepared by the Town Clerk and Borough Electrical Engineer and Manager.

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Electric Traction.

Blackpool.—The Council has approved the arrangements for the purchase of the Blackpool & Fleetwood Tramroad Co. for £260,000.

The Corporation were in competition for the tramroad with the Lancashire & Yorkshire Railway Co. who, if they had become the purchasers, would have controlled all transport between the two towns.

Glasgow.—More than 2,000 women (including 423 drivers) are now employed on the Corporation tramcars.

Last week the Corporation approved the minute of the Tramways Committee as to the limitation of the evening service.

The convener (Mr. MONTGOMERY) said the minute was not very happily framed. What was in their minds was to restrict the cars as little as they possibly could. Mr. Dalrymple had informed the Committee on June 26 that curtailment of the service would be necessary, as a great number of men employed in the department were likely to be called up for military service. The only way to curtail the service would be by withdrawing a number of night cars. They had recently lost over 200 employees, and at present they had between 600 and 700 working seven days per week. Then they had been informed by the Coal Controller that they must reduce their coal consumption by 15 per cent. Further, there were 50 cars at present in the depots because they had not the necessary men and material to work them. So long as the Committee were able to give the present service they would do so. They might begin with a partial withdrawal of cars after ten o'clock, if that was found advisable; on the other hand, they might require to withdraw the cars one hour earlier.

Hull.—At the meeting of the Tramways Committee last week a letter from the Board of Trade was read, stating that it was imperative that the consumption of coal should be cut down by 15 per cent. per annum from April 1 last.

The substitution of other fuel (such as coke) was suggested, and the Committee were recommended to reduce any part of the service not required in the national interest, to withdraw the whole or part of the service on Sundays, to stop running at earlier hours, and to reduce the number of stopping places.

Hurst (Lancs).—The Council has applied to the Board of Trade for sanction to lease (for five years) to the Ashton-under-Lyne Corporation the tramways constructed under the Hurst Tramways Order, 1900.

Keighley Trackless Trolley System.—In the annual report of the tramways department it is stated that trouble was experienced in connection with the trackless system owing to various difficulties, and these are likely to continue until the end of the war. In spite of increased revenue, the loss on the trackless trolley cars was £457.

Liverpool.—Revised tram fares were introduced on the Croxteth-road and Garston and Dingle routes on Monday.

The stages have been shortened and the fares increased. Further limitations of service with increases of fares on other routes will be introduced shortly.

Tramway Strike.—The women employed by the Lanarkshire Tramway Co. came out on strike on Monday because an advance of 5s. per week recently given to the men in the service had not also been granted to them.

At a meeting of the workers on the following day it was decided to take the advice of Mr. M'Lean, of the Ministry of Munitions, to return to work on the following day. The Committee on Production (he said) had granted the increase to the men, but their finding was that the women's claim had not been established. A committee was appointed to formulate the women's claim. Over 300 women are at present in the employment of the company.

Willesden.—The Committee recently appointed to inquire into the methods of house refuse collection reports that collection by electrically propelled vehicles is desirable on grounds of efficiency and economy, and that it should be instituted in the first instance in a part of the Council's area.

The Committee is considering the question of the area and also the number of vehicles to be purchased, &c.

Workmen's Fares in the Metropolitan Area.—A committee has been formed, consisting of members of tramway committees and tramway managers of Metropolitan Authorities to consider the question of the advisability of applications being made by certain tramway undertakings for a Government subsidy in respect of workmen's cars on routes serving munition areas by reason of Government grants made to a motor omnibus company for similar purposes.

Women Tramcar Drivers.—At Ilford three or four women have been trained to drive the cars, but they have not been presented for licensing, as Walthamstow Council, which applied for licences for 12 women several weeks ago, has not yet succeeded in persuading the Chief Commissioner of Police to issue same.

Telegraphy and Telephony.

An Australian-U.S.A. Submarine Cable.—At a recent luncheon in New York, given in honour of a party of Australian editors, the laying of a new direct submarine cable between Australia and the United States was urged.

German Telegraph Concession in Rumania.—It is announced that a special agreement has been entered by Germany and Rumania regarding the future regulation of the postal and telegraph services between the two countries.

Provision is made for the laying of a third direct line between Germany and Bukarest, and the establishment of a telephone service between Germany and Rumania, a telephone service over the Constantinople-Constanza-Bukarest-Berlin telegraph cable, and an eventual new line to Constantinople. The German Government obtains till the end of 1950 a monopoly of laying cables on the Rumanian coast.

Radiotelegraphy in Argentina.—The Siemens Schuckert Co. of Buenos Ayres (which is on the Government "black list") has applied for a concession to erect a high-power Telefunken station in Argentina.

According to "The Times," detailed plans are to be presented within 12 months, and construction is to be commenced one month after the signing of the concession, and the station is to be completed within two years after the plans have been approved, but force majeure is excepted.

Miscellaneous.

Alien Enemy Patents.—In the House of Lords last week Lord Somerleyton stated, in reply to a question, that the order of the Board of Trade with reference to payments to and on behalf of enemies in respect of patents, designs and trade marks would not have the effect of revoking the 944 enemy applications for patents filed and accepted since the commencement of the war.

The publication of these accepted applications would not prevent the deposit of British applictions for similar patents, but it would render invalid the grant of a patent for any precisely similar invention. It would not, however, prevent the grant of a patent for improvements on published inventions.

Census of Private Owners' Railway Wagons.—The Board of Trade have made an Order providing for a census of all railway wagons not owned by railway companies.

The form of return provides for a statement of the size, capacity and description of wagons, the traffic for which they are designed or mainly used, &c. The return must be furnished by the person or firm on whose behalf the wagon is running on the 1st inst., except in the case of wagons hired for less than three months. In the latter case, the owner is required to obtain and furnish particulars. The return is obligatory, and owners who did not receive a form before the 1st inst. should apply to the Board of Trade (Statistical Department), 68, Victoria-street, London, S.W.1, for a copy of the form. The return must be completed on or before Aug. 14.

Demobilisation Problems.—According to an official estimate up to July 1917 the total number of recruitments for the United Kingdom exceeded 5,000,000, exclusive of men serving with the forces at the outbreak of hostilities, of whom approximately 4,000,000 have been drawn from the industrial and commercial occupation and transport.

The Civil War Workers' Committee appointed by the Ministry of Reconstruction to consider the question has issued an interim report in regard to which Dr. Addison states that action is being taken in connection with some of the matters, while others are under examination. Some of the recommendations of the Committee must necessarily be considered by the Government in relation to other allied questions.

The estimated number of persons employed in munition work in October last were—men, 2,022,000; and women, 704,000. While in a number of the industries now engaged on munition work the cessation of war will not involve reduction of employment, large numbers of workers engaged in the production of explosives, shells, &c., will be unemployed permanently, so far as their present work is concerned, while in many other engineering works it will be necessary to convert the plant to entirely different purposes.

The total number of persons employed in January, 1917, in industries from which there is likely to be a considerable outflow of labour after the war, was approximately—men, 1,380,000; and women, 591,000. There is no reason to suppose that more than a proportion of these workers will, in fact, be discharged, but there will undoubtedly be extensive re-adjustments.

The Committee recommend that steps should be taken by the Government to assist munition and other workers discharged on the termination of hostilities to return to their former or other employment. As soon as there is a reasonable prospect of peace the local Advisory Committees and Employment Exchanges should take steps to ascertain where workers are likely to be required immediately on the termination of war, and what the demands of individual factories are likely to be. Steps should be taken by the departments concerned to encourage Government Departments, public or semi-public bodies and private employers to place post-war contracts in advance, the contracts being arranged (if necessary) at provisional prices to be adjusted later according to revised estimates of cost of labour, materials, &c., or, as an alternative on a profit basis.

Fuel and Lighting Order.—At a conference (held at Newcastle on the 24th ult.) of representatives of municipal boroughs in Northumberland, Durham and the North Riding of Yorkshire, the Fuel and Lighting Order was criticised very severely.

A motion by the Mayor of Middlesbrough asking for the withdrawal of the Order was carried, and a subsequent motion asking the Coal Controller to postpone its operation until Oct. 1 was agreed to.

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Mr. CHAPMAN moved that the fuel allowances should be increased in the north-east district on account of climatic and domestic conditions and other reasons.

The resolution was carried, with the additional request that the minimum coal allowance be raised to 5 tons. Resolutions were also carried urging that the gas equivalent for a ton of coal should be increased, and that allowances for gas and electricity be graded by single rooms instead of in groups, with a minimum gas basis of 7,500 ft. for one room. A deputation was appointed to lay the resolutions before the Controller.

Liverpool Engineers' Wages.—Awards have been made by the Committee on Production giving an advance of wages to men in the engineering, shipbuilding and allied trades in the Liverpool district.

By previous awards the men received advances over pre-war rates of not less tahn 20s. a week in the case of time-workers, and 13s. a week, plus an increase of not less than 10 per cent. on piece prices, in the case of piece-workers. In addition to these advances, earnings have been increased by grants of a bonus of 12½ per cent. in the case of plain-time workers and 7½ per cent. in the case of piece-workers and other workmen not paid at plain-time rates.

The present award is that men aged 18 and over are to receive a further advance of 3s. 6d. a week and boys and youths and apprentices under 18 1s. 9d. a week. The advances are to be first paid on the pay day in the week ending Aug. 10.

Educational.

University of Durham (Armstrong College).—In the department of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, &c., there are complete courses of instruction in preparation for degrees of the University of Durham. The next session commences on Sept. 23, and particulars of the courses may be obtained from the secretary (Mr. F. H. Pruen, M.A.), Armstrong College, Newcastle-on-Tyne.

The P.O. Technical Training Classes for Boys.—The third session of the London classes terminated on the 24th inst., when the Assistant Postmaster-General (Mr. H. Pike Pease, M.P.) distributed at the Post Office Factory (Holloway) the prizes won by the successful students.

Mr. G. MORGAN, I.S.O., Controller of P.O. Stores Department, presided, and pointed out how the classes originated in 1915 largely as a result of the recommendations of the Departmental Standing Committee on Boy Labour in the Post Office. He traced the development of the classes from that year, when six hours a week, divided equally between the department's time and the boys' own time, were given to training, to the present, when a weekly attendance of eight hours, three in the boys' time but five in that of the department, is given. The scheme comprehends trade work, elementary science, mechanical drawing, calculations, English and gymnastics. The classes are conducted on the Post Office factory premises by certificated teachers under the supervision of the L.C.C. Educational Committee, who pay the teachers' fees and whose assistance had been most valuable. Six boys had been awarded evening exhibitions by the L.C.C. for meritorious work during the session. Many of the lads had expressed a desire to continue attendance at summer classes, while others who, having reached the age limit of 17, were under no obligation to attend the training classes, had spontaneously requested to be permitted to continue attendance until they attained the age of 18, a request which had been readily granted.

The ASSISTANT POSTMASTER-GENERAL, having distributed the prizes, expressed his pleasure at the reports communicated to him and his admiration of the boys' work exhibited that evening, some of which gave great promise. He regarded the scheme of Post Office technical training for boys as further evidence of the great work being done by the department for the State. When in France recently he was greatly struck by the enormous contributions in telegraph and telephone stores and other equipment that the Post Office Stores Department was supplying for the prosecution of the war. He would like Post Office activities to be better known, and hoped that he would be able to bring some members of the House of Commons to visit the Post Office Stores Department, and so make themselves better acquainted both with the magnitude and character of that department's work.

On the motion of Mr. G. F. MANSBRIDGE (Assistant Controller), a vote of thanks was accorded to Mr. Pike Pease.

Tenders Invited and Accepted.

Turbo-Alternator, Condensing Plant, Water-tube Boilers, Stokers, &c.

LEEDS Corporation invite tenders for extension to feeder switchgear in new works and alterations of generator switchgear in old works, a 6,000 Turbo-alternator and Jet Condensing Plant, Two Water-tube Boilers, Stokers, Economisers, Induced Draught Plant, Coal and Ash Conveying Plant, Steam Piping and a large Centrifugal Pump. Tenders will be invited from selected firms. Makers willing to tender for one or more of the eight contracts and able to guarantee erection within 12 months should submit their names to the manager of the electricity department (Mr. C. Nelson Hefford), 1, Whitehall-road, Leeds, by Aug. 10. *See also an advertisement.*

BELFAST Corporation invite tenders for the manufacture and erection of two 6,000 kw. Turbo-alternators and one 30 kw. Balancer Booster; four Water-tube Boilers, Fuel Economiser, &c.; two steel Chimneys with Fans; two electrically-driven boiler-feed Pumps, Accumulators; three 500 kw. and five 1,000 kw. Rotary Converters, with Transformers, &c.; and two 250 k.v.a, two 350 k.v.a. and six 1,250 k.v.a. Static Transformers. Specifications, &c., from the consulting engineers (Messrs. Preece, Cardew, Snell & Rider), 8, Queen Anne's-gate, Westminster, S.W. 1; or Mr. T. W. Bloxam, M.I.E.E., city electrical engineer, Belfast. Tenders to Town Clerk, City Hall, Belfast, by Aug. 16.

REDDITCH.—The Urban Council has accepted the following tenders:—

C. A. Parsons & Co., one 2,000 kw. 3,000 k.v.a. turbo-alternator and condensing plant; Messrs. Ferguson, Pailin & Co., e.h.t. switchgear; Lancashire Water Cooler Co., cooling tower; Babcock & Wilcox, boiler, stoker, Green's economiser and induced draught fan.

ILFORD.—The Urban Council has accepted the tender of Mossay & Co. (at £1,122) for a 3½-ton Orwell electric vehicle.

Electrically operated unloading gear will cost £50 extra, or a patent unloading gear will be fitted by the makers. For the electricity department there is also to be purchased a Sentinel 3-ton steam wagon at £650, plus £60 for unloading gear.

SOUTHEND-ON-SEA.—The Council has placed an order with Messrs. Scott Anderson & Co. at £340 for an electric welding plant.

Appointments Vacant and Filled.

An experienced electrician is wanted to take charge of light and power plant in controlled establishment. *See advertisement.*

Teachers of engineering subjects (salary £275) and of mathematics and elementary science (salary £175) are required for West Ham Technical Institute. Forms of application from the Principal.

Mr. C. J. Spencer, general manager of Bradford Corporation Tramways, has tendered his resignation in consequence of having accepted a position on the executive of the London Underground group of railways.

Mr. Spencer, who was born at Halifax in December, 1875, has been manager of Bradford tramways for 20 years. He served his pupilage with the Blackpool & Fleetwood Electric Tramroad Co. and late accepted an appointment with the South Staffordshire Tramways Co. During the war his services have been utilised by the Admiralty for over a year.

Business Items.

The works of the New Switchgear Construction Co. will be closed from the 3rd until the 12th inst., but the offices will be open as usual.

The works of Messrs. Connolly Bros. (Ltd.) will also be closed from Aug. 2 until Aug. 12.

The directors of the Stanton Ironworks Co. (Ltd.) have entered into a provisional agreement with the directors of the Holwell Iron Co. for the acquisition of shares of the latter company.

It is claimed that the combined companies will be the largest producers of pig iron in the Midlands, and both companies have established a world-wide reputation for the high quality of their c.i. pipes and general castings

Plant for Sale.—Derby Corporation have two B. & W. water-tube boilers for sale. Particulars from Borough Electrical Engineer, 9, Irongate, Derby.

Municipal Accounts.

Bristol.—For the year ended March 31 the gross receipts of the electricity department were £177,339 and the expenditure £105,351, leaving a profit of £71,988.

After crediting £483, transferred from redemption and sinking fund (No. 2) account, &c., and paying dividends on stock, interest on loans, &c. (£20,596), and repaying capital borrowed (£32,330), the net profit is £19,555, making, with £72 brought forward, a total surplus of £19,617. Of this sum £5,0 0 was placed to reserve for contingencies and expenditure on meters for new connections and for renewals, on stokers replaced at Feeder-road works, and allowances to employees on service, &c., left a balance of £5,156, which has been carried forward. The loans amount to £931,062, of which £447,464 has been repaid or accumulated in stock and loan redemption funds, leaving £483,599 outstanding. The total number of units sold was 26,839,580 (an increase of 3,260,441 over 1916-17), maximum load was 12,347 k.v.a. (11,483 k.v.a.) and the load factor was 29·54 (27·59) per cent. There are 5,911 (5,736) consumers, and the total connections are equal to 971,768 (907,393) 30-watt lamps: there are 2,446 (2,351) motors and heating apparatus connected, of 25,797 H.P. (23,446 H.P.) and there are 69 cooking stoves (an increase of 1 over 1917).

In his report the city electrical engineer (Mr. H. Faraday Proctor) states that the new 3,000-kw. turbo-generator has been in regular operation during the greater part of the year and a 6,000-kw. set is on order. The result of the year's working has been very satisfactory, the number of units sold having increased by 3,260,441, a record which has only once been slightly exceeded. The coal consumption per unit has been reduced 18 per cent. The cost of installing new mechanical stokers has been paid for out of revenue during the past two years. Only 175 additional consumers were connected during the year, due to Government restrictions. 113 employees joined H.M. Forces, or 50 per cent. of the total number employed. 67 female employees now serve the department, being engaged on clerical work, meter reading, taking charge of running machinery at sub-stations, engine cleaning and general work.

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Companies' Meetings and Reports.

BRITISH COLUMBIA TELEPHONE CO. (LTD.)—The net profit for year ended March 31 was $391,750, and after providing for debenture interest, &c., and paying usual dividends of 6 per cent. and 8 per cent. on the preference and ordinary shares respectively, $6,935 has been carried forward.

COLOMBO ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—The available profit for the past year, after providing for debenture interest and including balance brought forward is £35,239, against £36,889. A dividend of 10 per cent (tax free) has been declared for 1917, £13,500 has been placed to general reserve and renewal fund (against £15,000), carrying forward £8,655.

GREENWOOD & BATLEY (LTD.)—The report states that after addin £13,488 from 1917, and providing for interest on debentures, expenses of management, writing down war capital expenditure and the anticipated liability under the Finance Acts, the accounts for the year to March 31, 1918, show a profit of £93,006. The directors have appropriated £5,000 to depreciation and placed £50,000 to reserve account. Interim dividends were paid in February, and final dividends are now recommended for the year as follows: Preference, 3½ per cent. (absorbing £3,514) and ordinary 10 per cent. (absorbing £17,419. 10s.), leaving to be carried forward £13,982.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.)—The gross earnings of the company for 1917, including dividends and interest from subsidiary companies, &c., were £110,420, and with amounts received in respect of fees payable by subsidiary companies, £3,025, balance from 1916, &c., the total was £133,360. Deducting working expenses, maintenance, &c. (£49,607) and interim dividends, debenture interest and redemption charges (£18,333), the balance is £65,420. 2s. 9d. The directors recommend payment of a final dividend of 3 per cent. (less tax) for the year on the preference shares (£1,500), a final dividend of 6 per cent. (tax free) on the ordinary shares, making 10 per cent. for the year (£10,759), and a bonus on the ordinary share capital of 1s. per share, tax free (£8,966), the transfer of £25,000 to general reserve, and of £2,000 to staff pension fund, carrying forward £17,196. The exchanges show additions in the number of stations connected during the year, with a corresponding increase in revenue. Additions are, however, small compared with developments in previous years, owing to the prohibition by the Government of India of new work, and to difficulty in obtaining supplies of material. The reconstruction of the Singapore building will be completed by the end of the current year, and the new exchange equipment is promised for delivery in Singapore at about the same time. Considerable expenditure on buildings, exchange equipment, cable installations, renewal of line construction, &c., will be necessary in Madras, Rangoon, Singapore and Mauritius when normal conditions are restored, as well as additions to capital account for new installations. The Bombay and the Bengal Telephone Companies show increased revenues. The Bengal Company has paid a dividend of 7 per cent., as in 1916, and the Bombay Company a dividend of 16 per cent., against 12 per cent. The net revenue in the case of the Telephone Company of Egypt and the China and Japan Telephone & Electric Co., is somewhat less than for 1916; in the former case this is largely due to increased trunk line rentals paid to the Government of Egypt under agreement, and in the latter to the high rate of exchange prevailing during 1917 and to additional taxation and working expenses. Both companies are paying their previous rates of dividend—viz., 10 per cent. As already notified, the Government of Egypt purchased the undertaking of the Telephone Company of Egypt for £755,000, as from Jan. 1, 1918.

An extraordinary general meeting was held after the annual general meeting when it was decided to increase the capital to £400,000.

New Companies.

COSMORE (LTD.) (150,933.)—Private company. Reg. July 11, capital £12,000 in £1 shares, to enter into an agreement with A. C. Cossor and W. R. Bullimore, and to carry on the business of manufacturers of oscillation valves and amplifiers for wireless telegraphy and telephony, and all apparatus necessitating low pressure, liquid air and other liquids of low temperatures, tungsten nad other targets for scientific and electrical purposes. First directors are A. C. Cossor and W. R. Bullimore. Reg. office, 11, Clerkenwell Green, E.C.

EXPERT METAL WORKERS (LTD.) (150,865.)—Private company. Reg. July 1, capital £1,000 in £1 shares manufacturers, treaters, depositors and producers of metals, mechanical and electrical engineers, &c. First directors are Sherard Cowper-Coles (permanent managing director) and T. S. Ball. Sherard Cowper-Coles has the right to nominate two directors. Reg. office, 1, French-street, Sunbury-on-Thames.

FLEET ENGINEERING CO. (LTD.) (150,750.)—Private company, Reg. June 18, capital £15,000 in £1 shares, to carry on the business of engineers, metal, wood and machinery merchants, motor manufacturers of and dealers in scientific and electrical apparatus, &c. L. Waterhouse is one of the first directors. Reg. office, 64, Haymarket, S.W.

HENLEY'S TYRE & RUBBER CO. (LTD.) (150,903.)—Private company. Reg. July 5, capital £200,000 in £1 shares, to take over the tyre department of the business of W. T. Henley's Telegraph Works Co., and to carry on the business of manufacturers of and dealers in wheels, rims, tyres, rubber, golf and other balls, &c. First directors are G. Sutton, M. Roberts and A. E. Salmon. Reg. office, 18, New Union-street, E.C.

PRATT BROS. (LTD.) (10,072.)—Private company. Reg. in Edinburgh May 31, capital £5,000 in £1 shares, to take over the business of an electrical contractor, mechanical and general engineer manufacturer, and agent, carried on by A. Pratt as Pratt Bros. First directors are R. Graham, A. Pratt, D. Pratt and M. Pratt. Reg. office: Dabry Electric Works, West Park-place, Edinburgh.

RADIO ELECTRIC CLOTHING CO. (LTD.) (151,017).—Private company, reg. July 20, capital £10,000 in £1 shares (5,000 10 per cent. preference), to carry on the business of manufacturers of and dealers in electrically heated clothing and all kinds of devices for lighting and heating by electricity, &c.

City Notes.

BRITISH COALITE (LTD.)—Negotiations between this company and Low Temperature Carbonisation for the exploitation by the latter of the Coalite patents in the United Kingdom have been completed. Treasury sanction has been obtained for the issue of the balance of the share capital, which now amounts to 200,000 £1 ordinary and 200,000 £1 deferred shares.

GENERAL ELECTRIC CO. (LTD.)—During the week this company invited applications for an issue of 80,000 6½ per cent. cumulative preference shares of £10 each at par and 16,000 ordinary shares of £10 each at £13 per share. The issue was largely over-subscribed.

HADFIELD'S (LTD.).—The directors have declared an interim dividend of 1s. per share (tax free) on the ordinary shares.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—The directors have declared a dividend on the ordinary shares for the half-year ended June 30 at the rate of 5 per cent. per annum.

LIVERPOOL OVERHEAD RAILWAY CO.—The directors have declared interim dividends for the half-year ended June 30 at rate of 5 per cent. per annum on the preference shares and 2½ per cent. per annum on the ordinary shares.

MATHER & PLATT (LTD.)—The directors have declared an interim dividend on the ordinary shares of 5 per cent. (less tax) for the half-year to June 30, being at rate of 10 per cent. per annum.

METROPOLITAN RAILWAY CO.—An interim dividend of 1 per cent. per annum has been declared on the ordinary stock.

STEWARTS & LLOYDS (LTD.)—The directors have declared an interim dividend for the half-year ended June 30 at rate of 6 per cent. per annum on the preference shares and at the rate of 10 per cent. per annum on the preferred ordinary shares.

VICKERS LIMITED.—The directors have declared an interim dividend of 1s. per share (5 per cent.) on the ordinary shares for the six months ended June 30, tax free.

The Round Table.

By "kVA."

Event of the Week.—The G.E.C. three million prospectus. Who says the electrical industry is in its infancy?

* * * *

The controversy between the respective champions of solid forged and plate type turbo-rotors continues apace. Dr. S. F. Barclay has had the last word so far, and says he "cannot agree with Mr. Behrend that a failure of the unpierced-plate construction will be heralded by a change of balance that will give timely warning of the impending trouble. Failure will be by a bolt snapping at the face of the nut, and the nut flying off with a stored energy of some 20 foot-tons will produce results that cannot be forecasted with any certainty except that the engine-room staff will steer a course for the exits rather than for the emergency trip valve."

In other words, the staff would make a bolt for the door!

* * * *

Thirty-Seven Years Ago.

[From The Electrician, July 30, 1881.]

Brooke's System of Insulation.—We understand that the work of extension of this system has been completed between Waterloo and Clapham, that the tests are satisfactory, and that in a few days it is to be tested for telephonic work.

The Faure Battery and Tramcars.—Another trial has been made with this battery as a motor for tramcars. "La Lumiere Electrique" says that an experiment was made the other day on the lines of the Compagnie des Tramways de Roubaix at Tourcoing. The cells were stowed under the benches, and contained motive power sufficient to run the car for four or five hours.

Telephone Wires in Belgium.—A good deal has been heard lately in France, the United States and amongst ourselves of over head telephone wires, and in the two former countries they have been in most towns ordered to be placed underground. In Belgium, however, they are still carried overhead, and, as the telephone is largely used in Brussels, Antwerp and the larger towns, these wires present a most dangerous appearance.

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CONTENTS.

Notes 305
Contract Prices During Demobilisation. By Captain W. P. Digby. Illustrated 308
An Address to Graduating Student Engineers. By E. W. Rice, Jr. 310
Armature Heating in Traction Motors. By Dr. L. Adler. Illus. 311
Calculation of Performance of Induction Motors Working in Conjunction with Flywheels and Slip Regulators. By Herbert Vickers, M.Eng. Illustrated.—*Concluded* 313
Safety Devices for Electric Cranes. By C. Ritz. Illustrated 315
Contract Prices 316
Review 316
Automatic Telephones at Australia House, London. Illustrated.. 317
The "Embargo" Strike. By a Labour Correspondent 318
Electrically-Welded Ships. Illustrated 319
Legal Intelligence 320
Parliamentary Intelligence 320
Volunteer Notices 320
Patent Record 320
Commercial Topics 321
Electricity Supply 321
Educational 324
Tenders Invited and Accepted 324
Companies' Meetings and Reports 325

Notes.

The Control of Industry After the War.

We are glad to note two main points in the report of the Committee appointed by the Ministry of Reconstruction to consider post-war arrangements in regard to materials, which will give satisfaction to manufacturers and traders. The first is the emphasis which the Committee lay upon the view that post-war control and allocation of materials shall be applied only in cases where it is absolutely necessary. The second is that the joint trade-bodies now being formed by the Ministry of Labour and the Ministry of Reconstruction are to become a definite part of the machinery for control. On Thursday of last week, at the Ministry of Reconstruction, the scheme was explained to a large gathering of representatives of the principal industrial and commercial organisations. The meeting was attended by representatives of the various Whitley Councils and interim industrial reconstruction committees which have so far been formed, and by delegates from the leading commercial and trade union organisations. Dr. Addison was supported by Sir Henry Birchenough, the chairman of the committee, whose report was under consideration, and a detailed explanation was given of the proposed machinery. This is roughly as follows: First of all, it is suggested that the Cabinet Committee now sitting under General Smuts should be continued as the final authority on all questions of raw material and rationing. Under this Committee it is proposed to appoint an Advisory Council consisting of representatives of Government Departments, with a limited number of leading representatives of industry, who should be responsible for advising the Cabinet Committee on particular questions of policy. Next in the scale will come the detailed rationing authorities, and it is proposed that the joint industrial councils and interim reconstruction committees should act in this capacity. The Committee emphasise the need for special consideration of those industries which are likely to provide a large measure of employment, and also that priority should be given to industries connected with the production of food and raw materials, the manufacture of machinery and equipment, the manufacture of finished goods for export, and the production of goods for home requirements of pressing need.

The Need for Action.

In these columns we have often dealt with the need for some form of control when the war comes to an end. Such control is absolutely essential, as may be gathered by the most superficial study of the shipping situation. On the other hand, the exercise of control should not be carried further than is really necessary, and this will be best secured by leaving the matter very largely in the hands of the trades themselves. Organisation is now proceeding on these lines. Dr. Addison announced that there were at present 51 joint bodies, representing 51 trades now meeting, and working together. It seems to us that other trades should fall in with this movement, so that industry may be completely represented in this joint advisory system, and so that no hitch can occur in a scheme which should cover all the industries of the country. Success can be achieved only if the scheme is organised on a national basis, and it is fairly obvious that if some trades continue to neglect the present opportunity, they will be making things difficult, not only for the Government but also for themselves. Smooth working can only be secured if all our trades work together. We do not think there need be any fear that too much control is contemplated. Indeed, it may be said that if the declaration of the Minister of Reconstruction last week means anything at all it seems that where an industry can show through its joint councils that no control is necessary, no control will be imposed.

Capital and Labour.

Writing on the Labour question in 1843 Carlyle said: "This largest of questions, this question of work and wages, which ought, had we heeded heaven's voice, to have begun a generation ago or more, cannot be delayed longer without hearing earth's voice." Seventy-five years later we are still talking of Capital and Labour, still suffering the inconvenience of strikes and lockouts, and appear to be very little nearer to a solution the problem of how Labour and Capital can be made to live together in peace. If any one fact can be held more responsible for this failure than another, it is, perhaps, that both sides to this perennial dispute habitually decline to make a study of the point of view of their opponents. Where there is ignorance, even on one side, there are certain to be misunderstandings. Much more so is this the case when there is ignorance on both sides. Is it too much to say that more than four-fifths of the strikes which have marked our industrial history during the last 40 or 50 years have been due to mutual ignorance? We think not. There has not only been ignorance of the difficulties experienced by both sides, but also of legitimate aspirations. Nevertheless, we should be sorry to say that some progress has not been made. During the past four years men in all ranks of life have been fighting side by side in the cause of Liberty, and have learned to respect each other. This comradeship has introduced a different spirit, a spirit of toleration, which gives rise to a greater hope for the future. As both sides learn more of each other's difficulties

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this spirit of toleration will increase. It is in the hope of promoting this feeling that we introduce an innovation in these columns this week, which we are sure will be welcomed by our readers. By the very nature of our pages the bulk of our readers will be found among what is known as the employing class, and we feel that they will be anxious to take any opportunity that offers of obtaining a better understanding of the Labour point of view. We therefore begin this week a column, which we hope to continue, from a Labour Correspondent, in which an endeavour will be made to state the opinions of Labour and to describe the movements which are now going on within the ranks of Labour organisations. Our correspondent this week attempts to justify, or at least explain, the Coventry strike. In this attempt he will not, perhaps, secure much sympathy from our readers, but it is at least worth while to have an authentic explanation of the reasons that led to the recent upheaval. Our Labour notes, which will appear from week to week, will be the work of a well-known member of the Labour Party, and will, we believe, be welcomed by our readers as affording a further opportunity to understand the theories and feelings which actuate the Labour world at the moment—theories and feelings which, unless they are met with a considerable amount of understanding, and indeed sympathy, are likely to lead to serious trouble when the day of peace arrives. On the other hand, if it is possible, between now and the signing of peace, for Labour and Capital in this country to obtain a better appreciation of each other's aims and aspirations, so that a basis may be found for that enhanced industrial activity which is the only way out of the troubles that the war has brought, then we shall be able to add to the winning of the war the winning of peace.

Heating of Electric Motors.

The old question as to whether a machine should be rated on temperatures determined by the thermometric or resistance method has a new illustration in Mr. L. Adler's Paper, of which we give an abstract in our present issue. As the result of practical experience it has been found that, on tramway systems, where the distance between the stopping places is small, and less than about 250 yards on an average, there is a notable difference between the performance of motors with commutating poles and those without them. This assumes that the rating is determined on thermometric principles. Experience shows that with commutating poles, the insulation in the armature becomes dry and brittle sooner than with the plain type of construction. Mr. Adler investigates the matter, and traces this effect to the fundamental difference in design in the two cases; in one case the iron losses are greater than those in the copper, while in the other the reverse is the case. Thus, a thermometric determination of the temperature of the iron may give misleading results, more especially in the case in which the copper losses are the main element. Under these circumstances, the hot copper conductors, embedded in heavy insulation, part with their heat by conduction to the iron. The thermometric method gives no idea of the actual temperature of the conductors, which is the measure of the actual thermic stress to which the insulation is exposed. The intermittent character of the load taken by traction motors with stopping places at short intervals accentuates the difference. Mr. Adler thinks that a method of rating, depending on resistance tests, should be adopted, and that, other things being equal, motors with commutating poles are not suitable for traffic on tramways, where stopping and starting occur at very short intervals.

An Inspiring Address to Engineering Students.

The address recently delivered to the students at the Rensselaer Polytechnic Institute, Troy, New York, by Mr. Rice, the President of the American Institute of Electrical Engineers, strikes us as extremely well suited to the present times. We are inclined to think that too little effort is made to arouse true practical patriotism in students, and to lead them to appreciate the dignity of their profession. Mr. Rice struck the right note in demonstrating that the time spent in learning their profession was by no means wasted from the standpoint of the war, and that it was their duty not only "to do their bit, but to do their best"—a best that could only be achieved by perfecting their special technical knowledge. Many instances were given of the essentially engineering character of the present war. Turning to applications of science in time of peace, Mr. Rice refuted the common impression that great inventions are made by accident. They are rather the inevitable result of some apparently trivial circumstance acting on a trained and carefully prepared mind. Mr. Rice was on equally safe ground in warning his hearers against the danger of extreme specialisation. To the average man every engineer is a specialist, and, as the future of science and engineering depend on the recognition of their value by the common mind, the engineer and scientist must not allow themselves to become isolated and lose the human touch. Germany, Mr. Rice suggested, is at the present moment a warning of this very form of undue specialisation—the pursuit and application of science irrespective of the claims of humanity. In short, the greatest engineers and scientists *must also be men.*

Scarcity of Copper in Sweden.—We observe that in Sweden experience in regard to scarcity of copper has been generally similar to that of Germany, and early in the present year an order was made that copper must not be used for conductors exceeding 6 sq. mm. in section without a permit from the Executive Committee dealing with the matter. It is understood that zinc is recommended as the most suitable substitute, being found in considerable quantities in Sweden and comparatively well adapted to electrical requirements.

Hydro-Electric Projects in Australia.—We observe that the question of the fuller utilisation of the water powers of Australia has been the subject of consideration recently. The Victorian Government appears to regard this as a more immediately promising line of development than the exploitation of the Crown coal deposits as a source of electrical energy. The Tasmanian Minister of Mines has also been quoted as in favour of the suggested development of water-power on the King River, from which, it is estimated, 45,000 H.P. can be obtained. The cost of the project has been assessed at about £1,000,000.

Magnetic Separators for Treating Waste Iron.—According to "Stahl und Eisen" magnetic separators are now being used in Germany for the recovery of scrap iron from many kinds of waste material and rubbish. By the aid of such apparatus, it is stated, a great deal of refuse commonly discarded in the neighbourhood of steel and iron works can be made to yield a considerable amount of iron—as much as 50 per cent. being obtained from refuse from steel works in some cases. Cupola furnace slag is said to give 5 to 15 per cent., and ordinary workshop rubbish 2 to 10 per cent.

Standard Specifications for Incandescent Lamps.—A Circular (No. 13) issued by the Bureau of Standards, Washington, contains the revised specifications, most recently adopted for carbon tungsten and gas-filled incandescent lamps. Particulars are given of the general specification under which lamps are purchased for the Government. The most important addition involved relates to gas-filled lamps. Such lamps are not to be rejected if the life test is not less than 1,000 hours when the lamps are tested to 75 per cent. of their initial candle-power, although the average is expected to be 1,000 hours with a fall in candle-power of not more than 80 per cent.

Twelfth Annual Report of the British Science Guild.—The 12th annual report of the British Science Guild, now issued, deals with a variety of matters of topical interest. An account

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is given of the objects of the British Scientific Products Exhibition, to be opened this month, and memoranda are presented by the Education Committee on the Education Bill, Scholarships for Higher Education and The Teaching of Science. There are also reports on the Introduction of the Metric System and on the British Dye Industry. Finally an account is given of the proceedings at the annual meeting on June 19th, when addresses were delivered by Lord Sydenham, Sir Algernon Firth and Sir Henry Newbolt. Copies of the report (1s. each) can be obtained on application to the Secretary, British Science Guild, 199, Piccadilly, W.1.

Transformer Repaired in Record Time.—The "Electric Railway Journal" mentions a case of a transformer being repaired in what is possibly record time. An 1,100 k.v.a. transformer in a sub-station of the United Railways of St. Louis short-circuited during the night, and the station was put out of commission. The transformer was dismantled, the coils removed, repaired and again installed in the transformer, and the laminations relaid by hand. This work was entirely finished and the transformer returned to service in five days. When it is considered that this transformer weighed 15 tons, and there were 50,000 laminations to be taken apart and relaid, the size of the task can be appreciated.

Magnetic Qualities of Zincblende.—It has long been known that there are a considerable number of weakly magnetic minerals which are appreciably affected by strong fields, the influence in some cases being sufficient to be of possible use technically. Relatively little has been published on this subject, but we observe in "Metall und Erz" an account of the experiments of several observers on the susceptibilities of 53 minerals, including a number of zincblendes. The special apparatus needed for the study of these feeble susceptibilities is described in some detail. The susceptibilities of the zinc samples studied range from below 10^{-6} up to 500×10^{-6}. The order of accuracy is computed at 1 per cent., but for materials of greater susceptibility (*e.g.*, magnetite $100{,}000\times10^{-6}$) the error may approach 20 per cent.

Tests on Metal Drills.—A series of experiments conducted by Messrs. Bruce W. Benedict and W. Penn Lukens on the performance of metal drills has been completed by the Engineering Experiment Station of the University of Illinois and the results published as Bulletin 103. One-inch drills of many well-known standard makes and special cast-iron blocks made in the shop laboratories were used. The power required at the drill point for different speeds and rates of feed was noted in all tests, the thrust and torque of the drill were recorded by special dynamometers, and the endurance of drills of different designs was studied. The economical helix angle, point angle, clearance angle, speed and feed were determined, and the effects of pilot holes and rounded corners were shown. Copies of this Bulletin may be obtained on application to the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

Instruments and Methods Used in Radiometry.—A new publication of the Bureau of Standards (Scientific Paper No. 319) deals with the application of certain physical and chemical properties of matter as a means of quantitatively measuring radiant energy. Dr. W. W. Coblentz, the author, discusses three types of selective radiometers: viz., the photo-electric cell of potassium and other alkali metals, the selenium cell, and the photographic plate. The photo-electric cell appears to meet the requirements of a quantitative radiometer, and may be used for measuring ratios of intensities extending from the blue throughout the ultra-violet part of the spectrum. The selenium cell does not fulfil the requirements of a quantitative radiometer. Quantitative data can be obtained with the photographic plate, but this method can be replaced by the photo-electric cell. Those interested may obtain a copy of this Paper on application to the Bureau.

Developments in Artillery during the War.—We notice in the "Journal" of the Washington Academy of Sciences an account of an interesting lecture on the above subject delivered before the Academy by Major-General Headlam, who is in charge of the British Artillery Mission. His description of the methods taken to speed up output of guns and shells, and especially the instances quoted of the constant variations in conditions of warfare, are most interesting. The lighter and simpler forms of artillery have been constructed in many cases by firms with absolutely no pre-war knowledge of the subject. It is related that the first German trench mortars were made by a firm famous for its cream-separators! Trench mortars, originally undervalued, were afterwards of great importance, but are now once more dropping out of use. For various reasons, apparently, promising improvements are often discarded almost as soon as they are completed. Such is the effect of changing conditions of warfare. Another point of interest is the relation between the output of guns and shells. The position was tersely described in 1916 by General Gossot: "Up to then the guns have eaten up shells; we shall now see the shells eat the guns." Efforts are constantly being made to increase range, the Germans, by means of a long clockwork fuse, ranging up to 20,000 yards accurately in attacking balloons. On the other hand, artillery is often brought nearer the enemy than for a century past, guns having sometimes been brought up to within 200 yards of the enemy's trenches.

Accidents in Quarries and Metal Mines in the United States in 1916.—Two publications issued by the Bureau of Mines, Washington, give an account of the accidents which occurred respectively in quarries and metal mines in the United States during 1916. In quarries there was an increase both in the number of fatalities (173 as compared with 148 in 1915) and in the fatality rate per 1,000 men employed (2·26 as compared with 1·8 in 1915). Non-fatal accidents also increased. It is suggested, however, that the figures do not indicate an increase in the hazard of the industry, but rather that the State compensation laws are now bringing out the full facts. Returns from metal mines, on the other hand, show the lowest fatality rate and the largest number of men employed during the six years during which the Bureau has collected statistics. There were 697 fatalities in 1916, making the fatality rate 3·41, as compared with 4·19 in 1911. The number of non-fatal accidents was, however, greater than in the previous year, and the non-fatal injury rate 235·66, as compared with 232·02. This result, like that obtained in quarries, is also ascribed to the effect of the enactment of compensation laws, which has led the companies to keep more complete records.

Light Production by Insects.—A recent issue of the "Journal" of the Franklin Institute contains some interesting notes by Mr. E. Karrer on the production of light by insects and other organisms. It is calculated that the Welsbach mantle emits as light about 0·5 per cent. of the total radiation emitted, and the tungsten electric incandescent lamp 1·65 per cent. On the other hand, it is computed for the firefly that 97 per cent. of the radiation emitted is in the visible form. The luminous efficiency of illuminants, reckoned in terms of the total amount of energy furnished to the source, is considerably less than the figures quoted above, being, for example, only 0·08 per cent. for the mantle and 0·113 per cent. for the tungsten electric incandescent lamp. There are no available data for determining the corresponding efficiency for firefly radiation. It is surmised that the efficiency of work carried out by many organisms is high, and it is common knowledge that many insects are capable of carrying a load in proportion to their weight vastly greater than that possible for a human being. A beetle weighing little more than 1 gm, for example, has been found to be able to crawl with 700 gm. on its back. But there are few data which would enable us to compute satisfactorily the efficiency of such an effort, and the processes involved in light-production by organisms are still more obscure.

Obituary.

JAMES A. BURT.—We regret to record the death, which recently took place at Dunedin (N.Z.), of Mr. James Alex., eldest son of Alexander Burt, sole surviving founder of Messrs. A. & T. Burt (Ltd.), electrical engineers. The deceased was director and representative at the London buying office of the firm until he had to return to New Zealand on account of his health.

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Contract Prices During Demobilisation.*

By Captain W. P. DIGBY.

It is advisable to define initially some of the factors related to contract prices during demobilisation. The mechanism by which wages rates are fixed will not be discussed. The author assumes that the index-numbers for weekly rates of wages for specified trades in the engineering industry will be readily available. Readers are referred to a definition of index-numbers given by Mr. R. H. Hooker in a Paper read before the Royal Statistical Society,† which is employed in this contribution. The process consists in accepting the price of a single date, or of a series of years, as a standard, and representing this price by the figure 100. The price at any other time (be it that of a given day, or an average of monthly or yearly prices) is then expressed as a percentage of the standard value; and this resultant percentage is called the index-number of the commodity at the date or period to which it refers.

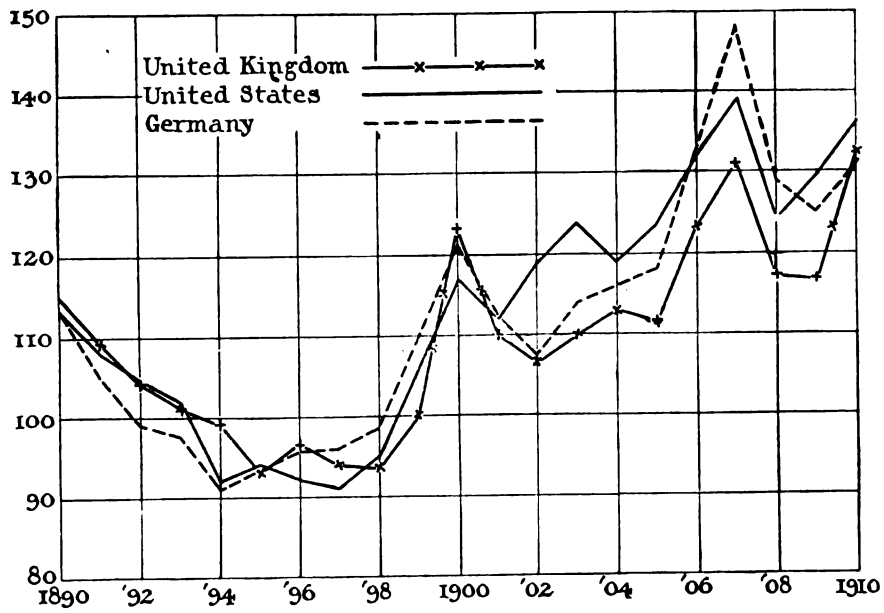

FIG. 1.—MATERIAL INDEX-NUMBERS.

To-day some thousands of works and factories are classed as "controlled establishments," and all concerns are affected by restrictions of import and export and by priority references. It is estimated, however, that for, perhaps, two years after the war food control will be necessary in several countries. Similarly, the prevention of industrial confusion in Great Britain will require a central authority, allocating part of all the imports of raw materials to specific purposes, and that in place of the present system of priority references issued by the Priority Branch of the Ministry of Munitions, we shall instead be governed in these respects by a Priority Branch of a Ministry of Commerce.

Before discussing the effects of such control the author considers some statistics of three separate periods. The first period is that of the Franco-Prussian War. The period from 1872 to 1875 was marked by all the features of a boom period, rising rates of wages and cost of food-stuffs, together with an artificial inflation of prices

The high prices of 1873 must not be claimed as solely due to the effects of the Franco-Prussian War. We have to distinguish between fluctuations due to normal and abnormal causes. As an instance of the fluctuation due to the normal, we may instance the change between 1890 and 1896, when the index-numbers for all commodities fell from 82·8 to 69·8, the coal and metals index-number falling from 113·6 to 83·8. The general conclusions to be drawn, for the period 1869-1879, are that :—

1. Foodstuffs, taking wheat as the key, did not revert to their pre-war value until four years after the close of hostilities.

2. That wages in neutral countries like the United States and Belgium took respectively three and seven years to revert to their old money value.

3. That taking the two cases given of belligerent countries, the wages in the defeated country remained until 1876 below those in the victorious country, in neither case reverting to their old value in seven years.

4. That in four typical cases given, wages rose in both belligerent and neutral countries after the close of hostilities, due in part to high food prices, and in part to the synchronising of a period of good trade with the demands to make good much of the material destroyed in the war or diverted to other uses.

The second of the three periods from 1890 to 1909 illustrates the fact that under pre-war conditions the prices of certain of the most widely used of the raw materials of the engineering industry were subject to much greater variations in price than were the prices of foodstuffs. This is really a surprising tribute to the adequacy and efficiency of the supply and transport systems of the world, no less than to the successful efforts which were opening up sources of foodstuffs at a rate almost commensurate with the growth of population in the food-importing as distinguished from that in the food-exporting groups of communities. Some of these data are plotted in Fig. 1.

While the prices of commodities fluctuate in this serious but inevitable manner, their interrelation and effect on industry can never be a constant one. High fuel prices are an incentive to fuel-saving; high prices for metals both serve to replace a lavish and rule-of-thumb use of the metal by a scientific one, and also, other conditions being normal, occasion a glut through over-production accompanied by the opening of new mines. Low metal prices permit the use of metal for fresh purposes, and while closing down unproductive mines necessitate cheaper production at the large mines.

The engineering manufacturer, moreover, always has his own works in a continuous condition of evolution. Machine tools are speeded up, the time required for machining operations is reduced, repetition work is the rule where possible. When raw materials rise in price this can only be set-off by a cheapening of the labour cost of the finished article, to which end constant effort is devoted. At the same time the rise in rents altered standards of domestic comfort and rises in food prices have all tended to complicate the industrial problem.

By the use of index-numbers we can compare nominal currency values in different years in terms of their relative food or commodity-purchasing value, and index-numbers must become a feature of all studies in engineering economics. But there is also room in engineering for the application of index-numbers to the true interpretation and analysis of activity in a number of directions. Wages boards in the colliery districts have been urged by the colliers' representatives to take into account changes in the food-purchasing value of the pound sterling. If similar boards should ever be established in other industries, those responsible for the presentation of the employer's case should be ready with figures of the burdens laid upon them by the extraneous causes of rises in prices of raw materials and the prices at which competing products from other countries are being sold. The increased output of new machine tools has increased the output of each artisan, but has increased works standing-charges. Selling prices for some classes of machinery had before the war fallen to a very low point. It is therefore advisable that our commercial analyses should be as full as possible.

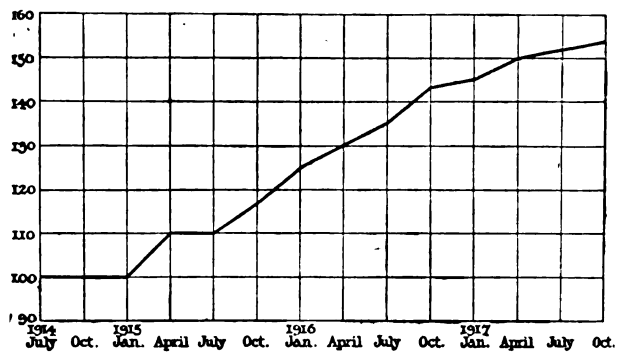

FIG. 2.—MAIN SELLING PRICE OF 21 ELECTRIC MOTORS OF VARIOUS SIZES AND TYPES.

* Abstract of a Paper read before the Institution of Electrical Engineers.

† "Journal" of the Royal Statistical Society, Vol. LXXV., Part I., pp. 1 to 50.

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We cannot come to any equitable settlement of economic problems so long as the community regards any unit of currency as a fetish of a stable potency instead of in its correct position as the resultant of a large number of complex forces.

For the third and last period from August, 1914, to November, 1917, the author puts forward some new figures showing the rise in selling prices f.o.r. of certain articles of electrical interest.

In order to obtain mean selling prices representative of electric motors, the author divides electric motors into three main groups: (*a*) Direct-current interpole machines without pulleys or slide rails; (*b*) three-phase squirrel-cage alternating-current motors; and (*c*) three-phase slip-ring alternating-current motors. Some such data are plotted in Fig. 2, while Fig. 3 relates to switchgear

The index-number in each case was the price f.o.r. makers' works at July 31, 1914.

As illustrative of the upward trend of prices in regard to switchgear, the author quotes two items: (*a*) Oil-immersed auto-transformer starters for squirrel-cage alternating-current motors and (*b*) rotor starter panels for slip-ring alternating-current motors. The rise in prices is appreciably lower than is the case in regard to electric motors of various sizes. The figures quoted are only true of one firm and of two items produced by that firm; the author does not regard them as typical of British switchgear selling prices during the period under review. The selling prices here quoted are a striking example of efficient manufacture of the two items mentioned. The percentage price received per unit sold is almost certainly lower than the percentage rises in weekly rates of wages and in the actual component materials.

As regards cables, the author has taken as typical (1) a high grade C.M.A. vulcanised rubber cable of small sectional area, a 6,600-volt three-core paper-insulated wire-armoured cable and a 500-volt three-core paper-insulated tape-armoured cable. He has also been furnished with the index-numbers for copper, lead and Para sheet at the maker's works throughout the period. These are presented in the form of diagrams, the price having nearly doubled in some cases and more than doubled in others.

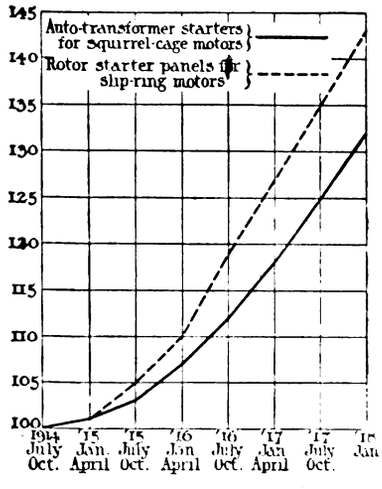

FIG. 3.—PRICES OF POLYPHASE STARTERS.

Of the price changes since the outbreak of the present war, we all have abundant and intimate knowledge, and the author presents in tabular and graphic form the increase in meat and cereals, textiles, minerals, &c., the relative change being more than double in many instances.

Into the complex question of the apparent or real variations in wages he does not enter in detail, but remarks that it seems a fair inference that the increase in wages paid has exceeded the family food budgets of all save the middle class. Arguing from data for the much smaller war of 1870-71, it appears that there can be no immediate marked fall in either food or material prices after the present war. We must reckon on a new standard of value for the £ sterling, and also that all conditions of trade will be very difficult during the period of industrial demobilisation.

Let us assume, therefore, that all manufacturing will still be controlled in a degree progressively relaxing in intensity as means of transport and supplies permit greater freedom in trading. How are prices to be equitably determined between buyer and seller? Violent fluctuations in prices and speculation should clearly be eliminated.

For years we have been accustomed to receive tenders from our leading cable manufacturers based on a sliding scale, say, for paper-insulated lead-sheathed wire-armoured cables, dependent on the market price of lead and copper at the date of acceptance of the contract. The author desires to urge the extension of the system of sliding-scale contract prices throughout the engineering industry, and that a tender, say, for an alternating-current generator would state that the tender is based on a price of:—

q£ per ton for copper
r£ per ton for core plates (unmachined).
s£ per ton for pig iron.
t£ per ton for shaft forgings.
v shillings per hour for machinists.
w shillings per hour for winders.
z shillings per hour for unskilled labour.
} Rates prevailing in the tenderer's district.

and that the tender price will be varied by a defined percentage for each defined rate of fluctuation under each of the above headings as and at the date of the priority certificate becoming effective. It is an open question whether there should be any further variation after the agreed date of the priority certificate taking effect.

The instance of the alternating-current generator might be multiplied almost indefinitely. Mutual convenience has established the sliding scale basis of tendering for cables. Mutual convenience can be secured by the extension of the same principles (allowing also for wages rates) to prime movers of all sorts, to steam boilers, to steel or cast-iron pipes, to transformers, to switchgear, to electric conduits tramway rails, to motors, or to almost every article that concerns the industry.

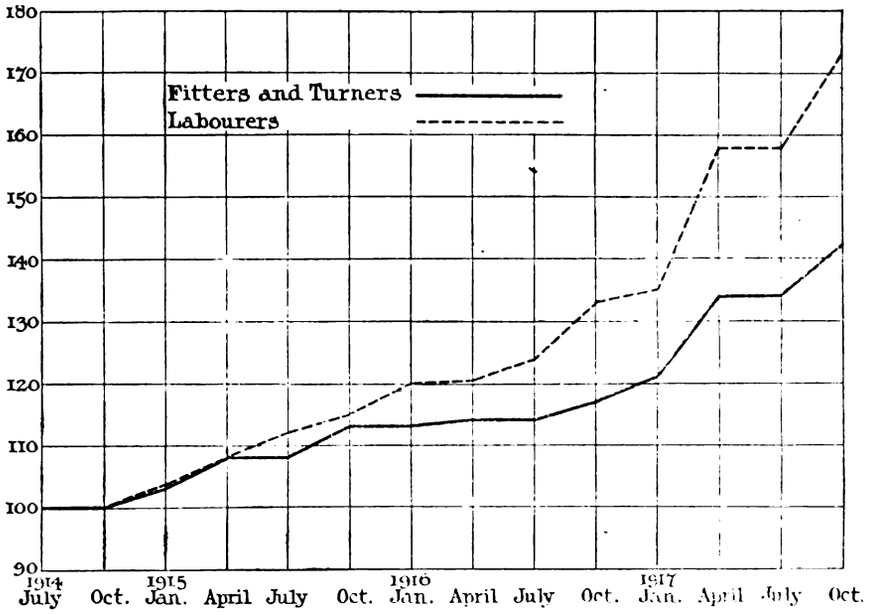

FIG. 4.—WAGES IN ENGINEERING TRADES, FOR FOUR LARGE CITIES, JULY, 1914-OCTOBER, 1917.

The perfecting of the suggested statistical basis must be in the hands of a competent and more or less impartial body. One means would be for the Board of Trade or Ministry of Commerce to issue an annual statistical summary with monthly correction sheets. Another means and one which will probably commend itself most to this Institution, is that the perfecting and application of the sliding-scale basis should rest with a statistical committee appointed by the Council of the Institution. When all is said and done, a very complex civilisation depends for its existence upon the barter of manufactured goods or services for foodstuffs.

Steel, copper, cotton, timber, oil, the thousand and one raw materials of industry are as vital as food to our national existence. Relative stability of prices, and a rationing of these commodities as part and parcel of a system of manufacture under a system of priority licences of gradually relaxing intensity, may be one road across a swamp of troubles to firmer ground and to an enjoyment again of the saner unfettered individualism to which we aspire. It is in the hope that such a road would prove of value that the author has ventured to submit this plea for its consideration by the only electrical authority to which alike the manufacturer, the consultant as representing the purchaser, and the user have a common allegiance.

The discussion on this Paper will appear in our next issue.

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An Address to Graduating Student Engineers.*

By E. W. RICE, Jr.

There never was a time when the world had greater need of engineers and of trained technical men. Workers as well as fighters are needed, and the trained brain should be the best brain for both tasks. Engineering is not only the foundation of modern society and institutions, but it permeates the whole structure, even as the universal ether permeates matter. Transportation, railroads, trolley lines, steamboats, subways, automobiles, transmission of intelligence by telegraph and telephone, wagon roads, bridges, tunnels, city streets, buildings, workshops, mines, and every luxury and every necessity are all dependent upon the work of the scientist and engineer, not only for their creation but for their continuous and successful existence. Such is the dependence of society upon engineering in times of peace. In modern war—the engineer is of even more importance. The men in the trenches must have guns, grenades, gas-masks; trenches must be planned; heavy artillery forwarded; machine guns, tanks, and ambulances must be supplied; railroads and bridges must be built and rebuilt. Each aeroplane draws upon the skill of all branches of engineering, provided as it is with guns, ammunition, engines, barometers, oxygen-producing apparatus, compasses, wireless telephones, &c. In fact, the work of the modern army is fully 80 per cent. engineering.

There is also an unlimited field for the effective use of all engineers in the important work behind the lines here at home.

The growth of knowledge and the extension of scientific engineering activities demand increased specialisation. Take, for example, the profession o electrical engineering. Up to 1880 an active intelligent man could keep thoroughly posted as to the progress in all the fields of electricity, not only in this country, but throughout the world. To-day it is impossible to keep well informed on even one of the many branches of electrical activities.

Still, there are dangers in too great specialisation. It tends to produce a limited view, not only of one's profession but of life. It leads to intellectual isolation, and, in a broad sense, to lack of efficiency. Each specialist should devote some of his time, not only to the study and appreciation of other fields of engineering and science, but to business, art and politics. Engineers should cultivate a sense of proportion, discrimination and good sense, often called "common sense." An engineer may, for example, be required to prepare a list of materials, with costs at current prices, for a given undertaking, say, a building, a bridge, a dynamo or other piece of machinery. Many times I have seen such estimates submitted, not only with the detailed items, but the sum total carried out to the second and third decimal places, when the quantity involved was of the order of $10,000. Such attempted accuracy is not only useless but ridiculous.

The same lack of a sense of proportion, or a fitness of things, may be shown in spending a large amount of time, money and effort in elaborating unimportant details under conditions when the fundamental factors have not yet been settled, and when what is wanted is to determine the limits of the essential factors. An elaborate calculation is an error when a simple one will suffice; a costly set of drawings is a mistake when a rough sketch will answer the purpose; costly and elaborate tools for saving labour may prove useless because the amount of labour to be saved may be insufficient to even absorb the cost of the tools. Work done by hand may in many cases be more economical than that done by the aid of automatic tools.

I think that specialisation which is tempered by a lively interest in other things also leads to better work in the special field. The great discoveries and inventions which have revolutionised the world have been produced by men who were more than specialists. Bell, the inventor of the telephone, was not an electrical engineer, but was a teacher and student of acoustics; Maxim, the inventor of the Maxim gun, was an electrical engineer as well as a mechanica engineer; Wright, inventor of the flying machine, was a bicycle manufacturer; Thomson, inventor of electric welding, the arc lighting system, &c., was originally a chemist.

There is a common idea that great inventions are the result of accident. This is not true. The telephone is an example. Bell had been working on a multiple telegraph device for years, thinking at the same time of the telephone, but a lucky accident during a test led almost instantly to the invention of the telephone. Watson, who was Bell's assistant at the time, has testified that the accidental noise which Bell heard over the wire meant nothing to him (Watson), but to Bell it meant the key to the solution of the problem which he had long sought.

Specialisation seems to lead either to an autocratic or to a democratic organisation of society.

In a democracy the thinking is not limited to a small class, but must be indulged in by the mass of the people. The specialist must, therefore, give thought to other matters outside of his field, so that he may be fitted to influence the general viewpoint. It is a safe conclusion that if man is to progress as a civilised social being it must be as the result of the general diffusion of a sound, well-balanced education.

Germany illustrates the danger and the weakness of an unbalanced and unsound educational programme. She fostered technical education. This, among other reasons, has helped her to great success in trade, manufacture and commerce and in the war. Her weakness, which will prove fatal in the end, is that she has, in her educational formula, omitted altogether the existence of other human minds in the world outside of Germany. This is a species of super-specialisation, and has led to an exaggeration of the importance of German achievement in German eyes to a point of insanity, and to the systematic degradation of science and industry to the vile purposes of offensive war.

I am an enthusiastic believer in the vital importance of a more thorough understanding, by the majority of our people, of the ideals and practical value of science and engineering. To this end, it is essential that the general public should have a better and larger education in scientific matters. There is nothing so dangerous as ignorance. If our people had been more extensively educated in science and engineering, we should not have been so slow to realise the dangers of this great war. Criticism is healthful and helpful, if based upon facts; and if kept within the facts is reasonable, constructive and patriotic; but much of the criticism we hear is unintelligent and is based upon ignorance of the stupendous nature of the problem.

This war is different from all previous wars, in that it requires for success the mobilisation of the entire resources of the country. It is, in fact, a business, and must be organised and run as a gigantic business, and yet it must be directed and operated by the Government. Now, all existing business has been built up and run by private organisations. However, our executives and Congressmen were not selected because they had demonstrated their fitness to operate large business. Successful business men, engineers, financiers and merchants are not yet popular candidates for Congress and for executives. Nevertheless, public opinion has forced, during the past few months, a welcome increase in the admission of business men of proven ability into positions of importance. No time should be lost in getting the right men into the right places. When the history of this war is written, after the conclusion of a victorious peace for our cause, I venture to prophesy that the future historian with all the facts before him will decide, as to America, that no matter how costly were all of the mistakes after we entered the war, in men and money, they were of trifling importance compared with our failure to prepare energetically for the war from the moment that Germany crossed the Belgium border.

I envy you your youth and energy and your opportunities. You have an interesting future before you as engineers and inventors. Some "doubting Thomas" among you may say, "But all the great discoveries and inventions have been made; there is nothing more of importance to be discovered or invented."

I have been engaged in engineering work, mainly electrical, for nearly 40 years, during which time the entire electrical industry may literally be said to have had its birth and development—the telephone, electric light, electric motor, trolley cars, wireless telegraphy, wireless telephone, electric transmission of power—all these have appeared since my first youthful venture in electrical work.

Now, on a number of occasions during these 40 years, a lull in new inventions and discoveries seemed to have come about; and on such occasions I have talked with eminent engineers and inventors who all agreed that there was nothing more of importance in our line to be discovered. This conviction was strongest about 30 years ago; fairly strong about 20 years ago; a little weakened, but still existing 15 years ago, but now is a dead doctrine. Therefore, I say with confidence that a great future awaits you in your chosen profession; greater things are waiting to be discovered than are now known. There is no limit to man's mastery over nature's secrets, excepting his own limitations of time, and willingness to study, think and experiment.

When the war is over, there is danger that many men and women, who are unscientific, will make the mistake of thinking that the

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terrible war was brought about by the German's devotion to science rather than by his degradation of science, and there might follow a reaction against science itself which, if successful, would plunge the world back into the darkness of the middle ages. It will be the duty of all scientific men, by education and example, to demonstrate that it was the abuse and not the use of science by Germany which was the cause of all our suffering.

It has been well said that "when the world has been made safe for democracy, democracy must be made safe for the world."

It is evident that a democracy founded upon ignorance and prejudice would be a sad reward for the world's agony. Such a disaster can happily be avoided by a general diffusion of a well-balanced education throughout the mass of the people; and in a well-balanced educational programme, science, both pure and applied, must form the foundation. An ideal democracy can only exist when the Golden Rule governs the relations of its human units with each other, and this fortunately would be the ideal atmosphere for the true followers of science.

Armature Heating in Traction Motors.*

By Dr. L. ADLER.

By the principle of the conservation of energy, magnetic, electric and mechanical losses appear in the form of heat. In the armature, the losses in the iron and the windings are the most important; in the field, the main point is the loss in the windings; if there are many brushes the commutator may cause serious losses, even if the commutation itself is perfect. There is also a process of thermal conductivity between the various parts of the machine. It is not easy to determine the losses in actual practice in traction motors, where the load is fluctuating and intermittent. Each case differs in consequence of the variable distance between successive stopping places. In urban traffic the windings carry heavy currents in consequence of the frequent starts, while the iron in the armature, the losses in which are mainly dependent on the impressed voltage and the speed of revolution, contributes less to the total loss. If the stopping-places are far apart the reverse is the case; under the two sets of conditions the insulation between the windings and the iron is very differently stressed.

Experience shows that the improved construction of motors and the introduction of commutating poles have very decidedly contributed to a reduction in the cost of maintenance, and to a longer life for the machine. But the curious fact has also been discovered that if the stopping-places are at very short distances apart (say, less than 250 metres) with commutating poles, the insulation of the armature becomes dry and brittle sooner than in the case where commutating poles are not used. If the cause of this is investigated it will be found to be the result of a difference in the electrical condi-

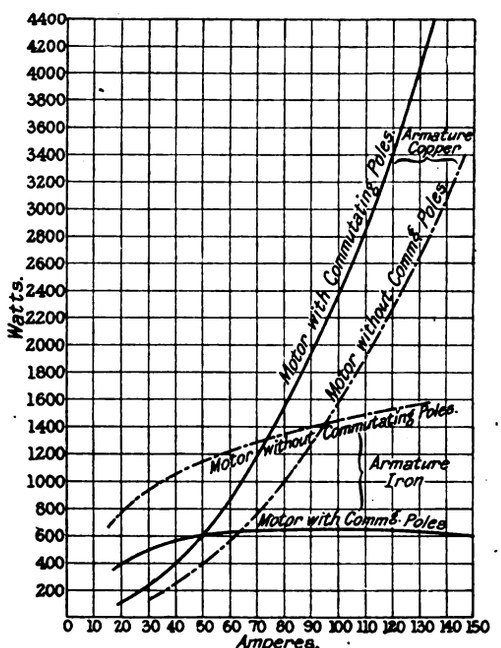

Fig.1.- Losses in Iron and Copper at 500 Volts.

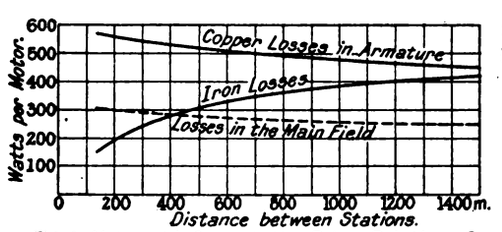

Fig.4.- Motor with Commutating Poles. Relation of Internal Motor Losses to the Mean Distance between the Stations.

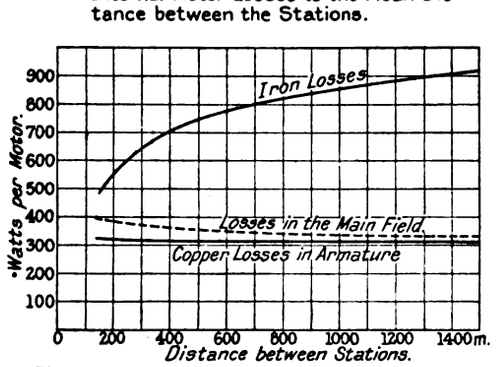

Fig.5.- Motor without Commutating Poles. Relation of Internal Motor Losses to the Mean Distance between the Stations.

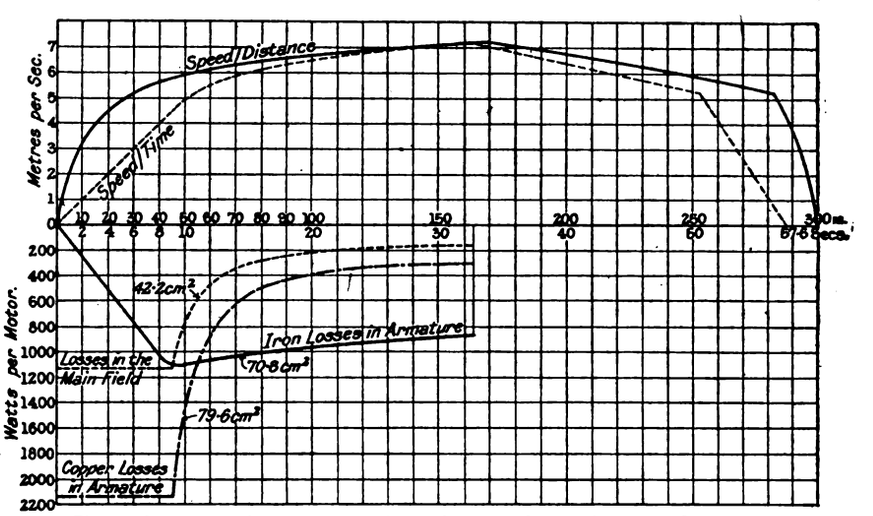

Fig.2.- Motor with Commutating Poles. Diagrams for a Distance of 300 metres between the Stations.

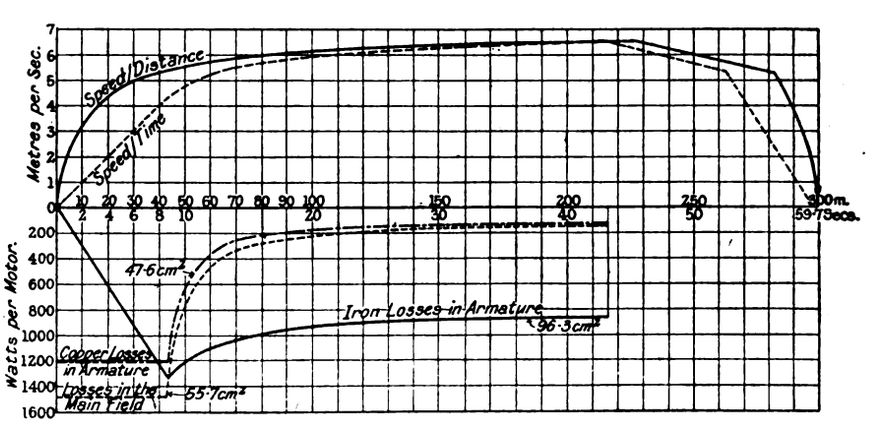

Fig.3.- Motor without Commutating Poles. Diagrams for a Distance of 300 metres between the Stations.

* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 26, 1917.

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tions. Motors without commutating poles, if they are to have satisfactory commutation in the neutral zone, are designed to have high iron losses and low copper losses; in this they differ from the other type, which has low iron losses and high copper losses, which depend on the maximum permissible armature reaction.

In Fig. 1 are shown curves for two normal motors with commutating poles, having about the same output; these curves show the losses in the copper and iron of the armature as dependent on the strength of the current at a working pressure of 500 volts. It will be seen at once that the copper losses for the motor without commutating poles are decidedly less than in the other type, while the opposite is the case for the iron losses. With a current of 85 amperes the ratio of these losses in the motor with the commutating poles is 2·7, while in the other it is 0·8. In actual practice the distribution of the losses will depend on working conditions. If the stopping places are close together the difference will be still more marked; more especially will this be so if the motors are run largely in series, and are therefore supplied with half the working voltage; this is often the case with low speeds and short distances between the stations. In order to examine these matters more closely a series of diagrams was calculated for the above-mentioned 37 kw. motors with different distances between the stopping places. This was done on the assumption that the motors carried the same mean current, which is the essential cause of the heating. The other conditions, such as train-weights and speeds, were correspondingly chosen. In Fig. 2 are given the curves for a motor with commutating poles, the distance between the stopping places being 300 metres; in Fig. 3 are similar curves for a motor without commutating poles. The train-weight in each case was 12 tons per motor, and the acceleration 0·5 metre per second per second. Above the axis of abscissæ are the speed/time and speed/distance curves; below are the losses in armature and field in relation to time. With the planimeter the following results were obtained for the armature: In the motor with commutating poles the copper losses were 552 watts and the iron losses 248 watts; the ratio of these was 0·49. For the motor without commutating poles the copper losses were 319 watts and the iron losses 745 watts; their ratio was 2·23. When the distance between the stations was reduced to 150 metres, the copper losses in the armature of the motor with commutating poles were 578 watts and the iron losses 149 watts; in the other motor the losses were respectively 324 watts and 496 watts. Similarly results were obtained when the distances between the stopping-places varied from 100 to 1,500 metres. These losses are connected into curves, which are shown in Figs. 4 and 5 for the two types, the field-losses being shown in dotted curves, while the armature-losses are shown in full curves. From these two sets of curves we see how completely the two motors differ with regard to armature losses. In the motor without commutating poles, if the distance between the stopping places is small, the iron losses are rather greater than the copper losses; as the distance between the stations increases, they increase to more than three times the copper losses. Precisely the reverse is the case with motors with commutating poles, where the copper losses begin by being four or five times as great as the iron losses; as the distance between the stations increases the difference between the two types of loss becomes less and less. The heat which is generated is not proportional to the losses. Other things being equal, the iron radiates its heat much better than the conductors, which are packed in thick insulating coverings. The heating effects will therefore differ more markedly than would appear from Figs. 4 and 5 at first glance. Naturally there will be an exchange of heat between the iron and the conductors; this exchange must pass through the insulation and prejudicially affect it, thereby shortening its life.

The question therefore arises as to whether the thermometer is a suitable instrument for determining the temperature of all kinds of machines, and whether the results in all cases will be equally accurate. It is plain that this is not the case. The facts, which have been set out above, show that it is impossible by ascertaining the temperature of the outer surface of the iron to have any accurate idea of the conditions that prevail in the inside of the machine, where the insulation may in places have to withstand much higher temperatures. Fig. 5 shows that for a motor without commutating poles the losses in the iron are much greater than those in the copper; the thermometer may in this case give sufficiently accurate results. Fig. 4 shows that the opposite is the case with a motor with commutating poles; the measured temperature will in this case be that due to the heat, largely conductive, which has passed from the copper to the iron. The difference between the measured and the actual maximum temperatures will therefore be completely different in the two cases. It will depend on the distance between the stations, and also on the type of construction of the motor—*i.e.*, whether it is ventilated or unventilated. It is impossible to measure the temperature of the armature winding directly by a thermometer in the closed type of traction motor in consequence of the thick layer of insulation around the conductor; errors of 50 or 100 per cent. could easily be made. It is only in rare cases that anything of the kind would be possible, and even then any exposed part would be liable to be cooled to a greater extent than the buried portion of the conductor. It is very difficult to measure the temperature of the iron accurately. It is often impossible to put the thermometer on the iron. In the older type of motor with broad brush-holders it is impossible to get at the armature from the commutator side. The temperature of the commutator can be measured, but this is very inaccurate, and depends largely on the conditions of commutation. With large motors of the open type these difficulties do not exist; but the time-constant must be considered, as in all thermometric measurements.

On the other hand, it is quite simple to determine the temperature by the resistance method. It used to be said that this method was difficult, and that very low resistances could not be accurately measured. It is not necessary to determine the whole resistance of the armature. It is quite sufficient to select some part of the winding. Two segments of the commutator should be selected and marked carefully. With armatures having series or series-parallel winding, as is usually the case with large machines, uneven equalising currents should be avoided by raising the one section of the brushes or by allowing them to press on a strip of insulating material; this can usually be done in a few seconds. With tramway motors, which have wave winding, this is unnecessary. The measurement can begin directly the machine stops; an exact heating curve can be constructed either in the laboratory or in actual working, as has been done on the Berlin tramway. As for the alleged difficulty of measuring very low resistances, it is possible in ordinary work with the improved Thomson apparatus to measure resistances as low as 0·001 ohm; and in traction work, armatures with resistances lower than 0·1 ohm are very rare. In measurements on traction motors, which require to be very accurate for the determination of the whole resistance of the armature, it is possible to have properly made double-pole contact pieces, which can be put in the brush-holders when the carbons have been removed. If this device were used on different machines it might be possible to have an error, corresponding to two segments of the commutator. Lengthened tests were carried out on an armature for 500 volts with 165 segments; it was found that with an error of even four segments the error in the resistance was only 1 per cent., which corresponds to an error in the temperature of $2\frac{1}{2}$ per cent. If with series armatures, p is the number of the poles, z the total number of the segments, f the error in the segments, then the percentage error will be $100 p^2 f^2 z^2$. If there is an error of four segments the resulting error will be 0·94 per cent., which agrees well with the experimental result, and can in practice be neglected. The smaller the number of segments the greater will be the error.

The foregoing considerations seem to show that machines of the same nominal output may give very different performances according to the conditions under which they are set to work, and the resistance method, seeing that it depends on the actual internal temperature, is certainly likely to give a better idea of the rating of the machine than any thermometric method. Any rating, too, which is based on the results of an hour's run, is likely to give misleading results.

Increasing the Evaporation in Boilers.—In the "Journal" of the American Society of Mechanical Engineers reference has been made to a new device developed by Mr. C. Hering, which is said to increase considerably the evaporating capacity of boilers. According to Mr. Hering's theory there exists outside the boiler-plate a thin film of gas, which is formed whenever a flame plays on the outer surface of an evaporating vessel, the liquid inside being at a very much lower temperature than the flame. Such a film offers an enormous resistance to the passage of heat. Thus, if the flame temperature is 1,300°C. and that of the water 100°C. there is a fall of 1,200°C. in the film, which, however, is estimated to be not more than 0·005 in. thick. This resistance, it is stated, can be diminished by forming lugs on the flame side of the boiler surface, their length and diameter being such that their ends approach a dull red heat. The best dimensions and spacing for such lugs are discussed in detail. Tests have shown that the rate of flow of heat through the base of a vessel provided with lugs was 27 times as high as in a vessel without lugs.

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Calculation of Performance of Induction Motors Working in Conjunction with Flywheels and Slip Regulators.

By HERBERT VICKERS, M.Eng.

(*Concluded from p. 295.*)

Summary.—The author deals with the subject mathematically, taking the two cases of continuous slip regulator and intermittent slip regulator; also the automatic slip regulator and the Ward Leonard system. Numerical examples are given.

We will now derive an expression for the R.M.S. horse-power or R.M.S. power.

Let

t_1=time in the pass, till regulator comes in.
t_2=time till end of pass from beginning of pass.
t_3=time in interval that the motor is on the regulator.
t_4=time till end of the cycle.

The power in time t_1 at any instant

$$=\left\{\frac{c}{a}+\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t}\right\}\left\{T_3-a\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t}\right\},$$

$$=T_3\frac{c}{a}+T_3\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t}-c\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t}-a\left(\omega_1-\frac{c}{a}\right)^2e^{-\frac{2a}{I}t}.$$

$$(\text{Inst. power})^2=T_3{}^2\frac{c^2}{a^2}+T_3{}^2\frac{c}{a}\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t}-T_3\frac{c^2}{a}\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t}$$
$$-T_3c\left(\omega_1-\frac{c}{a}\right)^2e^{-\frac{2a}{I}t}.$$
$$+T_3{}^2\frac{c}{a}\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t}+T_3{}^2\left(\omega_1-\frac{c}{a}\right)^2e^{-\frac{2a}{I}t}-T_3c\left(\omega_1-\frac{c}{a}\right)^2e^{-\frac{2a}{I}t}$$
$$-T_3a\left(\omega_1-\frac{c}{a}\right)^3e^{-\frac{3a}{I}t},$$
$$T_3\frac{c^2}{a}\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t}-T_3c\left(\omega_1-\frac{c}{a}\right)^2e^{-\frac{2a}{I}t}+c^2\left(\omega_1-\frac{c}{a}\right)^2e^{-\frac{2a}{I}t}$$
$$+ac\left(\omega_1-\frac{c}{a}\right)^3e^{-\frac{3a}{I}t},$$
$$T_3c\left(\omega_1-\frac{c}{a}\right)^2e^{-\frac{2a}{I}t}\quad T_3a\left(\omega_1-\frac{c}{a}\right)^3e^{-\frac{3a}{I}t}+ac\left(\omega_1-\frac{c}{a}\right)^3e^{-\frac{3a}{I}t}$$
$$+a^2\left(\omega_1-\frac{c}{a}\right)^4e^{-\frac{4at}{I}}.$$

$$\text{inst. power}^2=W_1{}^2=T_3{}^2\frac{c^2}{a^2}+2T_3{}^2\frac{c}{a}\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t}$$
$$-2T_3\frac{c^2}{a}\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t}$$
$$-2T_3c\left(\omega_1-\frac{c}{a}\right)^2e^{-\frac{2a}{I}t}\quad T_3{}^2\left(\omega_1-\frac{c}{a}\right)^2e^{-\frac{2a}{I}t}-2T_3a\left(\omega_1-\frac{c}{a}\right)^3e^{-\frac{3a}{I}t}$$
$$-T_3c\left(\omega_1-\frac{c}{a}\right)^2e^{-\frac{2a}{I}t}+2ac\left(\omega_1-\frac{c}{a}\right)^3e^{-\frac{3a}{I}t}$$
$$+c^2\left(\omega_1-\frac{c}{a}\right)^2e^{-\frac{2a}{I}t}+a^2\left(\omega_1-\frac{c}{a}\right)^4e^{-\frac{4a}{I}t},$$

$$\int_0^{t_1}W_1{}^2dt=T_3{}^2\frac{c^2}{a^2}t_1-2T_3{}^2\frac{c}{a^2}I\left(\omega_1-\frac{c}{a}\right)e^{-\frac{at_1}{I}}$$
$$+2T_3{}^2\frac{c}{a^2}I\left(\omega_1-\frac{c}{a}\right)+2T_3{}^2\frac{c^2}{a^2}I\left(\omega_1-\frac{c}{a}\right)e^{-\frac{a}{I}t_1}$$
$$-\frac{2T_3c^2I}{a^2}\left(\omega_1-\frac{c}{a}\right)+\frac{T_3}{a}cI\left(\omega_1-\frac{c}{a}\right)^2e^{-\frac{2a}{I}t}$$
$$-\frac{T_3}{a}cI\left(\omega_1-\frac{c}{a}\right)^2\quad\frac{T_3{}^2I}{2a}\left(\omega_1-\frac{c}{a}\right)^2e^{-\frac{2a}{I}t_1}$$
$$+\frac{T_3{}^2I}{2a}\left(\omega_1-\frac{c}{a}\right)^2+\frac{2}{3}T_3I\left(\omega_1-\frac{c}{a}\right)^3e^{-\frac{3at}{I}}$$
$$-\frac{2}{3}T_3I\left(\omega_1-\frac{c}{a}\right)^3+\frac{T_3cI}{2a}\left(\omega_1-\frac{c}{a}\right)^2e^{-\frac{2a}{I}t_1}$$
$$-\frac{T_3cI}{2a}\left(\omega_1-\frac{c}{a}\right)^2\quad\frac{2}{3}Ic\left(\omega_1-\frac{c}{a}\right)^3e^{-\frac{3a}{I}t_1},$$
$$+\frac{2}{3}Ic\left(\omega_1-\frac{c}{a}\right)^3-\frac{Ic^2}{2a}\left(\omega_1-\frac{c}{a}\right)^2e^{-\frac{2a}{I}t_1}$$
$$+\frac{Ic^2}{2a}\left(\omega_1-\frac{c}{a}\right)^2-\frac{aI}{4}\left(\omega_1-\frac{c}{a}\right)^4e^{-\frac{4a}{I}t_1}+\frac{aI}{4}\left(\omega_1-\frac{c}{a}\right)^4$$

The instantaneous power in time

$$t_2-t_1=T\omega_1+T\left(\frac{(T-T_3)}{I}\right)(t-t_1)$$
$$=T\omega_1+\frac{T^2-TT_3}{I}(t-t_1).$$

(Here t=time from commencement of pass.)

$$W_2{}^2=T^2\omega_1{}^2+2T\frac{(T^2-TT_3)}{I}\omega_1(t-t_1)+\left(\frac{T^2-TT_3}{I}\right)^2\{t^2-2tt_1+t_1{}^2\}$$

$$\int_{t_1}^{t_2}W_2{}^2dt=T^2\omega_1{}^2(t_2-t_1)+\omega_1\frac{2T(T^2-TT_3)}{I}\left[\left(\tfrac{1}{2}t^2-t_1t\right)\right]_{t=t_1}^{t=t_2}$$
$$+\left(\frac{T^2-TT_3}{I}\right)^2\left|\frac{t^3}{3}-t^2t_1+t_1{}^2t\right|_{t=t_1}^{t=t_2}$$
$$=T^2\omega_1{}^2(t_2-t_1)+2T\omega_1\frac{(T^2-TT_3)}{I}[\tfrac{1}{2}t_2{}^2+\tfrac{1}{2}t_1{}^2-t_1t_2]$$
$$+\left(\frac{T^2-TT_3}{I}\right)^2\left[\frac{t_2{}^3}{3}-\frac{t_1{}^3}{3}t_1{}^3-t_2{}^2t_1+t_1{}^2t_2\right].$$

A corresponding expression for the interval t_3-t_2 as this applies, and a similar expression to the first for the last part of the cycle. For example, the speed in the third part of the cycle

$$\omega=\omega_2+\frac{T-T_0}{I}(t-t_2),$$

and inst. power $W_3=T\omega=T\left[\omega_2+\frac{T-T_0}{I}(t-t_2)\right]$,

$$\int_{t_2}^{t_3}W_3dt=T^2\omega_2{}^2(t_3-t_2)+\frac{2T(T-T_0)}{I}\omega_2[\tfrac{1}{2}t_3{}^2+\tfrac{1}{2}t^2{}_2-t_3t_2]$$
$$+\frac{T^2-TT_0}{I}\left[\frac{t_3{}^3}{3}-\frac{t_2{}^3}{3}t_2{}^3-t_3{}^2t_2+t_2{}^2t_3\right].$$

Again, for the last period

$$\omega=f/a+(\omega_2-f/a)e^{-\frac{a}{I}t},$$

and the torque

$$=T_0-a(\omega_2-f/a)e^{-\frac{a}{I}t}.$$

$$\therefore\qquad W_4=T\omega.$$

$$\int_{t_3}^{t_4}W^2{}_4d=\int_{t_3}^{t_4}\left[\left\{T_0-a(\omega_2-f/a)e^{-\frac{a}{I}t}\right\}\left\{f/a+(\omega_2-f/a)e^{-\frac{a}{I}t}\right\}\right]^2dt.$$

It will be noticed that this is the same product on form as for the first period, and the result will be obtained, if in that expression T_0 is interchanged for T_3 and f/a for c/a; ω_2 for ω_1.

The R.M.S. power

$$=\sqrt{\left(\frac{\int_0^{t_1}W_1{}^2dt+\int_{t_1}^{t_2}W_2{}^2dt+\int_{t_2}^{t_3}W_3{}^2dt+\int_{t_3}^{t_4}W_4{}^2dt}{t_4}\right)}.$$

It is simpler in any given case to square the ordinates at each point and find the area with the planimeter. Then find the mean ordinate and take the square root.

The Ward Leonard System.

We will consider next the case of the electric winder operating on the Ward Leonard system with a flywheel provided on the induction motor shaft, and an automatic slip regulator in the rotor circuits.

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Fig. 4 represents the B.H.P.-time diagram for an electric hoist. The speed-time curve is also shown.

It is hardly worth while to calculate the speed between A and the time when the engine comes in, the time is so short, but to make the calculations complete we will attempt to calculate it.

Let W = output at B.

t_1 = period of acceleration in seconds.

The power equation is

$$T\omega - I\frac{d\omega}{dt}\omega = W\frac{t}{t_1}.$$

$$\frac{T}{T_F} = \frac{\omega_0 - \omega}{\omega_0 - \omega_F} \quad \therefore \quad T = \frac{T_F\omega_0}{\omega_0 - \omega_F} - \frac{T_F\omega}{\omega_0 - \omega_F}$$

$$\therefore \quad \frac{T_F\omega\omega_0}{\omega_0 - \omega_F} - \frac{T_F\omega^2}{\omega_0 - \omega_F} - I\frac{d\omega}{dt}\omega = W\frac{t}{t_1}.$$

$$\therefore \quad a_1\omega - a_2\omega^2 - \omega\frac{d\omega}{dt} = c_1 t, \text{ where } c_1 = \frac{W}{It_1}.$$

$$a_1 = \frac{T_F\omega_0}{(\omega_0 - \omega_F)I}; \quad a_2 = \frac{T_F}{I(\omega_0 - \omega_F)}$$

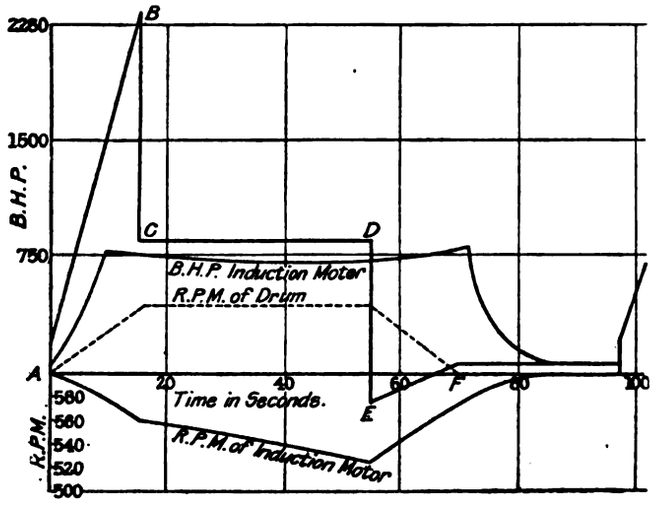

FIG. 4.—WINDING DIAGRAM FOR ILGNER SET.

The solution of this may be obtained approximately as follows :—

Let $\omega = a$ when $t = o$, and let $\omega = ue^{-a_2 t}$, so that $u = a$ when $t = o$.

$$\frac{d\omega}{dt} = \frac{du}{dt}e^{-a_2 t} - a_2 ue^{-a_2 t},$$

$$\omega\frac{d\omega}{dt} = u\frac{du}{dt}e^{-2a_2 t} - a_2 u^2 e^{-2a_2 t}.$$

$$\therefore \quad a_1 ue^{-a_2 t} - a_2 u^2 e^{-2a_2 t} - u\frac{du}{dt}e^{-2a_2 t} + a_2 u^2 e^{-2a_2 t} = c_1 t.$$

$$\therefore \quad a_1 ue^{-a_2 t} - u\frac{du}{dt}e^{-2a_2 t} = c_1 t.$$

$$a_1 ue^{-a_2 t} - c_1 t = u\frac{du}{dt}e^{-2a_2 t},$$

and

$$\frac{du}{dt} = a_1 e^{+a_2 t} - \frac{c_1}{u}e^{+2a_2 t}t.$$

Expand u in a series of Maclaurin

$$u = f(t) = f(o) + tf'(o) + \frac{t^2}{2}f''(o) + \ldots$$

$$f(o) = a.$$

$$f'(t) = \frac{du}{dt} = a_1 e^{a_2 t} - \frac{c_1}{u}e^{2a_2 t} \qquad f'o = a_1.$$

$$f''(t) = a_1 a_2 e^{a_2 t} - \frac{c_1}{u}e^{2a_2 t} - \frac{2a_2 c_1 e^{2a_2 t}t}{u} + \frac{c_1 te^{2a_2 t}}{u^2}\left(a_1 e^{a_2 t} - \frac{c_1}{u}e^{2a_2 t}\right)$$

$$f''(o) = a_1 a_2 - \frac{c_1}{a}.$$

$$\therefore \quad \omega = ue^{-a_2 t}.$$

$$= e^{-a_2 t}\left\{a + a_1 t - \tfrac{1}{2}\left(\frac{c_1}{a} - a_1 a_2\right)t^2 + \ldots\right\}.$$

This expression is not of much use, but it represents the manner in which the speed of the induction motor falls during the accelerating stage of the winding cycle of the direct-current motor.

We must next find the speed and output during the remainder of the cycle for the induction motor.

The power equation is

$$T\omega - I\frac{d\omega}{dt}\omega = Ct.$$

C = rate of increase of power with time on the accelerating part of the curve.

In this part of the cycle, the torque of the motor is constant.

$$\therefore \quad \omega\frac{d\omega}{dt} - \frac{T}{I}\omega + \frac{C}{I}t = o.$$

To solve this, let $\omega = vt$,

then

$$\frac{d\omega}{dt} = t\frac{dv}{dt} + v.$$

The equation may then be written

$$vt^2\frac{dv}{dt} + v^2 t - \frac{T}{I}vt + \frac{C}{I}t = o,$$

$$vt^2\frac{dv}{dt} + t\left(v^2 - \frac{T}{I}v + \frac{C}{I}\right) = o,$$

$$vt\frac{dv}{dt} + \left(v^2 - \frac{T}{I}v + \frac{C}{I}\right) = o.$$

$$-\frac{vdv}{v^2 - \frac{T}{I}v + \frac{C}{I}} = \frac{dt}{t}.$$

Let

$$\frac{T}{I} = b \text{ and } \frac{C}{I} = d.$$

$$\int\frac{dt}{t} = -\int\frac{vdv}{v^2 - \frac{T}{I}v + \frac{C}{I}} = -\int\frac{vdv}{v^2 - bv + d}.$$

$$\int\frac{dt}{t} = -\tfrac{1}{2}\int\frac{(2v-b)dv}{v^2 - bv + d} - \frac{b}{2}\int\frac{dv}{v^2 - bv + d}$$

$$\therefore \quad \log_e t = -\tfrac{1}{2}\log(v^2 - bv + d) - \frac{b}{2}\int\frac{dv}{v^2 - bv + d} + K.$$

$\int\frac{dv}{v^2 - bv + d}$ depends on when $b^2 \gtreqless 4d$, *i.e.*, $\frac{T^2}{I^2} \gtreqless 4\frac{C}{I}$, obviously $b^2 > 4d$.

For

$$C = \frac{T\omega}{t} - \frac{I}{t}\frac{d\omega}{dt}\omega$$

$$\therefore \quad \frac{C}{I} = \frac{T}{I}\frac{\omega}{t} - \frac{\omega}{t}\frac{d\omega}{dt}$$

$$\frac{T^2}{I^2} \gtreqless 4\frac{T\omega}{It} - \frac{4\omega}{t}\frac{d\omega}{dt},$$

but the torque given by the flywheel is usually greater than the torque of the motor, i.e., $I\frac{d\omega}{dt} > T$,

i.e.,

$$\frac{d\omega}{dt} > \frac{T}{I} = m\frac{T}{I}$$

$$\therefore \quad \frac{T^2}{I^2} + 4m\frac{T}{I}\frac{\omega}{t} \gtreqless 4\frac{T\omega}{It}. \qquad \therefore \quad \frac{T^2}{I^2} > \frac{4C}{I}.$$

$$\int\frac{dv}{v^2 - bv + d} = \int\frac{dv}{(v - \frac{1}{2}b)^2 - (\frac{1}{4}b^2 - d)}$$

$$= -\frac{1}{\sqrt{\frac{1}{4}b^2 - d}}\coth^{-1}\frac{v - \frac{1}{2}b}{\sqrt{\frac{1}{4}b^2 - d}}.$$

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$$\therefore \quad \frac{b}{2}\int\frac{dv}{v^2-bv+d}=-\frac{b}{2\sqrt{\tfrac{1}{4}b^2-d}}\coth^{-1}\frac{v-\tfrac{1}{2}b}{\sqrt{\tfrac{1}{4}b^2-d}}.$$

$$\therefore \quad \log_e t=-\tfrac{1}{2}\log(v^2-bv+d)-\frac{b}{2\sqrt{\tfrac{1}{4}b^2-d}}\coth^{-1}\frac{v-\tfrac{1}{2}b}{\sqrt{\tfrac{1}{4}b^2-d}}+K,$$

where K = constant of integration.

When $t=t_1$ the time when the regulator comes in, $\omega=\omega_1$.

$$\therefore \log t_1=-\tfrac{1}{2}\log\left(\frac{\omega_1^2}{t_1^2}-\frac{b\omega_1}{t_1}+d\right)-\frac{b}{2\sqrt{\tfrac{1}{4}b^2-d}}\coth^{-1}\frac{\omega_1-\tfrac{1}{2}b}{t_1\sqrt{\tfrac{1}{4}b^2-d}}+K.$$

$$\therefore \quad K=\log t_1+\tfrac{1}{2}\log\left(\frac{\omega_1^2}{t_1^2}-\frac{b\omega_1}{t_1}+d\right)+\frac{b}{\sqrt{\tfrac{1}{4}b^2-d}}\coth^{-1}\frac{\omega_1-\tfrac{1}{2}b}{t_1\sqrt{\tfrac{1}{4}b^2-d}}$$

$$\therefore \quad \log\frac{t}{t_1}=\tfrac{1}{2}\log_e\left(\frac{\dfrac{\omega_1^2}{t_1^2}-\dfrac{b\omega_1}{t_1}+d}{\dfrac{\omega^2}{t^2}-\dfrac{b\omega}{t}+d}\right)+$$

$$\frac{b}{\sqrt{\tfrac{1}{4}b^2-d}}\coth^{-1}\frac{\omega_1-\tfrac{1}{2}b}{t_1\sqrt{\tfrac{1}{4}b^2-d}}-\frac{b}{\sqrt{\tfrac{1}{4}b^2-d}}\coth^{-1}\frac{\omega-\tfrac{1}{2}b}{t\sqrt{\tfrac{1}{4}b^2-d}}.$$

Neglecting the second term, which does not usually affect the result sensibly,

we have $$\frac{t}{t_1}=\left(\frac{\dfrac{\omega_1^2}{t_1^2}-\dfrac{b\omega_1}{t_1}+d}{\dfrac{\omega^2}{t^2}-\dfrac{b\omega}{t}+d}\right)^{\frac{1}{2}}$$

$$\therefore \quad \frac{t^2}{t_1^2}=\frac{\dfrac{\omega_1^2}{t_1^2}-\dfrac{b\omega_1}{t_1}+d}{\dfrac{\omega^2}{t^2}-\dfrac{b\omega}{t}+d}$$

$$\therefore \quad \omega^2-b\omega t+t^2d-\omega_1^2+b\omega_1t_1+t_1^2d=0.$$

$$\therefore \quad \omega=\frac{bt\pm\sqrt{b^2t^2-4(t^2d-\omega_1^2+b\omega_1t_1+t_1^2d}}{2}$$

$$\therefore \quad \omega=\frac{\dfrac{Tt}{I}\pm t\sqrt{\dfrac{T^2}{I^2}-4\left\{\dfrac{C}{I}-\dfrac{\omega_1^2}{t^2}+\dfrac{T\omega_1t_1}{It^2}+\dfrac{t_1^2C}{t^2I}\right\}}}{2}.$$

This equation holds up to the peak. The output is constant from C to D, and our equation becomes

$$T\omega-I\frac{d\omega}{dt}\omega=E,$$

where E = constant output.

This equation is exactly similar to equation (15) and is solved in the same way.

Safety Devices for Electric Cranes.*

By C. RITZ.

The regulations of the German Electrical Engineers' Union state that it is possible to allow an occasional overload on conductors that supply an intermittent demand, but that no greater heating must result than would arise from the steady normal load. It is further stated that the fuses must correspond to the working current and yet must not be of greater carrying capacity than those which are suitable for the steady load. With intermittent loads there is a tendency to choose conductors which are not of sufficient size to carry the surge curents permanently, *i.e.*, to disregard the rush of current at the start: fuses must, therefore, be chosen to carry such current, and this does not seem to be allowed by the regulations. This rise of temperature ought not to exceed the permissible value. This happens approximately when the quadratic mean value of the whole current does not exceed the value of the permissible steady current. In a typical case, considered as representing average conditions, the quadratic mean value of the whole current works out as being 0·82 of the steady current, and in such a case the conductor will be of ample size. (It must be understood that in calculating this quadratic mean value, the interval of repose is taken into account.) The regulations would seem to prescribe that the fuses should correspond to 0·82 times the normal current. But in this case, how are they to carry the rush of current, which would probably be 2·5 times as great as the quadratic mean value? In such a case, there is a tendency to use fuses that are too heavy. In installations in which continuity of service is of importance, the matter of fuses must be taken cautiously in hand. The expenditure on fuses in these cases becomes serious, and some substitute for fuses has to be found, which usually takes the form of an overload relay, a device employed for many years in maximum cut-outs. The relay must be in a position to act as soon as the recurring overload begins, but there must be an interval before it effects the cut-out: this interval must be longer than the period during which the normal overload lasts at the moment of starting. This momentary overload does not cause an excessive heating of the cables beyond that allowed for in the design of the installation: it is rather when current rushes of the nature of a short-circuit take place that the release must be effected. The relay should have a double property: it should act only slowly in case the normal overload lasts over too long a period, but it should also act suddenly in an emergency, if there should be a rush of current, several times that corresponding to the normal overload.

The device employed by Siemens Schuckert works is shown in the diagram, and consists of a relay with a rotary armature. The force of attraction, acting on this armature, is counterbalanced by a spring f. If the relay is about to act, the arm S, attached to the armature

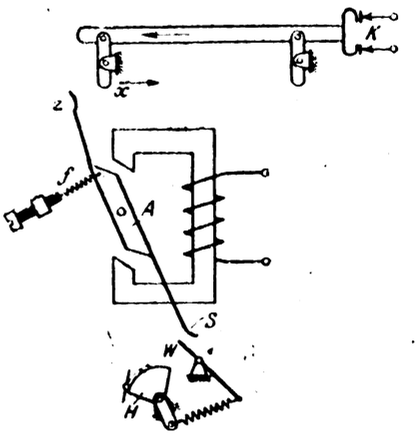

DIAGRAM SHOWING THE DESIGN OF THE SIEMENS-SCHUCKERT CUT-OUT.

A, strikes against H, which tends to check its movement, and which is constructed like an ordinary watch. This checking movement prevents the further motion of S, which, however, resumes its movement as soon as a pawl is lifted inside the watch. The arm which lifts the pawl can be rotated by turning the case of the watch, and in this way the time of action can be regulated. A scale is provided which shows the amount of the adjustment. If the armature is finally released, the piece z strikes against x and causes the contact k to open. The instantaneous cut-out with heavy current rushes is caused as follows. The contact piece on W is of the nature of a spring: in the case of heavy current rushes, the tip of this spring is bent to such an extent that S slides past and effects the cut-out at once. At the end of the operation the spring f pulls the various parts into their normal positions. A regulating screw adjusts the power of the spring f, and thus the apparatus is calibrated to cut out at any desired current.

If a crane is driven by several motors a relay is provided for each motor; all the relays are mounted in a single box, and act on the same contact.

* Abstract of an article in the "Elektrotechnische Zeitschrift," Heft 46, 1917.

Books Received.

[Copy of the undermentioned work can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"Wireless Telegraphy and Telephony" (second edition, revised and enlarged), by W. H. Eccles, D.Sc., A.R.C.S., M.I.E.E. (London: Benn Brothers, Ltd.) Pp. xx.+514. Price 22s.

"Manual of Wireless Telegraphy and Telephony for Naval Electricians." (4th revised edition.) By Capt. S. S. Robison, U.S. Navy. (Revised by Capt. D. W. Todd and Lieut.-Comm. Hooper, U.S. Navy.) (London: S. Rentell & Co., Ltd.) Price 8s. 6d. net.

"Telegraphy, Aeronautics and the War." By C. Bright, F.R.S.E. (London: Constable & Co.) Pp. xi.+407. 16s. net.

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Contract Prices.

A subject which is exercising the minds of those who are looking forward and who have to deal with engineering jobs is that of contract prices during the period of reconstruction—*i.e.*, during the period when the price of material and rates for labour may be varying somewhat rapidly. Attention was drawn to the subject recently in an interesting Paper read by Capt. W. P. Digby before the Institution of Electrical Engineers, and followed by a discussion, of which we give an abstract in our present issue. In this Paper reference was made to previous abnormal periods, such as that of 1872–1875, following the Franco-Prussian War. Although conclusions cannot now be safely drawn from these periods, owing to the fact that the present disturbance has been so very much longer and so very much greater, yet it is interesting to note that after 1871 foodstuffs did not revert to their pre-war value until four years after the close of hostilities, that wages in neutral countries took three to seven years to revert to their old values, that wages in the defeated country remained below those in the victorious country until 1876, and that wages rose both in the belligerent and neutral countries after the close of hostilities. We do not doubt that somewhat similar effects will be experienced after the present war, though we doubt if wages will show a tendency to rise. They have reached such an abnormally high figure during the war that we can scarcely expect them to rise still higher when labour is released from the Army.

Whatever the position may be, there certainly will be no steady values, and this will render the quoting of prices for tenders a very difficult matter. In order to overcome this difficulty Capt. Digby proposes that a sliding scale should be adopted, depending on the prices of certain materials and the prevailing rates of wages. In the discussion suggestions were made that some such rate as 1½ per cent. variation in the contract value should be made for each shilling per week by which the rate of labour is increased by authorisation of the Government, and that an average figure might be taken for labour generally, instead of taking the wages paid to each of the grades. There is a good deal to be said in favour of the latter suggestion, as it is difficult to say just to what extent the various grades of labour enter into a large job. The view was also expressed that any such method of tendering should be made obligatory, and not left to be optional, because the purchaser naturally prefers a fixed price, and, therefore, if certain firms quoted fixed prices and others quoted on a sliding scale, the latter would fail to secure the contract. We are inclined to doubt this view. It must be remembered that under war conditions prices have been rising, and therefore have always been against the manufacturer. The tendency has been for the purchaser to be the gainer. So much has this been the case that purchasers have been willing to meet the manufacturer in many cases so as to make good an unjustifiable loss. During the reconstruction period prices will tend to fall, so that if a fixed price is quoted the advantage, if any, will be to the manufacturer. It appears to us that the purchaser will probably see the advantage of a sliding scale contract.

There are, of course, certain difficulties in working on a basis of this kind. For example, from when should the variation take effect? We think it is most reasonable that variations should take effect from the date of the tender. Between this date and the actual date of getting to work there may elapse a very considerable interval. There must inevitably be delay between the receipt of the tender and its acceptance, and after this some time must be spent in the preparation of drawings, and possibly in the provision of tools. In reconstruction days, however, even this will not necessarily bring us to the time when work may be commenced. There will certainly be a rationing of material, and on that account we may expect priority certificates to be in force for the materials to be used. There may be delay in obtaining a priority certificate, and even when this has been obtained there yet remains the obtaining of the material itself. It follows, therefore, that a considerable interval may elapse between the delivery of the tender and the actual commencement of work. If the work is extensive, it may run over a year or two years, or even more, during which time there will be a continual variation of prices.

There is the further question of stocks. If a manufacturer secures stocks of material, and the material then rises in price, he gains an advantage over the manufacturer who has to use material purchased at a later date. On the other hand, if the manufacturer purchases stocks on a falling market he purchases to his disadvantage. This point has already been considered by a Government Committee. It appears to us that the manufacturer should be free to quote including material from his stocks, or material which may be purchased when required at market prices, whichever is most acceptable to him.

There are, no doubt, many details which would require working out before a sliding scale could be adopted which would work smoothly. We think, however, it is certainly desirable that an attempt should be made to work on these lines; otherwise the manufacturers of this country may lay themselves open to tendering for work on prices which are too high, and thus put themselves at a disadvantage with manufacturers in enemy countries, where labour will probably be paid at lower rates than in Great Britain.

Review.

A Text-Book of Physics for the Use of Students of Science and Engineering. By J. Duncan, Wh.Ex. M.I.Mech.E. and S. G. Starling, B.Sc., A.R.C.Sc. (London: Macmillan & Co.) Pp. xxiii.+1081. Price 15s. (also issued in separate parts).

The range of treatment is adapted to suit students in the intermediate stage, being such (to quote from the author's preface) as to cover the standard of the Intermediate Examinations of London University and Grade I. of the examination in Electrical Engineering by the City and Guilds of London Institute. A special feature of the book is that it is written to meet the requirements both of those interested in the purely scientific aspects of physics and of those whose aim is to fit themselves for an engineering profession. The reasonableness of such an undertaking will readily be admitted; nor is it difficult to concede that the authors of the present work have attained a considerable measure of success in negotiating their task. Pure science divorced from its large practical application is shorn of vitality; practical knowledge has its claims upon us which cannot be ignored without penalty. So, too, the prosecution of engineering practice without due study of the laws of physics is a cutting off of ourselves, in large measure, from the fountains of inspiration. This observation might be merely tedious did not one recollect the notorious tendency of the practical man to despise theory.

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The fact is that the acquirement by the same person of a wide and sound knowledge of both practice and theory is a very difficult and rare one; and, perhaps, the practical man's affected distrust for theory is merely a sort of moral camouflage.

Limitations of space must inevitably present difficulties in writing a book of this compound type. It appears a sound rule to lay down that applications of wide use should be included, even though their scientific basis should be intrinsically difficult to treat, and such as in a purely scientific treatise would be relegated to a more advanced stage in the student's course. This principle is generally satisfied in the present book. The only exception we can recall is in the omission of a chapter on wireless telegraphy.

The book is divided into five parts, dealing respectively with Dynamics (pp. 309), Heat (pp. 223), Light (pp. 126), Sound (pp. 104), Magnetism and Electricity (pp. 273). The large proportion of space allotted to dynamics is in our opinion a safe and wise measure. The student too often fails to appreciate the importance of the function of this subject as a gateway to all the physical sciences. This part is admirably done. We may note the inclusion of Bow's notation, the link polygon, pressure energy in liquids and Bernouilli's theorem, and loaded governors.

Under the heading of Heat are excellent chapters on fuel and fuel calorimetry, and on steam engines and internal combustion engines.

In the part on Light will be found accounts of instruments and devices sach as erecting prisms, immersion objectives, the constant deviation reflecting prism, prism binoculars, and range-finders, the inclusion of which heightens considerably the value of the book. The Pulfrich refractometer might perhaps have found a place too.

The part devoted to Sound strikes one as rather less closely related to engineering problems than it might be. Reference might have been made to a number of matters such, for example, as the critical speeds of running machinery.

The last part is that on Magnetism and Electricity. The treatment is in general most commendable, though exception may be taken in respect of a few points. The distinction between iron and steel is not so absolute as might be gathered from p. 822. Mild steel, so important in dynamo construction, does not differ very greatly in magnetic properties from the best soft iron. The omission of mild steel from the curves in Fig. 763 is a defect. In the chapter on thermo-electricity it is wrongly stated that all couples obey the parabolic law of variation of E.M.F. with temperature; but this is not true for a couple like that of platinum to platinum-rhodium, so widely used in thermo-electric pyrometry. The chapter on the dynamo and motor falls below the general high level of the book, and should be revised and brought up to date in a future edition.

The book is amply illustrated and stocked with examples; and a large number of experiments, 223 in all, are described with satisfactory detail, many being suitable for work in the laboratory. It is very free from misprints (we may note one on page 1035, where the wave-length of violet light is given as $0{\cdot}4 \times 10^{-5}$ cm.).

We have no doubt that this treatise will prove of the greatest help to students of either of the types indicated in the title page.

D. Owen.

Automatic Telephones at Australia House, London.

In addition to the Post Office instruments, a system of automatic telephones for inter-office communication has been installed at Australia House, London, the new home of the Commonwealth Government, which was officially declared open by His Majesty the King on Saturday last, August 3rd.

The equipment of the automatic exchange, which has been working for over 12 months, is for 80 lines, but the racks fitted provide for 200. At present 74 telephones are in use That such installations are valuable labour-savers may be gauged from the fact that these 74 telephones make nearly 600 calls per day.

The automatic exchange is located in a small room on the fourth floor, from which eleven 10-pair lead-covered cables radiate to eight distribution boxes fitted in convenient parts of the building. From these distribution boxes a twin lead-covered cable is run to each telephone. The cables and the office wiring are of 10-pair conductors, enamelled, cotton covered and waxed and lead covered. In cabling, use is made generally of the ventilation ducts over the corridors, and of two ventilation shafts, one on the Strand side and the other on the Aldwych side of the building. Ample provision is made in the cables to the distribution boxes for future growth, the single pair cables being run as new telephones are fitted. This arrangement gives great flexibility, and especially facilitates the removals which take place in large office blocks, owing to rearrangements of staff with the growth of the business. In such cases an official can retain his original telephone number, which is a great convenience. In some cases, where two officials share a room, but where the traffic does not warrant two lines being run, instruments are fitted in parallel in order that either can use the telephone without leaving his desk.

The system which has been installed is unusually interesting from the fact that all the operations of number selecting and connecting, ringing and disconnecting are performed by simple telephone relays of the same kind as those employed in ordinary manual telephone exchanges. A relay also is a device with which every telephone engineer is familiar. No electro-mechanical switches, usually essential to an automatic telephone system, are employed. The maintenance charges of such apparatus are claimed to be low, because mechanical wear and tear has been reduced to a minimum. The relay armatures work on a substantial knife edge, and have a movement of less than 1/32 of an inch. The relays require no oiling or cleaning.

The requisite energy for talking, signalling and operating the relays is obtained from a 24-volt battery of accumulators, fitted in duplicate to enable one set to be used whilst the other is under charge from the electric supply main.

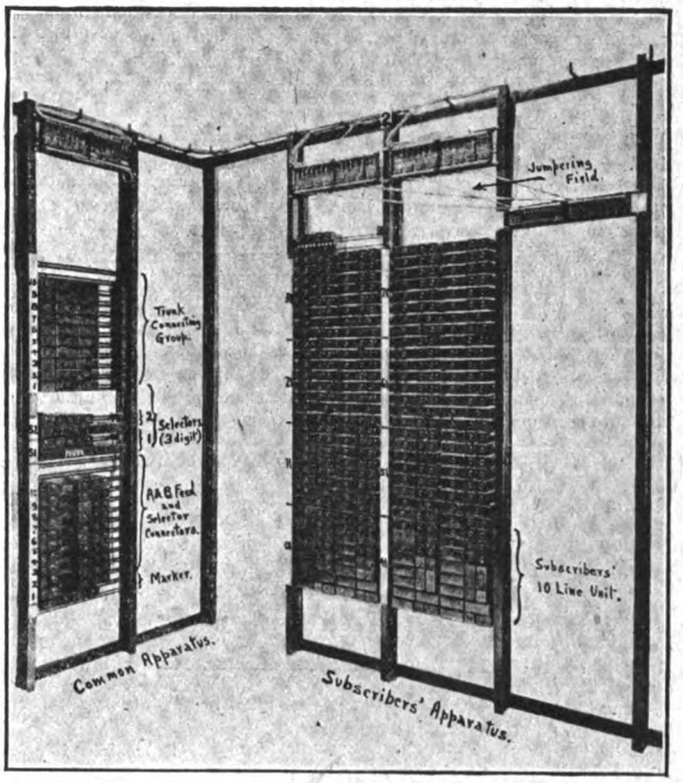

Fig. 1.—General View of Relay Automatic Telephone Installation.

The telephones in use are of three patterns: Standard desk set, desk set with hand combination and wall set. Fitted to each instrument is a dial, by the manipulation of which connection may be had

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with any other number on the system. The method of operation is as follows :—

To call number "64," for example. The caller will first remove his telephone from the rest, place the tip of his finger into the hole through which "6" can be seen, and pull the circular plate round until his finger strikes the stop. The finger is then removed, when a spring returns the circular plate to its normal position. A similar operation is performed for the second digit, except that in this case the finger tip would be placed in the hole opposite "4." Should there be a third digit to the required number, the operation would be again repeated in a similar manner If the wanted number be "engaged," an intermittent buzzing sound would be heard in the telephone The caller should then replace his telephone on its rest for a few moments and call again.

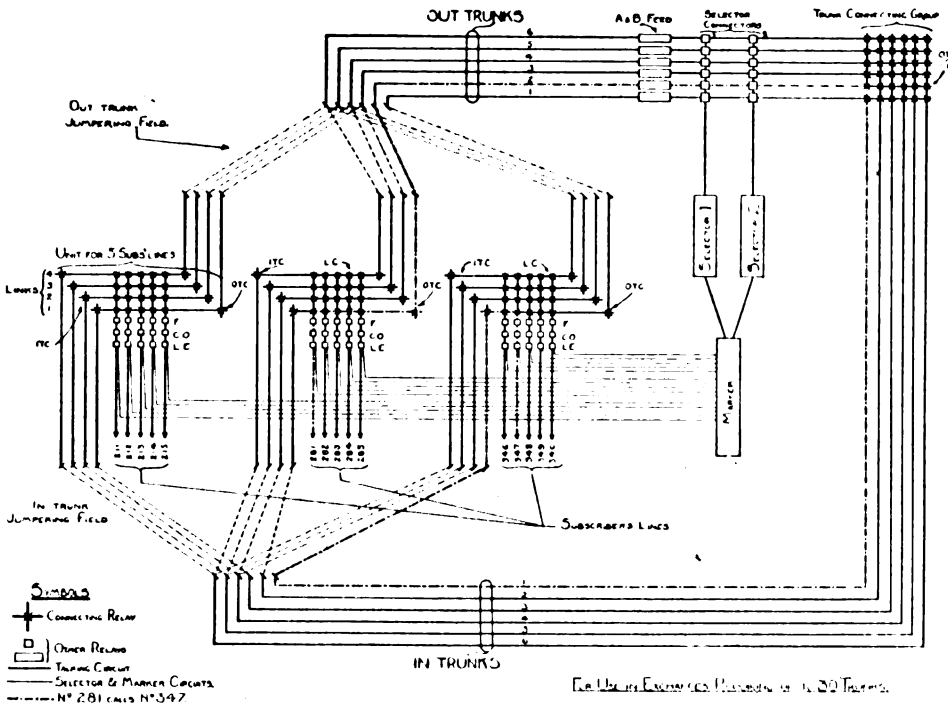

Fig. 2.—Schematic Diagram of Single Stage (3 digit) Exchange without Trunk Links.

Fig. 1 shows a general view of the plant at Australia House. Unit construction is employed, the relays being mounted and wired in groups. This arrangement certainly simplifies the installing of the apparatus and facilitates extension by units of 10 lines without interfering with the existing equipment.

Fig. 2 shows a schematic diagram of the trunking principle.

Primarily the subscribers are divided into five-line groups, each having access to a number of links which are common to both outgoing and incoming calls. In practice two five-line groups are assembled on a common frame to form a 10-line unit.

It is interesting to note that the selecting apparatus commences operating before any calling impulses are sent. We will suppose that subscriber No. 281 calls subscriber No. 347. When the calling subscriber takes his receiver off the hook, the line relay *LE*, associated with his line, closes a circuit, resulting in the first available connecting relay *LC* energising and connecting the calling station No. 281 to, say, link 1, which it is assumed is disengaged, while at the same time the connecting relay *OTC* is energised and connects link 1 to OUT, trunk 2. A relay *A* at the *A* and *B* feed of OUT trunk 2 now energises also cut-off relay *CO* of No. 281, which releases the line relay *LE*. No. 281 would now proceed to dial for No. 347. When the dial plate is released for the hundreds impulse, OUT trunk 2 will at the first impulse obtain exclusive connection with selector 1, if it is disengaged, via selector connector 1. The dialling of the three digits will set a train of impulse relays in the selector which act as intermediaries to energise particular relays for the required hundred, ten and unit, and, in conjunction with a group of relays, call the marker, establish a marking circuit, particular to No. 347, terminating on the *LC* relays of that line.

As a result, the *LC* relay on the first idle link—say No. 1—in the the five-line unit, which includes No. 347, will energise, also the associated *ITC* relay, thus connecting No. 347 to link 1, and link 1 to IN, trunk 1. At the same time, connecting relay *OT-IT* in the trunk-connecting group will energise and connect OUT, trunk 2, to IN, trunk 1, completing the connection between Nos. 281 and 347 When the connecting relays have energised, the selector connector No. 1 on OUT, trunk 2, de-energises and releases the selector and marker for other calls At the *A* and *B* feed, ringing is then connected to the called line and is cut off immediately the called subscriber answers. The two subscribers are connected by a "Stone" system transmission circuit.

The connection is released by the opening of the holding circuit of the connecting relays when the calling subscriber hangs up his receiver. If, however, the called subscriber hangs up first, the connection will be released, after a delay of approximately one minute, providing that the caller has not cleared in the meanwhile.

It is understood that this delayed release by the called subscriber is provided where the plant is unattended, and that a back release alarm can be fitted instead if required. If the wanted number is engaged, the selector and marker release and busy-back are connected to the calling line at the *A* and *B* feed. A thermostatic timing device is fitted to each OUT trunk to notify faults or errors in dialling and to restore the relays to normal under abnormal conditions. Provision is made at the selectors to render ineffective accidental impulses sent by the subscribers' switch hook

A feature of the system is that for this particular installation of 200 (maximum) stations, only two selectors are used As an example, with the present stations (80), during one week, the recording meters showed that one selector dealt with 2,643 calls and the other with 16 calls. It is also interesting to note that the selectors are cut out of the speaking circuit as soon as connection between subscribers is made.

The installation has been supplied and fitted by the Relay Automatic Telephone Co. (Ltd.), Marconi House, Strand, London, W.C., to whom we are indebted for the foregoing description and illustrations.

The "Embargo" Strike.

BY A LABOUR CORRESPONDENT.

There is no truer statement than that one-half of the world does not know how the other half lives. Particularly is this true in the world of industry. If workpeople fail to appreciate the value of the services the employer renders to the community and the difficulties and worries of his position, it is equally true that employers are unacquainted with the problems and difficulties, the outlook and ideas of the workers. And though it would be too much to hope that I shall succeed in bringing employers to agree with the workers' point of view, it may be possible to assist them to an understanding of the workers' position.

The recent "embargo" strike may be taken as an illustration of the ignorance which prevails as to the attitude of the skilled workers. I am not concerned to defend the strikers in Coventry and Birmingham, but it is worth while trying to show that there was more in the strike than met the eye. It will be remembered that a year or so ago the Government abolished "leaving certificates." There followed upon this a good deal of "poaching" by employers for skilled workmen. Hence the policy of the "embargo," under which arrangement skilled labour was to be "rationed." This decree was put into operation apparently without the knowledge of the workpeople. At the time of the Coventry outbreak it had been applied to about 100 firms. But the workmen did not know that; they were ignorant as to how far these secret instructions extended. They suspected that universal application was intended, and for some subtle intent or motives injurious to their interest. The "embargo" was applied to three firms in Coventry, and an unfortunately worded notice put up in one of these shops was the first the men had heard of the scheme. The demand of the men was for the withdrawal of the "embargo" not as a final measure, but in order that the whole question should be discussed by those affected.

The prior blame attaches, not to the men, but to the Ministry of

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Munitions, for taking action without even going to the trouble of consulting the workpeople whose labour they were going to ration. Employers will fully appreciate the feelings of the men against action being taken over their heads and without their advice and co-operation being sought. It is generally assumed that the Ministry had invited co-operation, but its own published statement makes the position clear enough. The Trade Union Advisory Committee (consisting of trade union officials) "had the scheme fully explained to them this spring. They were not asked to agree to or to approve of the scheme. The Ministry expressly stated that the responsibility was the Government's."

It will be agreed that this high-handed method of dealing with difficult industrial questions does not conduce to smooth working in the munition shops. When we bear in mind that as the war has proceeded the position of the skilled craftsmen has been steadily undermined and his future jeopardised, when we remember that promises have been made which have not been fulfilled, as, for example, the promise a year ago to amend the Munitions of War Acts so as to give statutory sanction to the pledge for the restoration of trade union customs, it is not surprising that suspicion and irritation exist and that the embargo policy, accidentally coming to light in Coventry, led to trouble

This mistrust is widespread. It is by no means confined to a few extremists, but is shared by a large body of workers of moderate views. The roots of this feeling lie in the methods of the Ministry of Munitions. So far as the recent strike was concerned the need for utilising skilled labour to the fullest extent was not really in dispute. The fundamental point at issue was the way in which the scheme was carried through.

What is the solution of these difficulties? The men themselves have supplied the answer. They do not suggest anything with which the most sober-minded person could not agree. During the dispute the Birmingham and District Joint Committee of Engineering Trade Unions issued a statement, one passage of which contains a solution: "The whole difficulty can be overcome by the Ministry raising the embargo for a few days and at once setting up a Committee composed of an equal number of representatives from the Birmingham and District Engineering Employers' Association, the skilled trade unions, and, if they so wish, the local representative of the Ministry, who shall see that the available skilled labour is being fairly apportioned amongst the firms, having regard to the urgency of their contracts, and that any surplus, should any be available, is used to the best advantage" Briefly, the men suggest that these questions should be left to local joint bodies of the employers and employed affected. Had this democratic method of treatment been adopted as the regular procedure many of the industrial troubles of the war would never have arisen. Until the workers are given an opportunity of taking part in determining the conditions under which they work, unrest will remain. The proposals of the Birmingham men for decentralisation and joint working in the district, it will be noted, are in the spirit of the Whitley Report.

Electrically-Welded Ships.

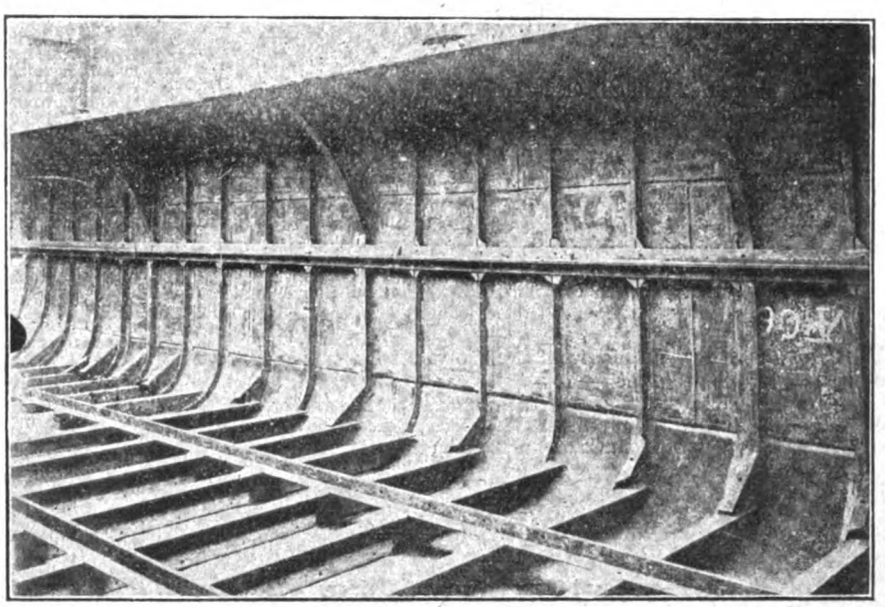
Particulars are now available of the interesting—and completely successful—experiment in rivetless shipbuilding, carried out at a yard on the south-east coast. The first steel vessel constructed entirely without rivets was recently launched in the presence of Lord Pirrie, the Controller-General of Merchant Shipbuilding, and other representatives of the Admiralty and the War Office. She has since been in service with full cargo during exceptionally rough weather, answering satisfactorily in every way to the severe tests imposed.

The object of the experiment, to which considerable importance was attached by shipbuilding authorities, was to prove the ability of welded construction to withstand the strains peculiar to a ship at sea. This principle having been established, it is not proposed altogether to dispense with riveting, which in certain sections is cheaper and quicker than welding; it is intended, however, that future vessels should be a combination of riveting and welding. The United States Shipping Board, for instance, having been in close touch with the **experimental work, are making arrangements for the construction of a number of 10,000 ton standard ships, in which the use of rivets will be reduced to 2½ per cent. of the number originally required.**

The recent progress achieved in electric welding by means of the flux-coated metal electrode process, and its successful use at Admiralty dockyards and elsewhere in the construction of fitments and superstructures of various vessels led to permission being obtained for the erection of a standard barge, with riveting eliminated and electric welding substituted throughout. Such a craft, it will be observed, is exposed to considerable rough usage in dock, besides being subjected to severe towing strains. In order to utilise material already available on site, this barge differs in no way from the standard riveted type with lapped joints, excepting that the hull plates were arranged for clinker build and plate edges joggled to permit horizontal downward welding in order to reduce the amount of overhead work, which is more difficult of execution.

The vessel to be welded was 125 ft. between perpendiculars and 16 ft. beam, with a displacement of 275 tons. The hull was rectangular in section amidships, with only the bilge plates curved. It was built up of 71 transverse frames, and contained three bulkheads, those fitted fore and aft being watertight and the one amidships non-watertight. The shell plating was $\frac{1}{4}$ in. and $\frac{5}{16}$ in. All joints were lapped in the manner described.

Curiously, the first day's work was poor, though all the operators were first-rate men, with extensive experience of electric welding in the shops and minor repairs and structural work at shipyards This



Interior View of Electric Welded Vessel Showing Attachment of Side and Bilge Plates and Longitudinal Stringers to Transverse Frames.

was probably due to the novelty of the undertaking and to the position—lying flat on the keel—which they had to adopt to get to the joints. In a few days, when they became accustomed to the job, the speed and quality of the work improved to equal workshop standard practice. With the more difficult welding, such as the vertical butt joints on each shell plating, and overhead work underneath the keel and on bilge plates, it was noted that the quality of the welds was excellent. For this overhead work special electrodes were employed and proved well worth the slightly increased cost. All watertight joints up to and including the underside of bilge plates were continuously welded both inside and outside, the other watertight joints being welded continuously on one side and tack welded on the other. On the shell plating, the continuous welding was on the outside in all cases.

For internal non-watertight joints and frame construction tack welding was adopted, the length of welding being carefully calculated to give a margin of strength over a similar riveted joint.

Taking all positions of work into consideration, the average speed was 4 ft. an hour at the commencement, while towards the end of the work an average of 7 ft. an hour was easily obtained.

Some interesting details are provided of the comparative cost of the electric welded and riveted barge. In labour, 245 man-hours were saved in construction, which can easily be improved on in future work. More than 1,000 lb. of metal was saved owing to the absence of rivets, but greater economy will result when the design is

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modified to suit electric welded ship construction. The total cost of welding was £301, detailed as under :—

Electrodes	£178
Electric current	61
Men's time	62
	£301

It is realised by the Admiralty experts that the proportion of cost for electrodes is high, but this is mainly due to the present limited demand. Demand and competition will have the usual effect, and should reduce the cost of this item by at least 60 per cent. It will then be possible to build a vessel of this size with an estimated saving of from 25 to 40 per cent. of time and about 10 per cent. of material.

It is interesting to add that, as a result of this demonstration, the yard has prepared a new design of barge, in which it is proposed to incorporate electric welding and riveted construction to the following extent :—

To be welded.	*To be riveted.*
Coamings.	Floor riveted to frames.
Shell seams to frames.	Beam knees to frames and beams.
Deck butts to beams.	Frames clear of shell seams.
Bulkheads (including boundary bars).	
Keel plate butts to be welded overlaps.	
After shell seams welded.	

Parliamentary Intelligence.

The Fuel and Lighting Order.—In reply to a question, the President of the Board of Trade (Sir Albert Stanley) stated in the House of Commons on Monday that a short form of the Household Fuel and Lighting Order had been printed.

The short form would embody the chief points of the Order in which consumers are interested, and was being circulated to coal merchants and gas and electricity undertakings throughout the country. Inasmuch as consumers would have to approach those three sources of fuel and lighting supply for their application and requisition forms, it had been decided that that was the best method of distributing the notice to consumers.

Royal Assent.—On 30th ult. the Royal Assent was read to the following Acts of Parliament :—

Expiring Laws Continuance, Electric Lighting Orders Confirmation, Aldershot Gas, Water & District Lighting, Morecambe Corporation, Londonderry Corporation, County of London Electric Supply Co.

Legal Intelligence.

Stoke-on-Trent Corporation v. S. Triner.

At the recent Staffordshire Assizes, plaintiff Corporation sought to recover from defendant £182 damage done to a weighbridge and an electrical converter rotor in November, 1916.

It appeared that Mr. Cuthbertson, resident engineer at Stoke station, wanted the machine repaired, and asked defendant for an estimate for its removal from the works to the railway station. Defendant undertook to remove the machine, and discussed the way in which it should be taken out with Mr. Cuthbertson. The latter said that the Corporation would take full responsibility until the machine was properly loaded, after which the responsibility would fall upon defendant. Defendant agreed to remove the machine for £3. 10s., but on one route the wheels of his tractor sank in a cable trench. Next day defendant decided to proceed by the weighbridge road. On one side of the weighbridge was a space of 5 ft., but the driver of the tractor seemed to turn on the other side near the weigh-house. The platform of the weighbridge was broken in, and the off wheels of the tractor went into the pit. The converter-rotor was also damaged. The actual cost of repairs was £182, and the Corporation alleged that defendant was negligent in driving over a weighbridge which he knew had only a capacity of 5 tons ; that if he was right in driving over it, he was negligent in driving over it in such a way as to put more weight on the weighbridge than he need have done : that if he had to drive over the weighbridge at all, he should have protected it by putting timber over it so as to avoid damage to it ; and, further, that defendant had an alternative road by which he would have avoided the weighbridge altogether. Defendant pleaded that whatever he did was done under the direction or with the knowledge of Mr. Cuthbertson, and that with regard to putting timber or some other protection on the weighbridge, it was the duty of the Corporation to do that.

After hearing the evidence on both sides, Mr. Justice Lawrence gave judgment for defendant, and said he could not say it was negligence to choose the one road rather than the other, seeing that Mr. Cuthbertson agreed that if the two off wheels of the tractor were the only wheels to pass over the weighbridge all would be well. On the other hand, he warned defendant about the existence of the electric cables on the "scrap" way. It seemed to him quite reasonable for defendant to say, "Well, I am not going to run the risk of damaging those cables." It was impossible for him to proceed by the weighbridge way without some part of the tractor going over the weighbridge. He could not hold that it was negligence on defendant's part ; he did the very best he could, and therefore he gave judgment for him with costs.

Re A.E.G. Electric Co. (Ltd.)—Mr. Justice Younger has adjourned the petition by the Board of Trade to wind up under the Trading with the Enemy (Amendment) Act, 1916, the A.E.G. Electric Co. (Ltd.) until the first petition day of next sittings ; but the Board of Trade may renew the application for an Order during the Long Vacation.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 Specifications.

104,161 Morrison. Variable speed and reversing gearing. (14/2/1916.)
107,591 Soulat. Speedometers. (30/10/15.)
108,473 Bosch Magneto Co. Distributing mechanism for electric ignition systems. (31/1/16.)
108,475 Bosch Magneto Co. Distributing mechanism for electric ignition systems. (15/2/16.) (Addition to 9,964/17.)
109,046 Weston Electrical Instrument Co. Thermal ammeters. (27/7/16.)
111,089 Murray. Electric welding machines. (23/10/16.)
111,099 Stewart. Locking electrical spigot and socket unions. (10/11/16.)
111,107 Cotte. Electrical accumulators. (25/10/16.)
111,835 Jones. Apparatus for electrically distilling ores and metal bearing materials. (7/12/16.)
112,026 Automatic Telephone Mfg. Co. Telephone systems. (15/12/16.)
114,422 Automatic Telephone Mfg. Co. Automatic telephone systems. (19/3/17.)
115,620 Compagnie Generale de Magnetos. Contact-breakers for magnetos. (3/5/17.)
116,075 Automatic Telephone Mfg. Co. Automatic telephone systems. (23/5/17.)
116,734 Stockel & Fyfe, Wilson & Co. Electrical switches. (16/5/17.)
116,747 Edison Accumulators Ltd., Monnot & Lewis. Electric controllers. (15/6/17.)
116,752 British Insulated & Helsby Cables Ltd. & Blades. Removable electrical fuse carriers for connecting devices. (18/6/17.)
116,755 Chilton & Brush Electrical Engineering Co. Turbines. (19/6/17.)
116,764 St. Helens Cable & Rubber Co. & White. Terminal sockets for electrical conductors. (25/6/17.)
116,780 Simms, & Simms Motor Units. Electrical condensers. (3/7/17.)
116,791 West & Co. & Satchwell. Lifting magnets. (20/7/17.)
116,806 Field. Magnetic compasses. (24/8/17.)
116,849 Automatic Telephone Mfg. Co. & Tomlins. Automatic telephone systems. (14/12/17.)
116,853 Kilburn. Manufacture of carbon electrodes. (9/1/18.)
116,883 Benjamin Electric Ltd. Signal devices for motor vehicles. (18/6/17.)
116,886 Noruhara. Rotary electric machines. (16/5/17.)
116,889 Joubert. Electrical installations. (4/6/17.)
116,892 British Westinghouse Electric & Mfg. Co. Electrical insulating bushings (8/6/17.)
116,895 British Westinghouse Electric & Mfg. Co. Control of electric motors. (13/6/17.)
116,908 Harvey. Apparatus for detecting and magnifying minute electric impulses. (25/4/17.)
116,915 B. T.-H. Co. & Pollock. Dynamo-electric machines. (21/6/17.)
116,925 West & Co. & West & Pickett. Electrical boat raising and lowering apparatus. (27/6/17.)
116,937 Chadburn & Chadburn. Speed indicators or tachometers. (30/6/17.)
116,956 George & Hutchinson. Temporary electric connecting clip. (24/7/17.)
116,978 Cranko. Luminous electric-light switch. (10/9/17.)
116,981 Conner & Puckette. Automatic electric switching apparatus. (14/9/17.)
117,019 Vaughan & Wood. Electrically operated overhead lifting gear. (17/11/17).
117,020 Western Electric Co. Production of alternating current for signalling in telephonic and other systems. (27/11/17.)
117,061 Speyer. Wristlet watches. (3/5/18.)
117,073 Martire. Ignition magneto switches for internal combustion engines. (8/6/17.)
117,082 Lund & Lawerentz-Aktiesselskab. Automatic switches. (23/6/17.)
117,089 Stefano. Electrical heating apparatus. (8/2/17.)
117,090 Lyons & Selective Signal Co. Apparatus for the reception and utilisation of electric current impulses suitable for wireless or other telegraphy and telephony. (10/3/17.)
117,099 Berry. Electrical heating apparatus. (3/5/17.)
117,113 Masters. Electrical telephones. (29/6/17.)
117,122 Marconi's Wireless Telegraph Co., Dowsett & Platt. Electro-magnetic vibratory interruptors. (3/7/17.)
117,132 Conradi & Newitt. Electric fuses. (5/7/17.)
117,138 Marconi's Wireless Telegraph Co. & Smart. Electric buzzers. (9/7/17.)
117,161 Gaynor. Clinometers. (3/8/17.)
117,166 B. T.-H. Co. Electric transforming and converting apparatus. (8/8/17.)
117,170 Western Electric Co. Selective signalling systems and selectively-operable devices therefor. (16/8/17.)
117,171 Automatic Telegraph Mfg. Co. & Smith. Electric bells and the like. (17/8/17.)
117,181 B. T.-H. Co. Electrical systems of power transmission and regenerative braking. (24/9/17.)
117,188 B. T.-H. Co. Electric switches. (11/10/17.)
117,209 Price. Electric batteries. (23/11/17.)
117,247 Lyons & Selective Signal Co. Wireless and other telegraphic or telephonic receiving apparatus. (10/3/17.) (Divided application on 3,558/17.)
117,263 Gambs. Electric generator for motor vehicles. (2/7/17.)

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters : Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.

Orders for the Week.

Captain of the Week.—Captain W. Darley Bentley.
Next for Duty.—Captain E. G. Fleming.
Monday, August 12, to Friday, Aug. 16.—Drills as usual.
Sunday, August 18.—Commandant's Parade at Waterloo Station, 8.45 a.m., for work at Esher. Dress, drill order, with haversacks and waterbottles. Midday and tea rations to be carried.

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Commercial Topics.

Measure of Damages for Breach of Contract.

An important judgment was recently given by Mr. Justice Rowlatt in an action brought by Messrs. A. Wiseman (Ltd.) against the Butterley Company for damages for breach of contract to supply a hydraulic accumulator.

Defendants agreed to supply plaintiffs with a hydraulic accumulator within five or six weeks from Sept. 21, 1916, but they did not deliver an accumulator that would do its work satisfactorily until some time in 1917. Plaintiffs alleged that defendants clearly understood when the order was given that the accumulator was required for making base adapters for shells, and they claimed as damages the profit which they would have made if the accumulator had been delivered in due time.

Mr. Justice ROWLATT came to the conclusion that defendants had been in default for 16 weeks and a few days. It was argued that plaintiffs were entitled to recover the whole of the profits which they would have made if they had had the accumulator during those 16 weeks. The principles applicable were clear from those enunciated in Hadley *v.* Baxendale, Grébert Borgnis *v.* Nugent (15 Q.B.D., 85) and other cases. It was not enough to say that a plaintiff told a defendant of the profit which he expected to make by the use of a machine which defendant was contracting to supply. That alone would not make defendant responsible for the loss of that profit if he failed to supply the article. There must be circumstances in the case to show that the defendant expressly or impliedly undertook to make good any loss which the plaintiff might suffer through his default. The damages could only be those which defendant could reasonably be held to have intended to make himself responsible for. If a man hired a cab to drive to catch a train, and by the negligent driving of the cab he missed the train, he could not hold the cabman responsible because it happened that by missing that train he had lost a fortune. The damages could be tested by seeing whether they were out of all proportion to the value of the work which defendant was undertaking. Here it was not as if a definite article of a definite value in itself was to be supplied. The accumulator was only a part of elaborate machinery of which other parts might have been wanting, and the damages due to its non-delivery were very problematical. He did not believe that plaintiffs ever told defendants the exact amount of the profits which they expected to make, and there was never, in fact, a bargain that for the payment of £135 defendants would undertake that plaintiffs should not lose their profits. So plaintiffs could not recover their lost profits. But they were entitled to something for being deprived during 16 weeks of a useful article. Possibly an article of that kind might in these days earn its cost in half a year, and in 16 weeks, therefore, it might have earned about £80 to £90. And if plaintiffs had asked defendants in the first instance what they would be willing to pay as liquidated damages if they failed to deliver he believed defendants would not have agreed to more than about £5 a week. Applying those tests, he assessed the damages at £85, and gave judgment for plaintiffs for that amount.

* * * *

The London Degree in Commerce.

We are pleased to observe that good progress is being made with the scheme for the institution of degrees in commerce at the University of London. Another successful meeting was held at the hall of the Mercers' Company last week, and, in addition to a General Committee, a number of committees, representing various commercial and trading interests, have been formed.

Dr. S. Russell Wells is chairman of the General Committee, and Mr. G. F. Goodchild (external registrar of the university) is secretary.

The London County & Westminster and Parr's Bank has promised £1,000 for initial expenses, and £1,000 a year for five years when the scheme is in working order; and Lloyds Bank has given 1,000 guineas for initial expenses and a promise of 1,000 guineas a year for five years.

The committees appointed include those representing banking, insurance, shipping, general trading, contracting, engineering, the coal, iron and steel trades, non-ferrous metals, power, water and gas, rubber, oils, &c. The function of the trade committees is to consider the part which each branch should play in the scheme, and to secure for it the support of members of their own branch.

* * * *

Rationing of Raw Materials.

Last year the Ministry of Reconstruction appointed a committee, under the chairmanship of Sir H. Birchenough, to consider the principles upon which, in the event of a shortage of supplies for industry after the war, such things should be rationed, &c.

In its report the Committee advised that control should be discontinued at as early a date as possible, and that in the meantime there should be the least possible interference with private enterprise; but certain recommendations are made as to the principles and machinery for allocation and priority after the war in necessary cases. Special consideration should be given to industries which provide a large measure of employment, and importance should be attached primarily to industries connected with (1) the production of food and raw materials; (2) the manufacture of machinery and equipment immediately necessary for industrial and transport requirements; (3) the manufacture of finished goods for export; (4) the production of goods for home requirements of a pressing nature.

Detailed recommendations are also made by the Committee as to the machinery to direct allocation and relative priority.

The proposals of the Committee have been considered by the Government, which has decided to take immediate action on the lines of the Committee's report and recommendations of the Minister of Reconstruction. It is the intention of the Government that post-war control and allocation of materials shall be applied only in cases where it is absolutely necessary. On the assumption, however, that of certain commodities there will be a shortage which will render some form of control imperative, arrangements require to be made for dealing with the matter. A small Cabinet Committee on Post-War Priority will be set up in order to determine large questions of policy and lay down the general principles upon which allocation and priority should proceed. This Committee will be assisted by a Standing Council, composed of the members of departments chiefly concerned, together with persons representative of commerce, industry and labour.

* * * *

Extension of Life of Patents.

Sir A. Stanley announced in the House of Commons on Monday that it was hoped to introduce after the recess a new Bill dealing with the life of patents interrupted through and by the war, and also with other matters relating to patent legislation.

* * * *

Excess Profits Duty.

The Board of Referees has refused the application of the Quasi Arc Co. (Ltd.) and the Quasi Arc Co. (Ltd.) for an increase of the statutory percentage as regards the business of the manufacture and sale of electrodes for the electric working of iron and steel, comprising metallic cores with blue asbestos yarn insulators.

Electricity Supply.

Extensions.

Birmingham.—As stated in our last issue the Corporation have adopted the amended scheme for the erection of a permanent generating station at Nechells for laying mains and supplying substation equipment and for laying a linking-up main from Nechells to Smethwick boundary at an estimated cost of £1,626,140.

The chairman of the Electric Supply Committee (Ald. JEPHCOTT) gave a resumé of the history of the undertaking and of the negotiations with the Ministry of Munitions, &c. The figure mentioned in the report was a large one, but if they compared the cost of the proposed station and the cost of the present stations they would find the former was £54 per kilowatt and the latter £40, the advance being due to higher cost of materials, and they had a great many persons applying for current, and it was their duty to try and meet that demand. If the Council did not go forward with the scheme they might find themselves left behind, and someone else would take their place as suppliers.

Mr. HAWKER said the Council must realise that the cost of the undertaking would be £70,000 a year more than it would have been if the Government had allowed them to go on with their original proposal. When the Government stopped them in 1915 the Committee were ready to carry out the work, which would have been much cheaper than now. The Government had also imposed conditions which would oblige them to provide a connecting link between Nechells and Smethwick. That would cost a considerable sum, and it would be of more use to the power company than to the city. If they did not go on it was possible that in 1920 they would be short of current.

Ald. CHAMBERLAIN said he understood they were faced by a constantly increasing demand for electric current, and although considerable additions had been made to the generating plant since the war, they were rapidly approaching the limit of their capacity, and they had to provide new plant at a very much enhanced cost or they would find themselves in the position in a few years' time of being unable to supply current to consumers. No one could avoid feeling that the Corporation had been treated very badly by the Government. There had been continual delays and changes of policy on the part of the Government, and they were primarily responsible for the fact that now the Council were obliged to put down that new plant they had to pay so much more for it. The natural corollary was that they ought to expect the Government to give them substantial assistance, and he would like to ask what assistance they were likely to obtain.

In reply, Ald. JEPHCOTT said the Government Departments concerned had conceded the principle of financial assistance being given to the Corporation on the following basis—*i.e.*, to pay the difference between the cost of proceeding with the scheme at present abnormal prices and the cost at post-war prices (date to be agreed). But the application of the principle was at the moment limited to one-half of the cost of the new station. Negotiations were proceeding with a view to inducing the Government to extend the application of the principle to the whole scheme and to the total expenditure.

Islington (London).—The Finance and Lighting Committees have been authorised to take such action during the vacation as may be necessary in connection with the scheme approved in July, 1917, for the extension of plant. Tenders have been received.

Stoke-on-Trent.—The L.G. Board has sanctioned a loan of £7,340 for laying a l.t. d.c. feeder from Bagnall-street sub-works to Hart's-hill. The loan is to be repaid in 25 years.

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General.

Braintree.—As the Crittall Mfg. Co. has notified that it will apply for an electric lighting provisional order, the Council has instructed the Electric Lighting Committee to make all necessary preparations to renew the Council's application.

Chorley. The Guardians have approved plans for the installation of a new heating system electric light plant, &c. at a cost of £5,750.

Electrical Power Engineers' Association.—Owing to the large influx of members it has been decided to form a London Western Section, and an inaugural meeting will be held on the 15th inst., at 7 p.m. at Hammersmith electricity works.

All staff engineers engaged in the generation, distribution or utilisation of electrical energy within an area of approximately 5 miles north, west or south and 1 mile east of Hammersmith Borough Council electricity works are invited to attend.

Extension of Time Orders.—The Board of Trade has extended by one year the periods limited by the undermentioned Acts and Orders for laying mains, acquiring lands, &c.

Knottingley Electric Lighting Order, 1914; York Electric Lighting Order (Extension Order), 1914; Farnham Electric Lighting (Extension) Order, 1914; Rickmansworth & Chorley Wood Electric Lighting Order, 1914; Slaithwaite U.D. Electric Lighting Order, 1914; Thornton Electric Lighting Order, 1914; Yeovil Electric Lighting Order, 1914; London Electric Railway Act, 1914.

Extension by one year from 31st inst. of periods mentioned in the Abercarn Electric Lighting Order, 1915, for laying mains, &c.

Grays.—The Council has decided that in future consumers using small heating and fire appliances consuming less than the average of half a unit per day be charged at lighting rate.

Increased Charges for Electrical Energy.—The charges at the following places are being increased:—

At Leeds an increase of 40 per cent. on the pre-war scale from Oct. 1 in place of the present increase of 20 per cent.

At Luton the charges are being increased by 12½ per cent.

At Rhyl the flat rate is being increased to 7d., the m.d. rate to 8d. and 3d., and the power rate to 4½d. and 2½d.

At Glasgow there is an increase of 0·075d. per unit in the charges for current, making the charge for private lighting, &c., on the m.d. system 5½d. and 1½d., and the flat rate 4¾d. For power the charge will be 2½d. for 1,000 hours of m.d. and 1½d. after.

At Hull the flat rate for lighting has been increased by 1d., and other charges have been increased by 35 per cent., making 67½ per cent. over pre-war rates.

Mexborough Council has increased its charges for lighting to 5d. and for power by 5 per cent.

Edinburgh Electric Lighting Committee recommend increases from 3½d. to 3¾d. for lighting, and from 1½d. plus 25 per cent. to 1¾d. plus 25 per cent for power.

At Nottingham prices have been increased to 40 per cent. over pre-war rates.

At Leicester it is proposed to increase the charges for lighting from 5½d. to 6d., and for power by 12 per cent., making both 50 per cent. over pre-war charges.

At Burnley the charge for current for lighting is to be increased from 3¾d. to 4½d.

Kirkcaldy.—The gross profit on the past year's working of the electricity department was £5,186 and the net deficit £12.

On the tramway the gross profit was £6,092 and net surplus £396. Traffic receipts increased by £2,537.

Stafford.—The Council has increased the salary of the electrical engineer, Mr. W. H. Robins, by £50 per annum.

Stroud.—The Finance Committee is to report upon a notice given by the Stroud Electric Supply Co. of intention to apply for a provisional order.

Twickenham.—The Board of Trade has authorised the Twickenham & Teddington Electric Light Co. to increase its maximum prices for electric current.

Welshpool.—At the next meeting of the Council a resolution will be moved in favour of appointing a committee to consider and report upon the desirability of establishing electric supply works.

Electric Traction.

Dundee.—The Tramways Committee has resolved to reduce the services on various routes. It is proposed to close down outlying sections, to reduce the hours of service and to curtail the Sunday service.

Edinburgh.—On Friday last a deputation from the Tramways Committee waited upon the Admiralty in order to clear up certain points as to the proposed Queensferry tramway service.

Electric Vehicle Progress.—Recently Gloucester Electricity and Light Railways Committee has been investigating the question of hauling coal and ashes.

The Engineer reported that the total outlay involved by horse haulage would be about £1,200, and he submitted particulars of the cost of working electrically propelled lorries in four other towns. The cost of running such a vehicle in Gloucester, which compared favourably with the present cost of horse haulage, was considerably better than the probable cost of continuing the present method.

The Council is, therefore, recommended to arrange to do the required haulage by an electrically propelled lorry, and to empower the chairman and engineer to accept the most suitable tender for such a lorry.

Glasgow.—The tramways department has resumed the system of raising money for war funds by the sale of tickets and by draws for prizes. This week's proceeds will go to the Prisoners of War Fund.

L.C.C. Tramways.—Last week the L.C.C. adopted a recommendation of the Highways Committee to expend £100 in the conversion of two tramcars for an experiment in the carriage of goods on the Council's tramways.

Experiments have been made in the use of canvas bags on tramcars for the collection of used tickets. Only about 12 per cent. of the tickets had been deposited in the bags, but it was believed that if an appeal were made to the public and all cars were fitted with bags a better result would be obtained, and they recommended that £800 should be expended upon bags. Glasgow Corporation, which uses annually 272 tons of tickets, collects 50 per cent. of them. The L.C.C. has recently saved 100 tons of pulp a year by simplifying its tickets, and the annual consumption is now only 270 tons, a much smaller quantity on the basis of the number of passengers carried than that consumed in Glasgow. If one-third of the tickets used were collected in the bags they would realise at present prices about £720 a year.

The recommendation was adopted.

A capital expenditure of £4,825 has been approved for providing a lay-by in Amhurst-park. The construction saves change of points at Stamford Hill and the equipment of cars in order to institute through running arrangements between the Council's tramways and those of the Metropolitan Electric Tramways (Ltd.). The company will contribute £875, one-half of the cost of constructing the change of points.

The Highways Committee has recently sanctioned the following items of expenditure: Re-winding of armatures, £3,640; purchase of articles for tramway maintenance and the execution of small works and repairs, £22,563; purchase of 50 tons of fish plates, £1,250; purchase of metals, £1,964; 2 miles of cable, £1,480; and 100 rolled steel bars, £570.

Mr. A. H. Scott, vice-chairman of the Highways Committee, and Mr. W. J. Squires will represent London County Council at the annual conference of Municipal Tramways Association to be held next month at Leicester.

Nottingham.—The Tramways Committee has discontinued the Sunday service of tramcars.

Preston.—It has been decided to increase ordinary tramway fares (except workmen's and children's) by a halfpenny and to increase the circular tour fare from 2d. to 3d.

Yorkshire Tramway Fares.—In order to discourage short distance travelling, the Yorkshire (Woollen District) Electric Tramways Co. has suspended all penny fares, except in the case of workmen, for whom the minimum fare is one penny.

In future the charge will be 1½d. for the first mile, but for longer journeys the fare after the first mile remains unaltered.

Imperial Notes.

Australasia.—Mobilong (S. Australia) District Council has applied for authority to raise a loan of £3,500 for electricity supply at Murray Bridge. Electric current will be obtained from the River Murray Milling Co.

The Melbourne Tramways Trust carried 103,118,379 passengers in 1917, compared with 96,107,763 in 1916; the traffic receipts were £841,784 (against £805,778) and the average fare per passenger was 1·959d. (against 2·012d.). A reduction of fares made in 1917 caused an increase in revenue per car mile from 16·217d. in 1916 to 16·261d.

A large wood pipe (36 in. int. dia.) has been constructed for the conveyance of water in connection with the borough of Oamara (N.Z.) electricity scheme. It was made in Australia, and is intended to supply water to two Pelton wheels developing 650 H.P. continuously.

Zinc Production in Tasmania.—At the recent meeting of the Amalgamated Zinc (de Bavay's), Ltd., the chairmon of directors (Mr. W. L. Baillieu), referring to the electrolytic zinc works at Hobart, said that, notwithstanding the Company had for the present to content itself with 2,500 H.P. from the Tasmanian Hydro-electric Department instead of 4,000 H.P., the estimated product of the first power-block, the production of electrolytic zinc from Broken Hill concentrates was practically as large as the plant had been estimated to yield with the full 4,000 H.P. The Company's technical advisers were completely satisfied with the operations of the electrolytic plant, and no doubt was entertained but that the continuous running conditions when the first block of 4,000 H.P. was made available would justify notice being given to the Tasmanian Government for the second block of 26,000 H.P. With this power available, and with the complementary extensions of the equipment completed, at least 100 tons of zinc per day should be produced, calling for the treatment of from 80,000 to 90,000 tons of concentrates per annum.

Sydney (N.S.W.) Municipal Council has instructed the city electrical engineer (Mr. H. R. Forbes Mackay) to draw up a scheme for the purchase by the Council of a colliery.

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Foreign Notes.

Austrian Hydro-Electric Works.—"Engineering" gives brief particulars of the Faal electricity works on the Drave in Southern Styria.

The works are the property of the Graz Electricity Works, the financial arrangements were carried out by the Swiss Railway Bank in Basle and the contractors were the Austrian Baugesellschaft für Verkehrs und Kraftanlagen of Vienna. Work was started in 1913 and at present there are five 6,000 H.P., but the plant is to be enlarged. About 15 k.m above Marburg the Drave has been closed by a dam which raises the water-level by from 11 m. to 15 m.; the dam has five openings, the power station being close to the dam and in the longitudinal axis of the river. There is room for two larger turbines, each of 8,000 H.P. The turbines are directly coupled with three-phase machines giving current at 10,000 volts. Local electrochemical works are directly supplied with power, but for long-distance power transmission the tension is raised to 80,000 volts, the transformers being installed in a separate building adjoining the power-house.

Hydro-Electric Power in Sicily.—The "Board of Trade Journal" states that the Higher Council of Waters has declared in favour of an investigation of a scheme for developing certain hydro-electric projects in Sicily.

The scheme includes the formation of two artificial lakes, one of about six million cubic metres on the Flascie torrent, at about 1,200 metre above sea level, the other on the Alcantara torrent, at about 1,135 metres above sea level, and with a capacity of about 24 million cubic metres. By a special channel the waters of the former would be emptied into the latter, and a total of 30,000,000 cubic metres of water would be stored and utilised. The hydro-electric scheme would stimulate the industrialisation of the fertile districts between Catania and Messina, and would render the electrification of the Catania-Palermo railway possible.

Italian Association of Rubber and Cable Manufacturers.—On the 3rd ult. an association of manufacturers of rubber, cables, electric conductors, &c., was formed by 14 Italian firms, which employ about 20,000 workpeople and have an output of goods valued at several hundred millions of lire per annum.

The president of the association is Senator G. B. Pirelli, and the vice-presidents Comm. Ing. V. Tedeschi, of Turin, and Ing. Romola Pola, of Moncalieri. The object of the association is the development of the rubber and electric-conductor industries in Italy by the study of all questions a ecting their expansion in Italy and abroad.

Trade Marks in Latin America.—The "Board of Trade Journal" calls attention to the fact that the special representative of the South and Central American Trade Section of the Liverpool Chamber of Commerce (Liverpool Chamber of Commerce, Exchange-buildings, Liverpool) will supply the names of British trade mark agents who will secure the registration of trade marks in the various Central and South American Republics at reduced rates, varying from £5. 18s. in Mexico to £14 in Argentina.

Miscellaneous.

Enemy Patents.—The Controller of the Foreign Trade Department of the Foreign Office (Sir E. Pollock, K.C.) has revoked the "licence" of April 13, 1917, by which persons or companies in the United Kingdom might apply for a grant or renewal of letters patent, or the registration of a trade-mark, on behalf of persons whose names were in the "Statutory List."

The list contained the names of persons with whom trading was forbidden by proclamations under the Trading with the Enemy (Extension of Powers) Act, 1915.

The Home Secretary recently stated that there were about 10,000 patents belonging to enemy aliens now in force in this country, and that the Government had decided to cancel the general licence for communications with enemy States on the maintenance of patents.

Fuel Economy.—Owing to the large number of miners called to the Colours, and the great need of coal for our Allies, the various Government departments and industrial undertakings, the Controller of Coal Mines has instituted a coal economy campaign with the object of reducing fuel consumption.

The Controller is being assisted by a technical staff attached to the head office, and arrangements have now been made for a large number of engineers in the provinces to attach themselves to the Coal Control Department for this special purpose. This arrangement enables the country to be mapped out in districts, so that all industrial consumers will within a reasonable time be in touch with the organisation. The scheme comprises two main sections—viz., (1) electrical undertakings, (2) industrial undertakings.

The work involved includes the careful scrutiny of the quantity and quality of coal consumed by the various undertakings and the efficiency obtained. It also includes the inspection of factories and works by experts, in order to ascertain means by which fuel consumption may be reduced and the best methods to that end. Some 400 engineers will shortly be at work in various parts of the British Isles, and these gentlemen are giving their services to the Government without salary. Any public body or company or person wishing to effect economies at once, and desiring the Controller's assistance, is invited to communicate with Coal Control Headquarters, Room 309, Holborn Viaduct Hotel, London, E.C.1, when arrangements will be made to send a technical expert to look into the conditions under which coal is being consumed. Apart from special applications, the Controller's representatives will visit firms in turn in accordance with a general plan of operations.

So imperative is the need to reduce coal consumption to a minimum that a rationing scheme for all industrial undertakings will be introduced shortly.

High-Duty Stokers for Low-Grade Coal.—In the recent report of Mr. Magoris, acting electrical engineer for Hull Corporation, it is stated that a recent sample of the coal allocated to them by the Coal Controller contained no less than 30 per cent. of incombustible ash, compared with about 8 to 10 per cent. of ash in the case of their pre-war coal.

For their latest extension, involving boilers with furnaces 15½ ft. width as before, the Hull electricity works' fourth order for Erith-Riley stokers is for the high-duty pattern of this fully automatic stoker, with 33 per cent. more capacity than previous ones, and suited for normal duty of 3 tons coal hourly. As nearly 1 ton will be incombustible ash, the continuous-cleaning feature of the Erith-Riley stoker is invaluable, eliminating all manual labour. Erith-Riley Stokers, in both standard and high duty patterns, are assembled from standardised self-cleaning units, so that individual stokers normally burning 5 tons coal hourly each, on an undivided and archless furnace of a large-unit boiler of any make, are just as satisfactory as a series of smaller stokers and boilers of same steaming capacity.

Erith's Engineering Co. (Ltd.), 70, Gracechurch-street, London, have executed repeat orders from central stations throughout the country, and are now delivering to the Bow power house of the Charing Cross Co. stokers for normal duty of 3 tons' coal hourly each, among many other large-unit Erith-Riley stokers.

Income Tax Up to Date.—The frequent modifications of the income tax law, together with the complexity of the various kinds of relief afforded to different classes of taxpayers, are a cause of bewilderment to the ordinary man.

If he wants a simple guide to all the intricacies of the system, he can get it for 9d. (postage one penny), in "Income Tax Up-to-Date," by Mr H. J. Gully, F.C.A., published by "The Financial News," at 111, Queen Victoria-street, London, E.C.4. The pamphlet crystallises all the regulations on the subject for the year 1918-19, and, moreover, it gives a table of the amounts payable on incomes between £131 and £200,000. The working of the Excess Profits Duty is fully explained.

Income Tax Allowance for Depreciation of Plant.—As the result of recent correspondence between the Inland Revenue Authorities and St. Pancras Electricity Committee, the allowance for wear and tear of the electricity generating plant and machinery has been increased from 5 to 7½ per cent.

Miners' Lamp Approved.—On the 30th ult. the Home Secretary made an Order approving the Fuller miners' electric safety lamp for use in all mines to which the Coal Mines Act, 1911, applies, and making additions and amendments to the specifications of certain safety lamps approved by previous Orders.

Munitions Dispute Inquiry.—In connection with the recent stoppage of work in munitions areas, a Committee of nine members has been appointed to investigate and report on the labour conditions which have rendered the embargo necessary, and to advise upon the administration of the scheme, &c.

The chairman of the Committee is Mr. Justice McCardie. There are three representatives of Government departments, three members nominated by the Engineering Employers Advisory Committee, and three members by the Trade Unions Advisory Committee of the Ministry of Munitions.

Mr. C. S. Hurst, 6, Whitehall-gardens, London, S.W.1, is secretary, and the first meeting of the Committee was held on Friday last for the purpose of settling methods of procedure, &c.

National Kitchens.—The Food Controller (Mr. Clynes) has announced that 12 national restaurants in London and eight in the provinces (at Glasgow, Newcastle, Manchester, Leeds, Birmingham, Bristol, Cardiff and Brighton) are to be established.

At the Wandsworth National Kitchen, which is installed at the Wandsworth Public Baths, both electrical and gas equipment has been provided. The kitchen is intended to serve parts of the Fairfield, Southfield and Springfield districts, with a population of over 100,000. The scheme provides for cooking about 2,000 portions per day and restaurant accommodation for about 200 persons. The total expenditure incurred in equipping the kitchen was £1,650. The charge for electricity for cooking is 1·15d. per unit, and the price of gas is 3s. 5d. per 1,000 cubic ft.

The makers of the kitchen equipment include the Carron Co., the Brompton & Kensington Electric Accessories Co., the Hobart Mfg. Co. and the Imperial Machine Co. The electric wiring work was executed by Philpot Bros.

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Educational.

University of Durham (Armstrong College).—In the department of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, &c., there are complete courses of instruction in preparation for degrees of the University of Durham. The next session commences on Sept. 23, and particulars of the courses may be obtained from the secretary (Mr. F. H. Pruen, M.A.), Armstrong College, Newcastle-on-Tyne.

University of Manchester.—In the physics department there are lecture and laboratory courses, preparing for both the ordinary and honours degrees, and particulars may be obtained from the Registrar. Prof. Sir E. Rutherford will meet intending students on Oct. 3.

A Nottingham University.—Nottinghamshire County Council has conditionally agreed to grant £5,000 a year towards the upkeep of the proposed Nottingham University.

Tenders Invited and Accepted.

Turbo-Alternator, Condensing Plant, Water-tube Boilers, Stokers, &c.

Leeds Corporation invite tenders for extension to feeder switchgear in new works and alterations of generator switchgear in old works, a 6,000 Turbo-alternator and Jet Condensing Plant, Two Water-tube Boilers, Stokers, Economisers, &c. Makers willing to tender for one or more of the eight contracts and able to guarantee erection within 12 months should submit their names to the manager of the electricity department (Mr. C. Nelson Hefford), 1, Whitehall-road, Leeds, by Aug. 10.

Belfast Corporation invite tenders for the manufacture and erection of two 6,000 kw. Turbo-alternators and one 30 kw. Balancer Booster; four Water-tube Boilers, three 500 kw. and five 1,000 kw. Rotary Converters, with Transformers, &c.; and two 250 k.v.a, two 350 k.v.a. and six 1,250 k.v.a. Static Transformers. Specifications, &c., from the consulting engineers (Messrs. Preece, Cardew, Snell & Rider), 8, Queen Anne's-gate, Westminster, S.W. 1; or Mr. T. W. Bloxam, M.I.E.E., city electrical engineer, Belfast. Tenders to Town Clerk, City Hall, Belfast, by Aug. 16.

Belfast.—The following tenders have been accepted by the Council:—

Callender's Cable & Construction Co., cables, £15,621. 5s.; British Westinghouse Co., 1,000 kw. transformer, £1,305.

Glasgow.—For supply of electrical materials for six months the Cleansing Committee has accepted the tender of Woodward & Co.

Hull.—The Council has accepted the tender of Thelwall & Co. for the supply of cylinder oil 2s. 11½d. per gallon net; non-superheat 2s. 9½d.; dynamo oil 3s. 1d.; and crank chamber oil 5s. 1d.

Manchester.—The Corporation has accepted the following tenders for the supply of cable:—

Callender's Cable & Construction Co., W. T. Glover & Co., C. Macintosh & Co., and Western Electric Co., for cable-laying required during the year. The tender of Hans Renold (Ltd.) has been accepted for chain drive for induced draught plant at Stuart-street.

Metropolitan Asylums Board.—The following tenders have been accepted:—

Electrical Contracts & Maintenance Co., telephone switchboard, £248; James Keith & Blackman Co., electric fan, £27; Pope's Electric Lamp Works, electric lamps for six months.

Walthamstow.—The Urban Council has accepted the tender of the Vaughan Crane Co. for an electric hoist at £116.

Wolverhampton.—The Council has accepted the following tenders:—

Staveley Coal & Iron Co., 20 tons flat c.i. plates for boiler house (£7. 15s. per ton), and c.i. piping for plant extensions, £275; Gibbons Bros., platform, handrailing, stairway, and ladder for 5,000 k.w. turbo set, £220; Siemens Bros. Dynamo Works, two e.h.t. switch panels, £160 and £165 respectively.

Appointments Vacant and Filled.

An electrician, competent to instruct discharged men in electrical work, is required. Salary £4 per week. Applications to secretary for Higher Education, Shire Hall, Durham. *See advertisement.*

A technical engineer is required to assist in control and manufacture of wireless telegraph apparatus in London. *See advertisement.*

A shift engineer is wanted for sub-works with steam d.c. plant and rotaries. Salary £3. 3s. per week. Applications to the Borough Electrical Engineer, St. Peter's-chambers, Glebe-street, Stoke-on-Trent.

An advertiser requires an electrician capable of making general electrical repairs and inspecting lifts, &c.

A draughtsman, with mechanical and electrical experience, is required. Applications to Commanding Officer, H.M.S. "Defiance," Devonport

A test room assistant is required by an advertiser

Mr. George Senter, D.Sc., Ph.D., F.I.C., has been appointed Principal of the Birkbeck College, in succession to Principal G. Armitage-Smith, who recently retired.

Mr. H. Lees, of Eastbourne, has been appointed shift engineer at Accrington at a salary of £195 per annum.

Business Items.

A depot has recently been opened by Pope's Electric Lamp Co. (Ltd.), makers of the well-known Pope "Elasta" drawn wire lamps, at 5, Arthur-street, New Oxford-street, W.C.1, where stocks of all types of lamps will be kept.

Messrs. Hindle, Son & Co., electric press makers, who are removing their branch from Manchester, have taken over part of the Union Foundry, Haslingden.

New Works.—Messrs. A. Reyrolle & Co. have accepted the tender of F. Nuttall & Co. for the erection of a new factory at Hebburn.

Industrial Varnishes.—Messrs. Jenson and Nicholson, Ltd., Goswell Works, Stratford, E, 15, have recently issued a pamphlet on the varnishes, japans, enamels, &c. manufactured by them. The firm specialise in the requirements of engineers and industrial firms.

Pipes.—The Stanton Ironworks Co. has issued its list of pig iron and c.i. pipes, castings, surface boxes, lamphole covers, &c Dimensions, weights and other information are given.

The company has also sent us a neat reminder of their c.i. pipes in the shape of a glass paper weight and pin tray.

Bankruptcies and Liquidations.

The sale of the Devonport & District Tramways Co.'s undertaking was completed on April 9, and Mr. P. Newton Gray, 136, Aldersgate-st., London, E.C., has been appointed liquidator of the company. Meeting of creditors at Manchester Hotel on Aug. 9.

A first and final dividend of 1½d. in the £ is payable in the bankruptcy of Frederick Griffin, printer and agent, and also in partnership as electrical engineer, formerly residing at 12, Fairlop-road, Leytonstone, and carrying on business at 69, Fore-street, London, E.C., and at 26½, Clarges-street, W., but now at 315, Regent-street and 14, Little Portland-street, W.

Municipal Accounts.

Bolton.—The net capital expenditure of the electric supply undertaking at March 31 was £269,426.

The past year's income was £109,230 and total working expenses came to £61,938, leaving £47,292 gross profit (against £42,983 in 1916–17). Interest, income tax and depreciation charges were £40,387 and after meeting special allowances to service men and contributing £3,584 for outlay on battery and booster, new meters, &c., the balance is £3,375 (against £2,708). The year's capital expenditure was £5,753 (£16,951) and the depreciation and renewals fund amounts to £46,131 (£36,051). The works costs were 0·417d. per unit (0·374d.) and total costs (including capital charges) 0·898d. (0·912d.); the average price obtained per kelvin was 0·96d. (0·96d.) and the maximum demand was 8,600 kw. (7,280 kw.). 23,186,516 units were sold, including 16,864,944 for power, 4,740,802 for tramways and 1,580,770 for private lighting. There are 1,811 motors of 15,633 kw. on circuit (against 1,738 of 14,789 kw.) and 659 consumers (against 651).

Carlisle.—The accounts of the electricity department for the year ended March 31 show capital expenditure of £131,233 (against £131,731 in 1917), of which £63,633 has been repaid.

Year's revenue from electricity supply was £32,582 (£25,154) and from meter rents, &c., £2,405 (£2,133), making a total of £34,987 (£27,287). Total cost of generation and distribution was £23,171 (£17,384) and gross profit £11,861 (£9,903). After meeting interest £4,223 (£4,097) and principal repaid £6,297 (£6,002) the profit was £1,295, against a loss of £196. The maximum load was 2,703 kw. (2,319 kw.) and load factor 24·8 per cent. (23·4); 5,879,532 units were sold (against 4,750,591), and the average price obtained was 1·42d. (1·37d.).

The report of the engineer and manager (Mr. F. W. Purse) states that at the end of last year sanction was given to instal a 2,000 kw. turbo-alternator, condensing plant and a water-tube boiler. Contracts have been placed, and it is expected that the plant will be ready for next winter's load. The net increase from the sale of current over the previous year (£7,428) was the largest increase in any year during the history of the undertaking. This increase was made up of £5,148 from additional sale of current and £2,280 from increase in price and "coal clause" charges. Owing to the continued increase on all items, the total increase in price has been made 25 per cent. over pre-war charges, and it is hoped that this will be sufficient to keep the balance on the right side during the year. The mainstay of the department has again been the power supply, this load accounting for 95 per cent. of the total increase for the year. The total increase in units sold (1,128,941) was also a record for the department. An increase of £2,478 in cost of coal is partly due to increased output and partly to increased cost. The coal consumption per unit sold only amounted to 4·48 lb., compared with 4·67 lb. last year. The increase of over £1,000 in repairs arises from the cost of long over

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due repairs and other work necessary to maintain the supply in the absence of the additional plant which they were not at first allowed to put down. War bonus was £1,123 above that of the previous year. For 1913-14 the total wages paid to workmen averaged £59. 10s. 3d. per week, against £112. 1s. 8d. for the past year, and at present (including war bonus and allowances to men on active service) the average is £153 per week, the total number of employees being, if anything, slightly less in the last two instances. Notwithstanding the increases, the total costs per unit sold have been reduced to the lowest record of pre-war conditions and in the history of the undertaking (1·37d.). The year's profit is to be carried forward. Mr. Purse points out that "a greater portion of the output is used directly or indirectly on war work, that amount which is exclusively war work and likely to cease when the war is over no doubt balances that which is entirely in abeyance on account of the war, and it is quite certain that there will be a period between present conditions and the change back to pre-war conditions which will cause a severe strain on the resources of the undertaking to maintain financial equilibrium. Once this gap is bridged the progress is likely to be very rapid, as the development of the supply of electricity is looked upon as a very important factor in the problems of reconstruction after the war." During the year a 2-ton electric tipping wagon was put into commission and proved most beneficial to the department in every way.

Fareham.—The accounts of the electricity undertaking for the year ended March 31, 1917, show gross capital expenditure £24,023 (increase £20), of which £8,454 is outstanding.

Revenue was £2,723, and working and general expenses were £1,373, leaving gross profit £1,350. Interest and instalments of loans required £1,212, the net prifit for the year being £138. Units generated were 140,790 and sold 70,152. The total maximum demand was 68 kw.

Glasgow.—The accounts of the electricity department for the year ended May 31 were approved by the Electric Supply Committee last week.

The total revenue was £789,001 and working expenditure £542,716. Interest on loans absorbed £92,454, and sinking fund, &c., £86,550, while £60,134 was written off as depreciation, leaving a surplus of £7,145, which has been transferred to reserve. The reserve fund now amounts to £28,692. The number of consumers at May 31 was 35,499, an increase of 775 over 1917.

Hull.—The total income of the electric supply department for the year ended March 31 was £119,734, and expenses were £84,957, leaving gross profit of £34,777.

Interest required £16,866, loan instalments £19,865 and income tax £2,510, leaving a deficit of £4,464. The gross total capital expended is £596,717, an increase of £37,565 over 1916-17. The units sold were 20,125,652, including 20,116,652 supplied to private consumers; the maximum supply demanded was 9,150 kw. (against 7,871 kw.), works costs were 1·02d. (0·92d.) per unit, and total costs 1·46d. (1·42d.).

In his report, the acting city electrical engineer (Mr. J. F. Magoris) refers to the recent practice of Government departments of making increases both in labour and coal retrospective. The bulk of these awards, although dating backwards over six months of the financial year, were only notified within the last quarter thereof. Up to January last the increases in the tariff were only ¼d. per unit on flat rate lighting and 15 per cent. on all other units except certain long term contracts. A very satisfactory contract for coal would have ensured the bulk of the undertaking's requirements to the end of the year in question was cancelled by the Coal Controller. At the same time the price was increased, and the department was in the unfortunate position of having to accept any type of coal which the Controller might be compelled by circumstances to allocate to it. The result has been a considerable decrease in the calorific value without any decrease in the cost per ton. A sample recently tested contained 30 per cent. of ash, compared with about 8 to 10 per cent. in pre-war coal. The output amounted to over 20 millions, compared to slightly over 12 millions for the year ended March 31, 1914, and representing approximately 3¾ millions (or 23 per cent. over the figures for 1916-17). In view of the two additional increases in the cost of coal recently imposed, and of the rapid and repeated enhancements of cost of other essential commodities, it has become necessary to arrange for a further revision of the tariff to operate as from the next readings of the meters. With regard to long term agreements without coal clauses, the practice has been approved of temporary cancellation of these contracts owing to war conditions, and Mr. Magoris now recommends that some arrangement should be made with the consumers on the question of increased cost of production. During the last quarter of the year the department has had the full use of the 5,000 kw. turbo-alternator (sanctioned by the Committee in February, 1915), with very beneficial results for the undertaking. The cooling towers authorised at the same time are nearing completion, and one of them has been placed in temporary commission. Notwithstanding the deficit for the past year, the Committee would appreciate the encouraging prospects for the future of the undertaking upon the resumption of more nearly normal conditions. No supply of whatever dimensions and purposes and sanctioned by the Government had as yet been refused, and the Committee would have noticed the large preponderence of the manufactures of the district which were now dependent entirely or to a very large extent on the Corporation's supply. The department had been unable to push the business in lighting, heating and cooking owing to Government restrictions, and, in addition, a very large amount of revenue from existing services had, from the same cause, been temporarily lost. The whole of that, however, the Committee might confidently look forward to recovering as soon as the existing restrictions were removed

Companies' Meetings and Reports.

BRITISH EMPIRE TRUST CO. (LTD.)—In the report for the year ended April 30 it is stated that, of the investments at the end of the year, over 61 per cent. were in railways, electric railways, electric light, gas or water-power companies.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—The directors state that it is impossible to submit at present a balance-sheet and profit and loss account for the year ending March 31, 1918; but they are satisfied that the result of the year's trading warrants them in recommending the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum for the half-year ended March 31, 1918 (less tax), making with the first dividend 8 per cent. for the year.

GENERAL ELECTRIC CO. (U.S.A.)—The 1917 orders are valued at $246,778,491, against $169,585,058, all lines contributing to the increase, especially shipping apparatus. Sales were $196,926,317, an increase of $62,684,027. Net profit was $29,004,539, and adding $4,512,289 other income, the total was $33,516,829. Debenture interest took $571,644, and interest and discount on notes payable $541,356, the amount available for excess profits tax and dividends being $32,403,826. Excess profits tax was estimated at $5,500,000, and dividends were $11,165,882, together $16,665,882, leaving $15,737,946, and increasing the total surplus to $49,898,699.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—The adjourned annual general meeting took place last week, and after a resolution of confidence in the managing director (Mr. G. C. Isaacs), with a request to him to withdraw his resignation, had been passed, Mr. Isaacs proceeded to give an analysis of the annual report and accounts. Their shares in the associated companies and patents stood at cost price in the balance-sheet, and showed an increase over last-year of £95,000. The par value, however, had increased by £210,000. The amount represented by patents was included in the figure of £1,400,000. Many of the patents were old, but their depreciation was more than compensated for by a large number of new patents. The year's profit showed a substantial increase, and after payment of the dividends, &c., they would carry forward approximately the same figure as was brought forward from the preceding year.

Now that their action against the Post Office in respect of the Imperial Chain of stations had been disposed of, he thought it right to give a review of the history of that most unfortunate contract. It originated by his proposing to the Colonial Office at the beginning of 1910 that they should give the company similar rights to those given to the cable companies, enabling it to erect for its own account on British soil a chain of stations (18 in all) around the world. The Government, while approving of his proposal, felt that the stations should be Government owned, and the company was invited to build them in partnership with the Government. They gladly accepted the Government's invitation, and the Imperial contract was the result. It was completed only after long negotiations, and was eventually reduced to six stations. When war broke out only three of them had been commenced. In September, 1914, there was a talk of accelerating the construction of the stations. At that time the company held that the Government had abandoned the contract, but, having regard to the fact that we were at war, the company placed itself at the disposal of the Government to build the stations with all possible speed. For some unexplained reasons the negotiations were discontinued, and on Dec. 30, 1914, they were informed that the Government were not going to proceed with the stations at all, as they were no longer required. The company had spent in the meantime £140,000 odd upon them, and had made various preparations. The company then asked the Government what it proposed to do with regard to reimbursing the large amount expended and as to compensation. That resulted in the company being offered three weeks later the reinstatement of the contract to build the six stations which three weeks earlier the Government had stated were no longer required. The company offered to enter into a new contract with the Admiralty. Then the Admiralty made an offer which they stated represented the equivalent of the repudiated Post Office contract, and in order to avoid friction the company agreed to the terms. The draft contract was to be submitted immediately, but it became clear in November, 1915, that the Admiralty did not intend to proceed with the matter. The company was thus obliged to have recourse to a Petition of Right. In order to avoid the petition going into Court, the company offered arbitration, provided that the letter of Jan. 21, 1915, offering the reinstatement of the contract, should be withdrawn. The Government could not see its way to withdraw that letter, and consequently the petition came before the Court, with the result that judgment was given for the company, and the matter had been referred to a referee to assess the damages. A judge had been appointed for that purpose, but he would not be able to sit until October. The position with regard to the other sums due from the Government remained just as it was last year. No remuneration or compensation had been received in respect of the invaluable services which the company had rendered, and no offer even approaching the sum which the company could reasonably accept had been forthcoming. The disadvantageous position in which the Government attitude placed them prevented the company from shaping a course abroad which it otherwise might do, enabling it the better to prepare to meet enemy competition after the war. Although wireless was, and would be perhaps more so in the future, a subject of extreme importance, there was, unfortunately, no Government policy, no central authority, no co-ordination between Government departments, nobody in a position to speak or act on behalf of the Government. There was a total absence of co-ordination and no authority to whom one could apply for any guidance whatsoever. The company's interests abroad continued to develop in a satisfactory manner. In the United States of America a

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new company had been formed, with the title of the Pan-American Telegraph & Telephone Co., for erecting stations for a commercial service of wireless telegraphy between North, Central and South America. The shares of the company were held as to 40 per cent. by the Marconi Wireless Telegraph Co. of America, as to 20 per cent. by the Federal Telegraph Co. (owners of the Poulsen system in the U.S.A.), and as to 40 per cent. by their company. It was intended to proceed immediately with the erection of high-powered stations. The Marconi Company of America had declared a dividend of 5 per cent. for the past year, and their works had been increased in order to cope with Government orders. The whole of their long-distance and coast wireless stations were under the control of the Government for the duration of the war upon agreed terms. The Marconi Wireless Telegraph Co. of Canada had made good progress, and a fair profit had resulted. After a review of the work of the other subsidiary companies, Mr. Isaacs said the war had restricted its sphere of action of the Relay Automatic Telephone Co. It had, however, been able to do some business, notably that of installing its system at Australia House, among other large establishments, where it was working to perfection. In his opinion the company had a great future after the war. Unquestionably automatic telephones would be the order of the day when circumstances changed, and there was, he believed, no automatic system as excellent as that of the relay.

NORTH MELBOURNE ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.) The gross receipts for the year ended Sept. 30 last were £39,361, compared with £40,358 in the previous year. Expenses increased from £28,888 to £30,429, and net revenue was £8,932, against £11,470. In tramways department 482,461 car-miles were run, as compared with 526,836, and passengers carried were 3,455,011, as against 3,782,430. In lighting department 206 new consumers were connected, making a total of 2,333 connections.

SINGAPORE ELECTRIC TRAMWAYS (LTD.) - At the recent meeting the chairman (Sir Frank A. Swettenham) said that last year's traffic receipts were £1,140 better than in 1916, and the receipts from the sale of electric energy also increased by £1,060; but costs had also increased. The cost of coal, which had for some years been under $10 per ton, in 1916 was $12.64; but in 1917 the average price was $25½, and in February last Japanese coal was costing $31 per ton, and Rawang coal (which they used to purchase for $6) was now over $9. The latter coal could only be used to a moderate extent for mixing with better class coal, as its calorific value was low, and it was a coal which could not be stored in very large quantities owing to the risk of combustion. Resulting principally from the increased cost of coal, the difference between the cost of the Diesel unit and the steam unit was greatly accentuated, the steam unit costing about 3¼ times the Diesel unit. Unfortunately, this year they would have to depend more on steam, as in December last the crank shaft of the largest of the three Diesel engines broke and was out of use. More than half of their energy was developed by the Diesel plant, and they had arranged with the engine builders for their representative in the East to go to Singapore and report on the breakdown. They were now supplying the municipality with electricity at a loss, and they were endeavouring to get an increased price for the supply.

TROWBRIDGE ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting the chairman (Mr. J. H. Blake) said the profit on the year's working was £622, and with £31 brought forward the available total was £653. Dividends of 7½ per cent. on the ordinary and 5 per cent. on the preference shares were declared. A sum of £258 was placed to depreciation account, £100 to reserve and £82 carried forward. The revenue had considerably increased, due to the power load. The plant had been working at very high pressure night and day, and heavy repairs would have to be faced, hence the amounts placed to depreciation and reserve.

YORKSHIRE ELECTRIC POWER CO.—The report for the half-year ended June states that after payment of bank and other interest the net profit is £23,683, against £17,617 and £13,550 for the corresponding periods of 1917 and 1916 respectively. The dividend for the half-year on the 6 per cent. cumulative preference shares has been paid, but in view of the financial conditions arising out of the war the directors are deferring payment of a dividend on the ordinary shares until the accounts are made up for the year. The second 6,000 kw. turbo-alternator at Thornhill power station is now in use. The Bill to extend the company's powers has received the Royal assent. The Act empowers the company and local authorities who have electricity undertakings to make working agreements and to enter into joint schemes for co-ordinating the whole of the existing supply undertakings in the company's area. The association of the company with Bradford Corporation for joint working has been extended by a further agreement, and arrangements have also been entered into with the Corporations of Sheffield and Rotherham having a similar object in view.

New Companies, Mortgages and Charges, &c.

BAT MOTOR MFG. CO. (1918) (LTD.) (150,962).—Private company, reg. July 15, capital £60,00 in £1 shares, motor-car manufacturers, dealers and agents, electrical engineers, &c. First directors are: E. R. Godar and A. van den Dries. Reg. offices: 2-4, Kingswood-road, Penge, S.E. 20.

PLATIT (LTD.) (151,024).—Private company, reg. July 23, capital £10,000 in 5,000 20 per cent. preference shares of £1 each and 100,000 ordinary shares of 1s. each, to take over the business of chemical and electrical plating and all other kinds of plating carried on by Agnes Dalby as "Dalby's Patents," with the patents granted in certain countries First directors are: - E. R. N. Hyde, J. Lee and Agnes Dalby (managing director). Reg. offices: 63, Finsbury pavement, E.C.

THOMAS SMITH & SONS (RODLEY) (LTD.) (150,707)—Private company. Reg. June 12, capital £150,000 in £1 shares (50,000 preference), to take over the business of mechanical and electrical engineers carried on as Thomas Smith & Sons, also to carry on the business of tool makers, iron and steel converters, &c. First directors are F. H. Smith, W. T. Smith and G. E. Smith. Reg. office: The Steam and Electric Crane Works, Rodley, near Leeds.

Mortgages and Charges.

RECORD ELECTRICAL CO. (LTD.)—Issue on May 25, 1918, of £500 debentures, part of series of which particulars have already been filed.

YORKSHIRE ELECTRIC WIRING & MOTOR CO. (LTD.)—Mortgage on leasehold premises at Sheffield, &c., dated May 4, 1918, to secure all moneys due or to become due from Company to London County and Midland Bank.

City Notes.

CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.)—An interim dividend at rate of 4 per cent. per annum has been declared for the past half-year.

CHARING CROSS, WEST END AND CITY ELECTRICITY SUPPLY CO. (LTD.)—The directors have decided not to pay an interim dividend on the ordinary shares of the West End undertaking.

CHATHAM & DISTRICT LIGHT RAILWAYS CO.—An interim dividend at rate of 8 per cent. per annum (8s. per share) has been declared on the ordinary shares for the past half-year.

COMPANIES TO BE STRUCK OFF THE REGISTER.—The following companies will be struck off the register of Joint Stock Companies unless cause to the contrary is shown before Aug. 24: Argentine Electrolytic Synd., Armour Plate (Cowper-Coles Patents), Bachelet Levitated Railway, Crowther & Co.'s Electrical Industries, Davis Electrical Co., Electromobile Co., Miners' Lamp Electric Lighting Co., Salt Lake & Ogden Gas & Electric Light Co., Spiral Regulating Dynamo Co.

FIFE TRAMWAY LIGHT & POWER CO. (LTD—The company is inviting applications for £130,000 5 per cent. debenture stock at 89 per cent.

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD.)—An interim dividend at rate of 7 per cent. per annum (less tax) is recommended for the half-year ended June 30.

The Round Table.

By "kVA."

The "Daily Chronicle" recently had an amusing article on subjects for election "stunts," which were discussed in an imaginary conversation between the candidate and his Political Agent. The conclusion finally arrived at was as follows:—

"The gas and coal ration, you know. We have the winter coming on. A good campaign against compulsory frigidity ought to have a kick in it."

"There's something in it."

"It is mean! It is bad! It is crass! To rob a poor man of his gas!"—recited the P.A.

"Cold—by Act of Parliament," said the candidate with a platform shiver.

"Coal and electric light don't lend themselves very kindly to popular treatment," mused the P.A. "But gas. Why, it's second nature to an Independent candidate. Give it 'em, my boy." The Political Agent lowered his feet and stood on them. "Never shall it be said—you know the line—that I stood idly by while you, my fellow citizens, were robbed of your legitimate supply of gas. Never! Gentlemen, for four long years we have put up with the bungling and muddling of stupidity, but this crowning act of folly is past all bearing. You shall not be robbed of your gas. I will see that you get it——"

But the Candidate had leaked out.

* * * *

Thirty-Seven Years Ago.

[From The Electrician, August 6, 1881.]

Electric Light at Naples.—The railway station at Naples has been for some time past illuminated by five electric lamps, said to be each equal to 50 gas lights. The lamps are worked by Gramme machines, and are said to have given satisfaction.

Electricity and Our Navy.—It is stated that revised instructions have been issued by the Admiralty for the planning and fitting of electric and torpedo gear in ships of the Navy. The position, arrangement and fitting of all machines for the generation of electricity, circuit lights, torpedo gear and wire leads, pumping and charging columns, for either ship or boat are to be planned with the concurrence of the captain of the Vernon School Torpedo Ship at Portsmouth When completed, and if possible before a ship is passed into the first division of the Steam Reserve, the Captain of the Naval Torpedo School is under directions from the Admiral Superintendent to cause the whole of the fittings to be tested and inspected.

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CONTENTS.

NOTES 327
The Use of High-Pressure and High-Temperature Steam in Large Power Stations. By J. H. Shaw. Illustrated 330
Electric Winding Engines and Mine Hoists. By H. H. Broughton. Illustrated.—*Continued* 332
Contract Prices During Demobilisation 336
Crystalline Wire and Its Application to the Incandescent Lamp. By F. Schroter 337
The Normalising of Carbon Steel 337
ELECTRICITY SUPPLY UNDERTAKINGS AND THE WAR 338
REVIEW 338
The Construction of Abaci. By A. B. Eason. Illustrated 339
The British Scientific Products Exhibition 341
Commercial Topics 342
Electricity Supply 343
Tenders Invited and Accepted 345
Companies' Meetings and Reports 346

Notes.

The British Scientific Products Exhibition.

WE give elsewhere a brief account of the meeting of the Circle of Scientific Technical and Trade Journalists held on Monday last at the British Scientific Products Exhibition, which was officially opened by Lord Sydenham on the following Wednesday. We propose to refer more fully to the exhibits in subsequent issues; on the opening day there were naturally some sections of the Exhibition still receiving the finishing touches. It is evident, however, that there is much of genuine interest, not only to the technical expert, but to the general public, and we hope that the enterprise of the British Science Guild will be rewarded by a corresponding stimulus to public appreciation of the value of science. The descriptive catalogue is arranged in an interesting manner, the summaries of progress which precede the account of the exhibits being a valuable feature. In an exhibition of this kind much depends on the method of presenting exhibits, and on the facilities for explanation. To the man in the street the ingenuity and industry involved in the production of a chemical dye or drug, a special variety of optical glass, a magneto and similar exhibits which are small in bulk is not readily apparent. We are glad to note, therefore, that a series of lectures during the course of the exhibition is being arranged. Prof. GREGORY'S address to the gathering of journalists on Monday last was a model of what such an exposition should be. He infused into his presentation of technical facts an element of imagination which captured his audience at once, and did not fail to emphasise the fact that all such applications have their root in the pursuit of science for its own sake, and develop only in the congenial soil of generous facilities for higher education. In formally opening the exhibition on Wednesday, Lord SYDENHAM referred to our unpreparedness for war four years ago. Not only were we unprepared from the military point of view, but we were singularly weak in certain industrial lines owing to our dependence on Germany for many "key" industries. Through the work done by scientific men this position has now been entirely altered. The present exhibition will serve a very useful purpose if it brings home to the general public that the scientific men of this country are well able to hold their own against German competitors, and that originality is rather a British than a German quality.

Daylight Saving in the United States.

THE "Electric Journal" quotes some interesting data from an address recently delivered before the Electrical Development League of San Francisco by Mr. S. INSULL, President of the Commonwealth Edison Co., in Chicago, in which he gave some account of the anticipated results of the application of the daylight saving scheme in America. It is estimated that the application of the scheme for seven months in the year will lead to a saving of about 300,000 tons of coal, but will occasion a gross loss in revenue to supply companies of about $9,500,000. Deducting the saving on fuel, estimated at $900,000, there remains a net loss of approximately $8,500,000. It is interesting to observe, however, that, according to Mr. INSULL'S views, the change does not go far enough. He argues that, if daylight saving were made effective throughout the entire year the day power load and the evening lighting load would not overlap to so great an extent as at present. Therefore, if the change were applied all the year round, not only would an additional 100,000–125,000 tons of coal be saved, but upwards of 400,000 kw. capacity would be released. This would also involve a release of capital of 150–200 million dollars, because the electricity available by the reduction of the winter peak could be sold for the purpose of supplying essential industries. While, therefore, there are admitted drawbacks to an "all-the-year" daylight-saving scheme in other directions, it would appear to have certain advantages from the standpoint of economising electricity supply.

Depreciation and Obsolescence.

ALTHOUGH the Board of Inland Revenue has allowed deductions on account of wear and tear to be made since 1878, and has permitted an allowance for obsolescence since 1897, it is only during the war that the latter allowance has been made statutory. In fact, during the last year or two the Board have shown a much greater tendency to look upon profits a little more from the point of view of the manufacturer than was the case formerly. Doubtless considerable differences still exist, and the average surveyor of taxes will certainly show quite a profit from accounts where the average board of directors would show none. Matters, however, have moved in the right direction and the state of affairs has now been rendered still more clear by a Memorandum which has been issued by the Board of Inland Revenue. Very naturally, during the war exceptional cases of wear and tear have arisen. There are also cases where machinery and plant are temporarily out of use and where controlled concerns have undertaken exceptional expenditure which may be of little or no post-war utility. In such cases relief may be claimed. With regard to wear and tear, a rate of 5 per cent. is allowed in the case of electrical plant. In all probability this figure has arisen in connection with plants which were run on comparatively low annual load factors, such as 20 per cent. In these days, however, the load factor is rising steadily, and may amount to 40, 50 or 60 per cent. Under these circumstances it may be doubted whether 5 per cent. is sufficient, although it must be remembered that this figure is in addition to any allowance

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in respect of repairs. The Memorandum issued by the Board will certainly be useful and should be studied by all who are responsible for industrial undertakings.

American Engineers and War Service.

As we have mentioned previously, engineers in this country are naturally watching with interest the step being taken in the United States to mobilise technical men for war service. Information hitherto received has suggested that the United States has profited by our mistakes in this direction. We observe in the "Electrical Review and Western Electrician" that the Engineering Council has available a classified list of 25,000 engineers, and unclassified lists of many more, and that 10 to 15 per cent. of the memberships of the associated engineering institutions (with a total membership of about 50,000) are in the service of the Army and Navy, while many others are doing equally valuable work as civilian engineers. This appears an encouraging record. Yet we observe that there is still a fear that technical men may be drafted into the Army without proper regard for their qualifications. The Engineering Council recently drafted a strongly-worded resolution on the subject, which was submitted to the Secretaries of War and of the Navy. We imagine that representations by this body, constituted by the American Society of Civil Engineers, the American Institutes of Electrical and Mining Engineers and the American Society of Mechanical Engineers—to mention only a few of the prominent bodies which are co-operating on the Council—will have the desired effect.

Institute of Metals.—The autumn meeting of the Institute of Metals will be held in the Rooms of the Chemical Society on Sept. 10 and 11, when a number of Papers will be read.

Water-power Development in Russia.—In view of the unrest in Russia, one would hardly anticipate any ambitious schemes for developing the water-power of the country; but, according to the "Zeit," the National Economic Council is considering the erection of electric power stations to utilise water-power on the Neva, Volkhov, Narova and other rivers. The requirements of Petrograd are being specially considered, and a station for this city is to be erected on the Volkhov, power being transmitted at 60,000 volts.

Aluminium Sleeves for Connecting Wires.—According to the "Zeitschrift des Vereines deutscher Ingenieure," aluminium sleeves are being utilised on the Austrian telegraph systems for the connection of iron wires, the intention being to avoid using solder, which is very scarce, as well as to save time. Copper sleeves were formerly employed, but are now difficult to obtain. The sleeves are said to withstand the effect of corrosion very well, although electrolytic effects have been noticed. The results are sufficiently hopeful to render it likely that the same method will shortly be applied to transmission lines.

Industrial Applications of Magnesium.—Since the outbreak of war many new uses have been found for the metal magnesium. In combination with aluminium and other metals, it produces an alloy, with a specific gravity about half that of aluminium, which is largely used for aeroplane parts. On the other hand, if the weight has only to approach that of aluminium, a considerable admixture of heavy metals is possible: an alloy containing only 10-30 per cent. of magnesium is stated to have great strength. The formulæ of some compositions containing magnesium and aluminium recommended for use in automobile and aeroplane construction are given in "Metallurgical and Chemical Engineering." Reference is made to a recent patent claiming that 92 per cent. of magnesium and 8 per cent. of aluminium gives an alloy of specific gravity 1·75, with a strength equal to that of gunmetal. Before the war practically all the magnesium used in the United States came from Germany, but it is now being produced in America in relatively large quantities.

Acid-Resisting Ferro-Silicon Alloys.—Mr. Camille Matignon, in the "Comptes Rendus," gives the results of some corrosion tests conducted in 1913 on various ferro-silicon alloys. These alloys contained 13-17 per cent. of silicon, nearly 1 per cent. of manganese and traces of phosphorus and sulphur. Various other compositions derived from Germany and Italy are also mentioned, including ferro-boron. The corrosion tests were made in boiling nitric acid and in boiling mixtures of acetic acid and butyric acids, concentrated and diluted, the tests being in some cases continued for 360 hours. Ferro-boron was easily attacked, and none of the alloys resisted hydrochloric acid.

Modern Uses of Asbestos.—In "La Nature" an interesting account is given of the chief sources of asbestos and its chief applications. The asbestos of commerce comes largely from Italy, although supplies are also available from Canada, Siberia, Natal, Cape Colony, Corsica and the United States. Canada gives the best yield, producing about 100,000 tons annually. The working of the asbestos quarries and the subsequent spinning of the fibre into yarn are illustrated. Asbestos, in addition to its well-known applications for work where its non-inflammable nature is important, has found many special uses—*e.g.*, for packing piston rings and in the production of self-lubricating ropes. It also serves as the bases of many insulating materials when it is incorporated, as powder, with gums and rubber, the material being subsequently vulcanised.

The Electrification of Pumping Stations.—By the electrification of its pumping stations on the Shawmont-Roxborough filtration system, the Philadelphia Water Bureau has recently effected a considerable saving in fuel. An account of the process is given by Mr. H. R. Cady in the "Engineering News-Record." Several small pumping, power and lighting loads have been combined, and the work of the boiler equipment centralised, with the result that fuel consumption is reduced more than 70 per cent. and 4,000 tons of coal are saved annually. Particulars are given of the operation of the electric system, which, besides carrying on the standpipe and lift pumpage, also furnishes power for lighting, driving filter-wash pumps, sponge washer, coal conveyor, machine shop and other auxiliary plant. Besides the fuel saving, there has been a considerable reduction in the cost of maintenance.

The Recovery of Potash.—Various recent contributions to the discussion of methods of recovering potash are dealt with in the last number of the "Journal" of the Society of Glass Technology. Among the materials recently treated is glauconite or greensand, which has the advantage of being almost free from soda, and contains 6-7 per cent. of K_2O, which can be almost completely recovered. Another advantage is that the residue after treating this material for potash can be profitably employed as a building material. About 100 lb. of K_2O and binder material for 20-30,000 bricks are obtainable from each ton of greensand. Another source of potash mentioned is the bitterns of the salt works in San Francisco Bay, which it is estimated would add 10 per cent. to the present potash production in the United States. In this country much attention is now being given to the treatment of blast furnaces and cement works dust. The spent liquor obtained in Scottish practice seems to deserve more attention than the fluedust, which only contains about 3 per cent. of potash. Yet another possible source is by the treatment of wool-scouring waste.

The Determination of Internal Phase Angle in Alternators. Prof. A. Blondel contributes to "L'Industrie Electrique" an account of a method by which the phase displacement between the internal E.M.F. and the terminal voltage of a motor may be determined. A disc with equi-distant lines, equal in number to the poles on the machine, is attached to the shaft and illuminated by an intermittent source of light, supplied from the machine or from a spark discharger in synchronism with it. The position of the lines at the moment of illumination is observed, first with the alternator unloaded and subsequently with the machine loaded. The difference in angle thus noted gives the phase difference between internal E.M.F. and terminal voltage. By means of an ammeter, voltmeter and wattmeter

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the external phase angle between current and terminal voltage can also be determined, whence the phase angle between current and internal E.M.F. may be deduced.

Air Screens for Furnaces.—In the "Zeitschrift des Vereines Deutscher Ingenieure" an account was recently given by Mr. F. Wellmann of the latest methods employed in Germany for screening furnaces. Workers tending furnaces, and required to examine the glowing material at frequent intervals, suffer from the excessive heat radiated, and various devices have been tried to minimise these ill-effects. For example, hollow furnace doors cooled by water have been used, but this is obviously only a protection whilst the doors are closed. Again, devices have been installed for drawing off the hot air in front of furnaces by means of centrifugal exhausters placed in front of the furnace opening. An objection to this method is that workers, when approaching the furnace are subjected to great variations in temperature which are prejudicial to health. According to Mr. Wellmann, the most effective device is the installation, immediately behind the furnace door, of a narrow slit through which cold air is blown upwards, thus interposing a screen of relatively cool air between door and furnace. This arrangement is stated to give adequate protection to the worker, and has the incidental advantage that the outflow of flames when the doors of the furnace are opened is checked. Full particulars of the design of this ventilating device are given.

Diesel Engine Users' Association.—Several new members were elected at the July meeting, and the usual annual donation to the benevolent fund of the Institution of Electrical Engineers was voted.

Correspondence was reported with the Board of Trade in regard to exempting from the operation of the Lighting, Power and Heating Order (so far as electricity supplies are concerned) consumers in areas in which electricity is generated by means of Diesel oil engines, on the ground that such electrical undertakings had already effected an important economy in the use of coal.

The President (Mr. Napier Prentice) announced that at a meeting in the autumn a Paper on the general subject of Semi-Diesel Engines would be read.

There was a short discussion on the subject of a recent alteration in the nature of certain lubricating oils used by members of the Association, and some criticism in connection with the supply to certain undertakings of a "substitute" oil in place of the lubricating oil formerly supplied. A discussion of considerable interest took place on the Paper on "Atomisation and Turbulence," which had been presented at the previous meeting by Mr. P. H. Smith under the title of "Two Essential Conditions for Burning Tar Oil in Diesel Engines." In his reply, Mr. Smith gave information concerning the advantages and diasdvantages of the different systems of burning tar oil in varying conditions of loading and size of cylinders. Referring to questions that had been asked concerning mixtures of petroleum fuel oil and tar oil, Mr. Smith stated that he did not think mixed oils satisfactory, and that he would much prefer to run an engine on a straight oil.

The Marvin Pyrheliometer.—The behaviour of the Marvin pyrheliometer is discussed in some detail by Mr. P. D. Foote in a new publication of the Bureau of Standards (Scientific Paper No. 323). The instrument was calibrated by two methods: (1) A known amount of electrical energy was dissipated in the receiver; and (2) a known amount of radiation from a black body was allowed to fall upon the receiver in the same manner as when the pyrheliometer is employed for solar measurements. The calibration by the two methods agreed very closely. The various constants of the instruments were determined. The fundamental constant, relating the amount of energy received with the rise in temperature of the receiver, is independent of the rate of energy supply—at least for an electrical calibration. This fact could not be determined with certainty for a radiometric calibration, because the amount of energy which can be supplied radiometrically from a black body is much less than that for which the instrument was designed. The Marvin pyrheliometer has been compared by solar observations with U.S. Weather Bureau Smithsonian standardised pyrheliometer S.I. No. 1, which had been calibrated by comparison with the Smithsonian primary standard water flow pyrheliometer. The Marvin instrument gave 2 per cent. lower values than the Smithsonian pyrheliometer—a difference within the errors of observation in the calibration of the Marvin pyrheliometer by the methods employed above.

An Electric Brass Furnace.—Our contemporary, the "Electrical Review," of Chicago, states that the U.S.A. Bureau of Mines recently announced the perfection of a type of electric melting furnace that may be revolutionary in the making of brass.

Patents covering the furnace (known as the Rocking electric furnace) have been taken out by the Bureau, and have been assigned to Secretary of the Interior (Mr. Lane) as trustee. Free licenses to operate the furnaces, it is stated, can be obtained by making application through Mr. Van H. Manning, director of the Bureau of Mines. The new furnace, which it is claimed will reduce the important losses in brass melting, is the result of five years' experimental work by Mr. H. W. Gillett, chemist of the Bureau of Mines, in co-operation with the laboratory of Cornell University, the American Institute of Metals and some brass manufacturers.

Up to the present most brass has been made in costly crucibles of imported clay and graphite. Since the war it has been impossible to obtain the imported materials for crucibles, and manufacturers have had to put up with crucibles of much poorer quality, and at a cost many times that of pre-war prices. With the huge tonnage of brass needed for war purposes, manufacturers have been anxious for a solution of the crucible problem. The Bureau states it is inevitable that the next few years will see electric furnaces largely replacing crucible furnaces, and that there will be a development comparable to that seen in the steel industry in the last few years. The electric furnace, it is also declared, will greatly decrease the loss of zinc, which, together with copper, makes brass. Zinc boils at a much lower temperature than copper, and there have consequently been large losses in the open crucible furnace through volatilisation of the zinc. The electric furnace is closed, and these losses are avoided. It is estimated that the unnecessary losses in brass making are more than $3,000,000 a year in normal times, and perhaps $10,000,000 a year in war times. Another claim for the electric furnace is that it gives healthier working conditions for the men. The Michigan Smelting & Refining Co. (Detroit, Mich.) already has one of the furnaces in operation and has four more under construction. The C. B. Bohn Foundry Co., of Detroit, is also building two of the new furnaces.

Power for Colliery Winding.—Mr. H. F. Bulman, discussing at last Saturday's meeting of the North of England Mining Institute a Paper dealing with the installation of an overhead Koepe winding plant at Plenmeller Colliery, Northumberland, gave a series of interesting calculations as to energy utilised in winding engines at collieries.

In the case of Plenmeller, with the plant working at about half capacity, the actual steam consumption was about 23 lb. per shaft-horse-power-hour, the colliery generating sets taking 17 lb. to 18 lb. of steam per unit. (He remarked in passing that turbo-generators were now constructed to give at full load a guaranteed steam consumption of 10·2 lb. per B.T.U.) On the authority of Mr. W. C. Mountain, the estimated steam consumption of winding engines at 13 collieries in various parts of Great Britain ranged from a minimum of 43 lb. to a maximum of 178 lb. per shaft-horse-power-hour, an average of 101 lb. It had been ascertained that the steam consumption of three winding engines at an Upper Silesian colliery ranged from 34·9 lb. per horse-power-hour to 134·8 lb. In the former case the engine was compound, working condensing, and in the latter a twin engine, working exhausting into the atmosphere. The average consumption of net winding steam for all three shafts was found to be 87·5 lb. of saturated steam per shaft-horse-power-hour. These figures showed by comparison the economy of the electrically-driven overhead Koepe winding plant at Plenmeller. Now that the plant at so many colllieries was driven entirely by electricity it would be useful if some normal standard of the mechanical power required per ton of coal produced and its cost could be ascertained. From figures supplied by the late Mr. Geo. Hann in a Paper on the Britannia Colliery (S. Wales), the consumption of power during one week in January, 1917, was 282,600 units for an output of 10,158 tons, or 28 units per ton. During a week in November of the same year it was 406,300 units for an output of 12,589 tons, or 32 units per ton. That gave an average of about 30 units per ton. As regarded the cost, in a recent discussion at the Scottish Institution the cost of mechanical power in ordinary colliery work was stated to be ¼d. per horse-power-hour, or £18 a year. In a modern factory, with fuel at 12s. 6d. per ton, when working about a third of full time, the cost of an indicated horse-power had been stated to be £12 a year. Where waterfalls could be utilised, as in Norway and Sweden, the cost of continuous power production was said to be as low as from 35s. to 50s. per electric horse-power per year. The cost of a horse-power-year generated by a 2,000 H.P. recovery producer-gas plant had been estimated by Mr. T. R. Wollaston to be £2. 17s. 11d. at pre-war prices, allowing credit for the ammonium sulphate and tar produced. Assuming that 3,000 H.P. was a normal requirement of mechanical power at a large colliery, the cost at £18 would be £54,000 a year. Evidently there was a considerable margin for economy, the importance of which was increasing as manual labour became more costly.

Obituary.

Prof. Olaus Henrici.—The death occurred on the 10th inst. of Prof. Olaus Henrici, Ph.D., F.R.S., who was formerly professor of mathematics and mechanics at the Central Technical College, Kensington.

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The Use of High-Pressure and High-Temperature Steam in Large Power Stations.*

By J. H. SHAW.

Summary.—The author considers the results of using high steam pressures and temperatures in boilers in power houses, and presents data showing the effect on efficiency and coal consumption for a wide range of conditions. Some modifications in boiler design, resulting from such higher temperatures and pressures, are discussed.

With the use of steam as a medium for carrying the heat contained in the coal from the boiler to the prime mover at present the greater part of the heat in the coal is lost. In the future we may use a substance, other than water, which will require less heat to convert it into gas, or the gas turbine may offer the solution But engineers are, for the time being, compelled to focus their attention on increasing the economy of plant using water as a heat conveyer, by increasing the working range of temperature and pressure. The upper

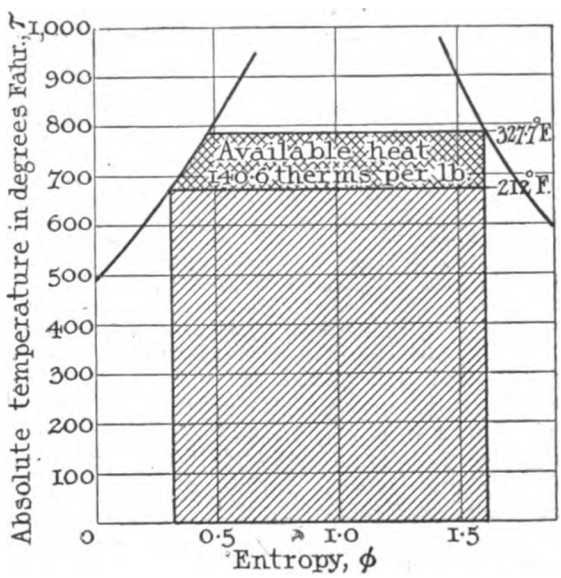

Fig. 1.

limit is perhaps the temperature at which metals lose their strength, and the erosive effect of the very hot steam on the blading of the turbine. The lower limit is decided by the locality of the power station. A bottom temperature of 75°F. to 80°F. is to be expected; 80°F. will give 28 in. vacuum or 2 in. absolute pressure. A station near a cold river or the sea, where the temperature of the water may be 55°F., can be equipped with condensing plant designed for 29·1 in. of vacuum—*i.e.*, 0·9 in. absolute pressure. Doubt exists as to whether it is more economical to increase the steam-temperature by superheating or to increase the range by the use of higher pressures and a moderate amount of superheat. An interesting plant has been installed by the British Thomson-Houston Company at Rugby, consisting of a B.T.-H. turbine and a Babcock & Wilcox marine-type boiler, capable of a normal evaporation of 18,000 lb. per hour with feed water at 80°F. (the pressure being 350 lb. per square inch, the final temperature of the steam after passing the superheater 700°F., and the test pressure of the boiler 525 lb. per square inch). Good results have been obtained, and the machine after a year's operation showed no undue signs of wear. At the Carville power station, Newcastle-on-Tyne, the latest section of the boiler house is designed for 275 lb. pressure, and at Glasgow the boiler pressure at the new works is to be 250 lb. per square inch. A good case can be made out for 600 lb. pressure with a total temperature of 700°F. to 800°F., but this will involve a considerable amount of development charges. Practically all existing apparatus can be so modified as to admit of pressures of 350 lb. to 400 lb. per square inch.

By the aid of the temperature-entropy diagram the gain due to increasing the working pressure and temperature ranges of the substance can be shown with advantage. Assuming frictionless, adiabatic expansion, Fig. 1 shows the amount of heat available in 1 lb. of dry saturated steam at a pressure of 100 lb. per square inch absolute (327·7°F.) expanding to 14·7 lb. per square inch absolute (212°F.), and is equivalent to 140·6 therms per lb. Figs. 2 and 3 represent the heats available per lb. of superheated steam expanding from 365 lb. per square inch absolute (736·4°F.) to 1·5 in. (mercury) absolute pressure (91·6°F.) and 500 lb. per square inch absolute (736·4°F.) to 1·5 in. (mercury) absolute pressure (91·7°F.). The amounts of heat available are 470·2 therms and 485 therms per lb. of steam respectively. True isentropic or unresisted adiabatic expansion involves no change of entropy, and would be shown on the diagram by a straight vertical line.

The expansion in a steam turbine is not isentropic, and is usually called adiabatic and resisted. Due to the friction, re-heating takes place during the passage of the steam through the nozzles and blades and the mixture gains in entropy. This gain can be calculated with considerable accuracy. Mr. Goudie, in his book on "Steam Turbines," has calculated a series of curves by which he arrives at the "re-heat factor"; these curves are reproduced in Fig. 4, and can be used for multi-stage turbines and pressures between 150 lb. and 200 lb. per square inch. The curves are likely to be low for higher steam pressures.

In the original Paper the author next presents a schedule comparing a comparison between the cost of running a power station at 200 lb. pressure (gauge) and at 350 lb. pressure for a riverside station, where the water is suitable for surface condensing. The comparison assumes 20,000 kw. sets, coal within a reasonable distance; the cost of the coal, with a net calorific value of 10,000 therms per lb., 10s. per ton at the works; incombustible contents of the coal, 20 per cent.; average water temperature, 60°F.; vacuum 28·5 in., with the barometer at 30 in. The overall efficiency of the boiler-house plant is assumed to be 77·5 per cent.

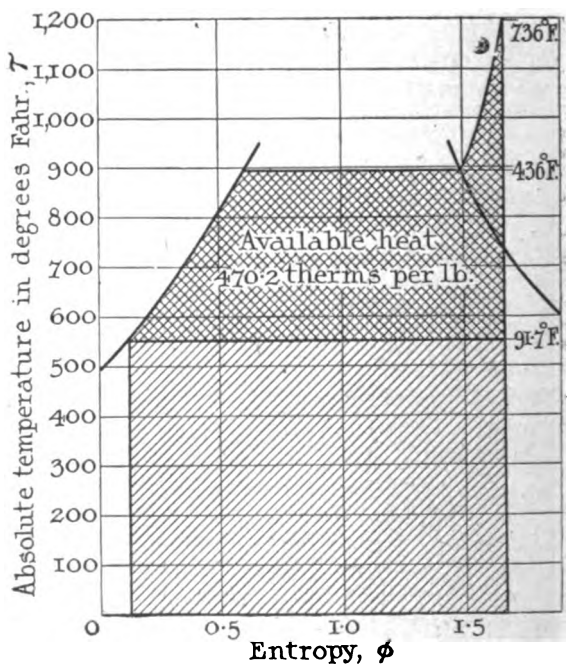

Fig. 2.

Turbine makers are not all in accord as to the efficiency of turbines of this size. One firm states that between 200 lb. pressure and 350 lb. pressure there will be a drop in ratio efficiency of 2½ per cent; other manufacturers state that efficiency at 350 lb. pressure and at 200 lb. pressure will be the same. Increased density of the steam at the higher pressure will doubtless increase the internal losses in the turbine, but there are other factors. We may, however, anticipate that the efficiencies of turbines of this size will be improved in the near future. A turbine ratio efficiency of 80 per cent. is assumed, at both 200 lb. pressure and 350 lb. pressure, with the steam superheated 150°F. and a constant vacuum of 28·5 in. The corrections used for obtaining the consumptions at different steam temperatures

* Abstract of a Paper read before the Institution of Electrical Engineers.

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are taken from Mr. Baumann's Paper.* A 20,000 kw. alternator can be built to give an efficiency of 97 per cent. at unity power factor, thus making the turbo-generator ratio efficiency $0{\cdot}80 \times 0{\cdot}97 = 77{\cdot}6$ per cent. If bearing and other friction losses absorb 2 per cent., the internal efficiency of the turbine will be 82 per cent.

The schedule presented by the author shows the cost for coal when generating 175·2 million kw.-hours with a load factor of 100 per cent. will be £64,400 at the higher pressure of 365 lb. per square inch (superheat 250°F) and £69,200 at the lower pressure of 215 lb. per sq. in., with corresponding superheat. This is a saving of £4,800 per 175·2 million kw.-hours, or 0·007d. per kilowatt-hour. In order to avoid assuming a curve of load and calculating the consumptions at partial loads, a convenient method of computation is to assume that the ratio of the station output to the total coal consumed is in accordance with Willans' law—*i.e.*, a straight line.

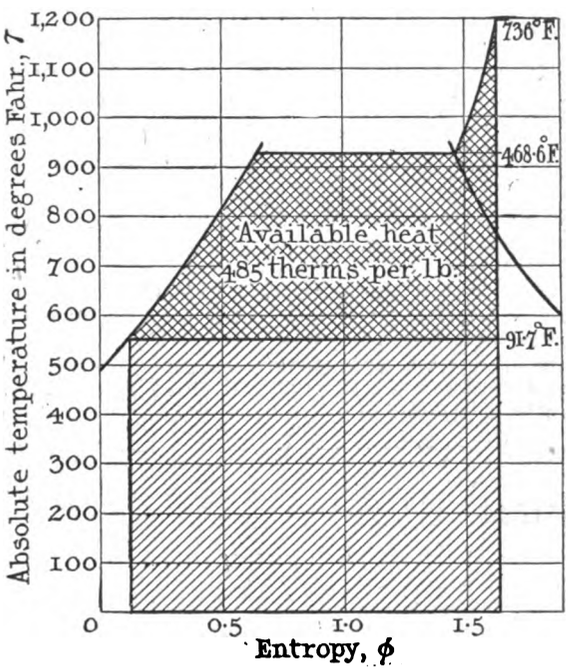

FIG. 3.

Fig. 5 is plotted from results obtained at the Bradford Corporation's Valley-road power station for a number of days in the year 1917, The weight of coal used is 60,000 lb. per day, no-load consumption. plus 2·32 lb. per unit generated. If we deduct the no-load consumption of one machine (5,500 lb. of steam per hour) from the works' no-load consumption, assume an evaporation of 6 lb. of water per lb. of coal, and call the figure so obtained the works' standing loss, we have :—

$60{,}000 \times 6/24$ = no-load consumption of works in lb. of steam per hour = 15,000 lb. of steam per hour.

Deduct the no-load consumption of one machine—

$= 15{,}000 - 5{,}500 = 9{,}500$ lb. of steam,

and $9{,}500/6 = 1{,}583$ lb. of coal per hour.

To arrive at an estimated figure for the power stations under discussion, it is assumed that the standing loss of the station designed for 200 lb. will be the same as for the Valley-road power station—*i.e.*, 1,583 lb. of coal per hour, and the same basis is taken for the plant at 350 lb. pressure, with 8 per cent. added to the works' standing loss, which is approximately proportional to the top temperature, as this affects radiation boiler exit losses, etc.

For a 20,000 kw. set the no-load consumption will be approximately 22,000 lb. of steam, or 3,666 lb. of coal per hour By the aid of several further assumptions the author arrives at the consumptions and costs as given in schedule.

A further schedule was also prepared in the original Paper, showing comparative coal costs of riverside stations working at 200 lb. per square inch (gauge), 300°F. superheat, and 350 lb. per square inch (gauge), 250°F. superheat, and 485 lb. per square inch (gauge), 220°F. superheat.

All the efficiencies and calorific values used in the previous schedule 1 are used again. At the pressures of 215, 365 and 500 lb. per square inch, the coal consumption per effective kilowatt-hour is

* K. Baumann, "Recent Developments in Steam Turbine Practice," "Journal" I.E.E., 1912, Vol. XLVIII., p. 768.

	Max. load of 20,000 kw., and 50 p.c. load factor $87{\cdot}6 \times 10^5$ units per annum.	
	209 lb. pressure 250 deg. superheat, 28·5 in. vacuum.	350 lb. pressure 250 deg. superheat, 28·5 in. vacuum.
Works standing loss in tons of coal.....	6,200	6,700
No-load consumption of turbo-generators in tons of coal	15,100	15,314
Load consumption of turbo-generators in tons of coal	65,300	59,867
Total	86,600	81,881
Lb. of coal per unit on station bus-bars	2·211	2·094
Total cost at 10s. per ton	£43,300	£40,940
Cost of coal per unit	0·119d.	0·1122d.

respectively 1·656, 1·62, and 1·536 lb., the corresponding costs of coal (at 10s. a ton) being £64,750, £63,300 and £60,100. A third schedule in the original Paper shows the coal required and power for auxiliaries for a cooling-tower station working between 200 lb. per square inch gauge, 250°F. superheat, and 350 lb. per square inch gauge 250°F. superheat exhausting against a back pressure of 1 lb. absolute pressure. Schedule 4 gives the relative steam consumptions with steam at a temperature of 688°F., 215 lb. per square inch gauge, 265 lb. per square inch gauge, and 315 lb. per square inch gauge, exhausting against a back pressure of 1·5 in. of mercury or 28·5 in. vacuum.

The foregoing relates only to the cost of coal ; the remaining items which make up the total works costs are less affected by the use of higher pressures and temperatures. Oil, waste and water are practically unaffected ; repairs and maintenance may be increased, but not to an appreciable extent. Capital cost of the plant may be affected to a considerable extent, but cannot be discussed at present. Whereas, before the commencement of the War a 5,000 kw. turbine, alternator and condenser could be purchased for £2·9 per kilowatt, a machine of 20,000 kw. capacity now costs £4·1 per kilowatt.

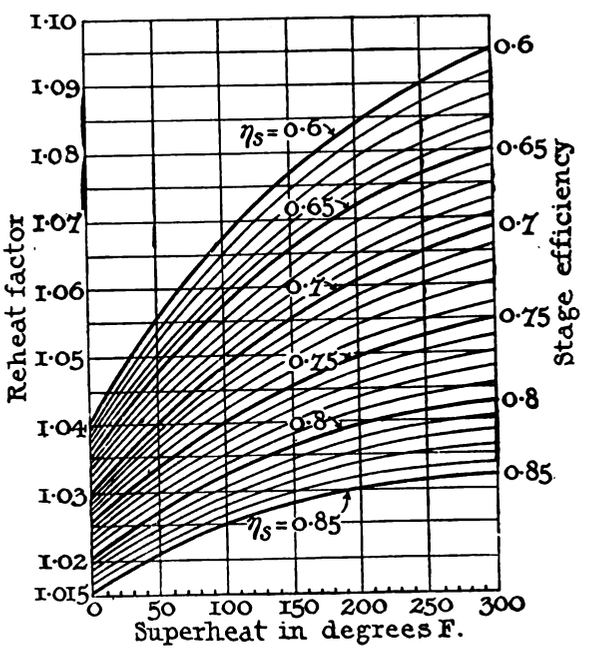

FIG. 4.

A radical departure will have to be made in present boiler construction before pressures of 500 lb. or 600 lb. per square inch are adopted. Square boxes and headers will be eliminated, the drums and tubes will be smaller in diameter, and the design of the boiler made more elastic, resembling a flash boiler, with practically no steam or water reserve, and fired by gas on the surface-combustion principle. For more moderate pressures, up to 350 lb. per square inch, the existing type of boiler can be modified and successfully used. Marine-type boilers are already being used, at 275 lb. and 350 lb. per square inch, and Messrs. Babcock & Wilcox have two boilers on order for a working pressure of 475 lb. per square inch with steam superheated to a final temperature of 700°F. With higher steam pressures the tempera-

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ture of saturation is raised, and greater care must be exercised in the quality of the water used for the boiler feed. The purer the water the greater affinity it has for air, CO_2 and oxygen, and every care should be taken that it is not exposed to the air between the condenser and the boiler. The feed pump should, therefore, be an extension of the condensate pump, and the condensed water pumped direct into the feed line.

The natural development of the turbine for higher pressures appears to be in a line with Parsons two-cylinder machine, with a

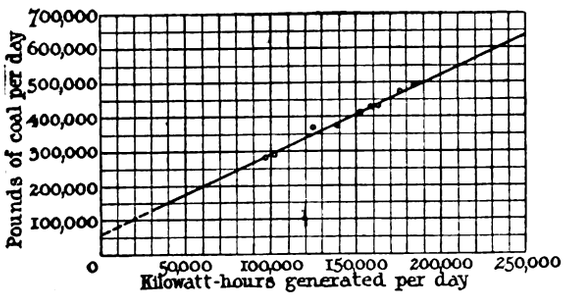

Fig. 5.

Station Conditions :—180 lb. per sq. in. (gauge); 100 deg. F. superheat; 28 in. vacuum; 30 in. barometer.

flexible claw-type coupling between the cylinders and a thrust bearing for each cylinder. For very large sets, above 50,000 kw, the cross-compound turbo-generator will no doubt be used, the high-pressure turbine being attached to a generator and the low-pressure turbine to another generator. Each set can then be run at its most suitable speed, with resulting high efficiency. The design of the condensing plant is not likely to be modified, but steam pipes will have to be very carefully designed, and the question of expansion at higher temperatures will be of the utmost importance.

The designer should ensure that the expansion would always take place lengthwise in the pipe range, and the main steam connections of the boiler will have to be designed in a flexible manner, in order to relieve the main range of stress. These connections should be of the manifold or header type—*i.e.*, made up of many small pipe connections. A large portion of the pressure drop in steam pipes as at present erected is due to the method of arranging ring mains and duplicate paths for the steam when certain parts of the main are down for joint making, and the provision of a duplicate path often so spoils the design that joints cannot be kept tight. If the piping is designed on the unit principle—*i.e.*, a number of boilers practically isolated on to one generating unit, a small equalising main only need be provided at the end of the boiler house. Ample arrangements can be made for expansion with such an arrangement.

Boiler mounting and valve makers are quite alive to the possibilities of high-pressure and high-temperature steam coming into commercial use, and valves for pressures up to 600 lb. per square inch, and temperatures up to 700° F. have been made in this country.

It must be admitted that in order to attain a higher overall efficiency it is necessary to increase both the pressure and the temperature of the steam. An increase of pressure with a constant temperature means that the dew point is carried further up the turbine towards the high-pressure end, thus tending to accelerate blade erosion in the lower stages and a reduced stage efficiency of the turbine. The high-pressure blading of a turbine is considerably less efficient than the low-pressure stages, and although the losses in the high-pressure end are partly recovered in the low-pressure blades, turbines for extra-high pressures may not be built with the same efficiency as one for a lower pressure. There is therefore justification for hesitation before adopting extra high pressures involving considerable expenditure.

Electric Winding Engines and Mine Hoists.*

By H. H. Broughton.

(*Continued from page* 227.)

Summary.—In this article a start is made with the mechanics of the winder. Simple expressions are given which lead to the evaluation of the cardinal points of the torque diagram of a balanced cylindrical-drum winder. Finally the derivation of the diagram by a step-by-step method is explained.

THE MECHANICS OF THE WINDER.

The engineering staffs of the larger mining and colliery companies usually decide on the kind of winder and on the system to be used before tenders are invited. In some cases with the specifications are issued the torque diagrams, as well as the ratings of the several motors and dynamos forming the equipment. Sometimes, however, it is found that the information accompanying an inquiry is too indefinite. The large electrical manufacturing companies do not, as a rule, rely on the information supplied by customers or mechanical firms, as the latter usually give the peak rating, or the output somewhere near the peak, as the normal rating. Although correct for the steam engine, it is very wide of the mark for the motor. The normal rating of an electric motor depends upon the heating, and this in turn depends upon the root-mean-square rating. Since an electric motor is easily capable of taking a peak torque of two to three times the torque corresponding to the normal rating, it will be seen how important it is to distinguish between the two.

In this section will be given methods for determining the torque at every instant throughout the wind and for finding the horse-power for typical drums. These methods will be used subsequently when we consider a number of winder problems.

The general case is that of an inclined shaft served by a conical-drum winder, and a complete solution of this problem would cover every kind of shaft and drum; but it is thought to be preferable to consider the vertical shaft in the first place, and to begin with the cylindrical drum.

Vertical Shafts.

In order to determine the size of motor for driving a winder working to a definite cycle of operations it is necessary to take into consideration the forces required for accelerating and retarding the lifted cage and load, and the dropping cage; and for accelerating and retarding the lifted and dropping ropes. Allowance must also be made for the inertia of the heavy winding drums, pit-head sheaves, motor armature and gearing (if any). In addition, friction and windage have to be provided for, and note taken of the effect of the decreasing and increasing weights of the lifted and dropping ropes.

As usually presented, the problem is to obtain a certain output from a known depth of shaft in a given time, which is so set as to allow for the unavoidable delays that always occur. The time for changing the tubs, or for filling and emptying the skips, is usually stated, as also is the weight of coal or ore per wind.

With relatively unimportant exceptions, the problem resolves itself into one of elementary dynamics. The careful perusal of an informative article entitled "A Winding Engine Problem" in "The Engineer"† is recommended, and it is there pointed out that it is not so much the knowledge of higher analytical mathematics that is required for tackling such problems, but rather the possession of a few simple expressions and formulæ in applied mechanics, and of graphical methods, combined with a thorough facility in applying them.

The total time the winder is in motion is made up of the accelerating, constant speed and retarding periods respectively. Assuming uniform acceleration and retardation, the maximum hoisting speed can be obtained when the times required for starting and stopping are known.

If the nett hoisting time be denoted by T, and if the starting, constant-speed and stopping times be t_1, t_2 and t_3 respectively, then

$$T = t_1 + t_2 + t_3 \text{ seconds.} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

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† December 11th, 1903.

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At the end of the starting period the velocity, in feet per second, is

$$v=a_1t_1, \quad \ldots \quad (2)$$

where a_1 is the acceleration in feet per second per second; and the distance moved through at the end of the starting period, reckoned since the commencement of the wind, is

$$s_1=a_1t_1^2\div 2. \quad \ldots \quad (3)$$

Substituting equation (2) into equation (3) gives

$$s_1=vt_1\div 2. \quad \ldots \quad (4)$$

During the whole of the constant-speed period the distance moved through is

$$s_2=vt_2, \quad \ldots \quad (5)$$

and during the stopping period the distance moved through is

$$s_3=vt_3\div 2. \quad \ldots \quad (6)$$

Therefore, since the depth L of the shaft is equal to $s_1+s_2+s_3$, by combining (4), (5) and (6) we have

$$L=(vt_1/2)+(vt_2)+(vt_3/2), \quad \ldots \quad (7)$$

and by inserting equation (1) for t_2,

$$L=v[T-\{(t_1+t_3)\div 2\}] \quad \ldots \quad (8)$$

Hence the full speed of the hoist will be

$$v=L\div\{T-(t_1+t_3)\div 2\} \quad \ldots \quad (9)$$

Or, if the full speed be fixed, the time available for acceleration and retardation will be

$$t_1+t_3=2\{T-(L/V)\} \quad \ldots \quad (10)$$

If the maximum speed of the drum be N revolutions per minute, then

$$N=60V\div 2\pi R,$$

where R=radius of drum in feet.

Knowing the acceleration a_1 and retardation a_2, and the maximum constant velocity v, it is possible to ascertain the distance of the cage, or of either cage in the case of a balanced winder, from the bottom or top of the shaft at all times during the wind. Thus, during the accelerating period, that is to say from $t=0$ to $t=t_1$, the distance moved through is $s=a_1t_1^2\div 2$. During the constant-speed period, namely, from $t=t_1$ to $t=t_1+t_2$, the distance moved through since the commencement of the wind is $s=s_1+v(t-t_1)$; and during the retarding period, from $t=t_1+t_2$ to $t=t_1+t_2+t_3=T$, the distance moved through since the commencement of the wind is

$$s=s_1+s_2+v\{t-(t_1+t_2)\}-a_2\{t-(t_1+t_2)\}^2\div 2. \quad \ldots \quad (11)$$

By means of these expressions the weights of the lifted and dropping ropes at any instant can be found. Knowing these weights, it is possible to determine the torque due to each rope, and hence the resultant rope torque, throughout the entire wind.

The torque required at the drum shaft to accelerate or retard the moving parts depends upon the mass and acceleration. Take, for example, a winding drum of radius R, weight W and radius of gyration r. A speed of v ft. per second is obtained at the periphery of the drum at the end of t_1 seconds, which gives at the radius of gyration a speed of $v\times r\div R$ ft. per second. With uniform acceleration, the acceleration a of a point at the extremity of the radius of gyration is $vr\div Rt_1$ ft. per second per second. Remembering that force is equal to the product of mass and acceleration, we at once get accelerating force

$$F=\frac{W}{g}\times\frac{vr}{Rt_1},$$

and the corresponding accelerating torque or moment at the drum shaft is

$$M=F\times r$$
$$=\frac{W}{g}r^2\times\frac{v}{Rt_1}.$$

Putting $v=\omega R$, where ω is the angular velocity in radians per second, it is found that

$$M=\frac{W}{g}r^2\times\frac{\omega}{t}$$

=moment of inertia×angular acceleration,

an expression familiar to all engineering students.

The inertia of the mechanical parts varies greatly with different builders. The total inertia is made up of rotating and travelling parts. Of these, the drums, sheaves, motor armature and gearing (if any) are rotating, and the cages, tubs, load and ropes are travelling.

In the preliminary design of a winder it is convenient to take the probable inertia of each of the rotating parts from data relating to existing winders or from curves. The importance of such data has long been recognised. Thus Mr. Hans C. Behr, in his Paper on "Winding Plants for Great Depths," read before the Institution of Mining and Metallurgy in 1902, said:

"In designing winding plants it is advisable to keep a detailed record of the moment of inertia of the parts of rotating members, as well as of their total moments of inertia. Such records will be useful, because from the data a sufficiently close guess can often be made for the moments of inertia in the designing of other plants, and thus a considerable amount of labour and time will be saved in arriving at the proper proportions of drums, engines . . . &c."

As this section of the article is introductory, we shall assume, for the time being, that all the necessary data are furnished with the inquiry. In a later section the subject will be dealt with at some length, and tabulated data and curves will be given.

Knowing the diameter of the sheaves, the equivalent inertia at the drum shaft can be found. Thus, if I_s=inertia and N_s=speed of sheaves, and if N=speed of drum, then

$$\text{Equivalent inertia of sheaves}=I_s(N_s\div N)^2.$$

The estimation of the inertia of the motor armature is less straightforward, since at this stage the size of the motor is not definitely known. Reference to tabulated data, the existence of which is here assumed, enables us to make an estimate which is sufficiently accurate for preliminary calculations. From an examination of many winders, the author has found that the horse-power of the motor is approximately $0{\cdot}122\times W\times V$ for geared winders and $0{\cdot}116\times W\times V$ for direct-coupled winders, where W is the nett load in tons* and V is the maximum winding speed in feet per minute. From either of these expressions, and knowing the speed of the motor, a fair idea of the size and weight of the armature can be found.

In the case of a geared winder, the equivalent moment of inertia at the drum shaft is

$$I_m(N_m\div N)^2,$$

where I_m=inertia of armature, N_m=speed of motor and N=speed of drum. The inertia of the gearing is small in comparison with the inertia of the winding drums and motor armature.

If the weights of the travelling parts are known, the inertia of these is readily obtained, since the radius of gyration is the radius of the drum. Thus, if w=total weight of all the travelling parts and R=radius of drum, the inertia of these parts is equal to $wR^2\div g$.

The friction and windage torque depends on the condition of the shaft, cages, guides and sheaves, as well as upon the winder and the winding speed. The allowance to be made is largely a matter of experience. As a rough guide, Mr. W. Sykes† states that for direct-coupled winders running at moderate speeds the friction may be taken as being equal to an extra load of 5 to 7·5 per cent. of the total suspended weight, including ropes, cages and load; and for geared hoists from 7½ to 10 per cent. Messrs. D. B. Rushmore and K. A. Pauly‡ give as an approximation 15 per cent. of the resultant torque due to load, cages, tubs and rope. Mr. R. Livingstone§ estimates the friction at the sheave and drum bearings separately, besides taking into account the pull required to bend the rope and allowing for windage in the shaft and for the friction of the guides. In a test made on an electric winder at the collieries of Espérance and Bonne Fortune, Montegnée, Prof. P. Habets‖

* All tons are of 2,240 lb. throughout the article.
† "Transactions" Am.Inst.E.E., Vol. XXIX., p. 291.
‡ "Transactions" Am.Inst.E.E., Vol. XXIX., p. 249.
§ THE ELECTRICIAN, Mining Issue, June 10, 1908, p. 33.
‖ "Proceedings" Inst.Mech.Eng., June 1905, p. 467.

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determined the friction and windage losses by giving the masses a certain velocity and measuring the height through which the useful load was lifted. He found that these losses amounted to from 4 to 9½ per cent. of the useful work done in lifting the load.

BALANCED CYLINDRICAL DRUM WINDER.

The above mechanical principles can now be applied to the winder, and we will begin by considering a balanced cylindrical drum winder without tail rope. Let

W=weight of material hoisted, in pounds.
W_c=weight of each cage, in pounds.
W_t=weight of tubs or trucks per cage, in pounds.
w=weight of rope, in pounds per foot.
L=depth from which the material is wound, in feet.
v=maximum rope speed, in feet per second.
t_1=accelerating time, in seconds.
t_2=retarding time, in seconds.
R=radius of winding drum, in feet.
M_a=accelerating torque, in pound-foot units.
M_r=retarding torque, in pound-foot units.
M_f=friction torque for complete mechanism, in pound-foot units.
M_1, M_2, M_3, &c.=torque at drum shaft during different parts of the cycle.

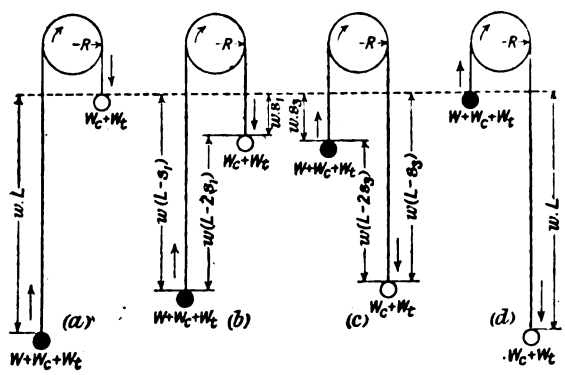

FIG. 5.—CYLINDRICAL DRUM WINDER.

Beginning of Wind.—From Fig. 5 (*a*) it will be seen that the torque M to sustain the load at rest at the bottom of the shaft is the difference between the torque on the loaded side and the torque on the unloaded side, or

$$M=(W+W_c+W_t+wL)R-(W_c+W_t)R$$
$$=(W+wL)R.$$

The torque required to start the load upwards with a uniform acceleration, a_1, must exceed the static torque by the amount necessary for overcoming friction and windage, and for accelerating.

$$M_1=(W+wL)R+M_f+M_a \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

End of Accelerating Period.—At the end of the accelerating period, and just before the constant-speed period begins, the weight on the loaded side, Fig. 5 (*b*), will be decreased by the weight of the length s_1 of the rope wound on the drum during the accelerating period. From the other drum an equal weight of rope has been unwound, so that the resultant load will be reduced by an amount corresponding to twice the weight wound on the drum during the accelerating period. Hence the torque on the drum shaft has been reduced by $2s_1wR$ lb.-ft. Substituting for s_1 from equation (4), the torque reduction is $vtwR$ lb.-ft. At the end of the accelerating period, therefore, the torque is

$$M_2=(W+wL-vtw)R+M_f+M_a \quad . \quad . \quad . \quad . \quad . \quad (13)$$

Beginning of Constant-speed Period.—At this point the accelerating torque drops out and the resulting torque becomes

$$M_3=(W+wL-vt_1w)R+M_f \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

End of Constant-speed Period.—At the end of the constant-speed period, and just before retardation begins, most of the rope has been wound on the drum on the loaded side, Fig. 5 (*c*), and a corresponding amount has been unwound by the descending cage. Hence, at this point, the condition is the reverse of that at the end of the accelerating period, and the torque required is

$$M_4=(W-wL+vt_3w)R+M_f \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

Beginning of Retarding Period.—When retardation begins the torque on the drum shaft is decreased by an amount, M_r. This gives a torque

$$M_5=(W-wL+vt_3w)R+M_f-M_r \quad . \quad . \quad . \quad . \quad . \quad (16)$$

End of Wind.—At the end of the wind, Fig. 5 (*d*), the rope on the loaded side is all wound on the drum and on the other side the rope is all unwound. At this instant, therefore, the load gives rise to a torque

$$M_6=(W-wL)R+M_f-M_r \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

Equations (12) to (17) give the torque conditions at the *cardinal points* of the wind, and the torque diagram is drawn by plotting the several points to a time base.

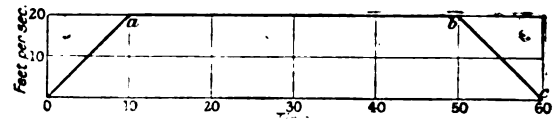

FIG. 6.—SPEED OF ROPE.

Precisely the same result is obtained by considering separately each item which contributes to the total torque. In some cases this is preferable to the method just described.

An example will serve to illustrate the method.

Example 1.—To draw the torque diagram for a balanced cylindrical drum winder intended for the following duty:—

Net load	6,000 lb.
Depth of shaft	1,000 ft.
Weight of each cage with suspension gear	4,000 lb.
Weight of each set of tubs	2,500 lb.
Diameter of rope	1⅛ in.
Weight of rope	3·0 lb. per ft.
Decking time	20 seconds
Net hoisting time	60 seconds.
Time per wind	80 seconds.
Accelerating period	10 seconds.
Retarding period	10 seconds.

Drums: Two, each 10 ft. diameter by 4·25 ft. wide.
Total inertia=40,000.
Sheaves: Total inertia=2,000.
Motor: Geared 8·2 to 1, about 300 H.P. Inertia=285.
Friction: 7½ per cent. of the load, cages and tubs.

From equation (9), the maximum winding speed v=1,000 ÷ {60−(10+10)÷2} =20 ft. per second, which corresponds to a drum speed of $20\times60\div10\pi$=38·4 revs. per min. approximately. The curve *oabc*, Fig. 6, shows the speed of the rope at every instant during the wind.

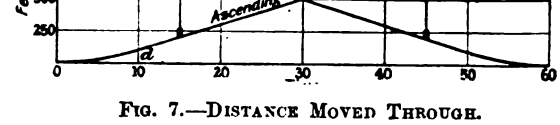

FIG. 7.—DISTANCE MOVED THROUGH.

The distance s_1 moved through during acceleration is $vt_1\div2=20\times10\div2$=100 ft., and since the accelerating and retarding periods are equal, the distance moved through during retardation will likewise be 100 ft. A distance $s_2=vt_2$ =20×40=800 ft. is moved through at constant speed. At the end of 10 seconds, therefore, the distance moved through is 100 ft., and at the end of 50 seconds the distance moved through, since the commencement of the wind, is 100+800 =900 ft. Hence the points *o*, *d*, *e* and *f* on the curve, Fig. 7, are known. To find intermediate points on the part *od* of the curve, take t=5 seconds as an example. As the acceleration a_1=20÷10=2 ft. per second per second, the distance moved through since the beginning of the wind is $s=2\times5^2\div2$=25 ft. Points on the part *ef* of the curve can be found by using equation (11). Thus, five seconds after retardation begins, that is, when t=55 seconds, $s=900+(5\times20)-(2\times5^2\div2)$ =975 ft.

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Torque Due to Ascending and Descending Ropes.

Time, t secs.	Distance moved through s ft.	Ascending rope. Weight, $w(L-s)$ lb.	Ascending rope. Torque $m_l = wR(L-s)$ lb.-ft.	Descending rope. Weight, $w.s$ lb.	Descending rope. Torque $m_d = wsR$ lb.-ft.	Resultant torque $m = m_l - m_d$.
0	0	3,000	15,000	0	0	15,000
2	4	2,988	14,940	12	60	14,880
4	16	2,952	14,760	48	240	14,520
6	36	2,892	14,460	108	540	13,920
8	64	2,808	14,040	192	960	13,080
10	100	2,700	13,500	300	1,500	12,000
12	140	2,580	12,900	420	2,100	10,800
...	...	...	...	...	...	...
48	860	420	2,100	2,580	12,900	−10,800
50	900	300	1,500	2,700	13,500	−12,000
52	936	192	960	2,808	14,040	−13,080
54	964	108	540	2,892	14,460	−13,920
56	984	48	240	2,952	14,760	−14,520
58	996	12	60	2,988	14,940	−14,880
60	1,000	0	0	3,000	15,000	−15,000

Resultant Rope Torque.—The torques due to the lifted and dropping ropes, as well as the resultant rope torque, may be determined arithmetically from a table connecting t and s. This has been done, and the rope torque curves have been plotted in Fig. 8. Assuming that the curve *og*, for the dropping

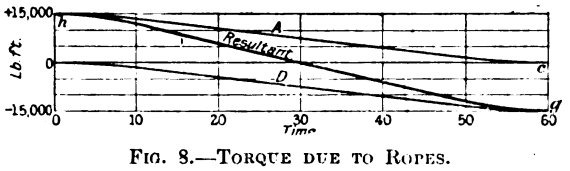

FIG. 8.—TORQUE DUE TO ROPES.

rope, has been plotted, then by shifting this curve bodily upwards till *g* and *c* coincide we get the torque curve *hc* for the lifted rope, and the resultant rope torque curve *hg* is found by subtraction.

A rapid graphical method of finding the rope torque at every instant is given at the end of this example.

Torque due to Load.—The positive torque due to the ascending cage, tubs and load=(4,000+2,500+6,000)5=62,500 lb.-ft. is set off above the datum line; and the negative torque due to the descending cage and tubs=(4,000+2,500)5=32,500 lb.-ft.

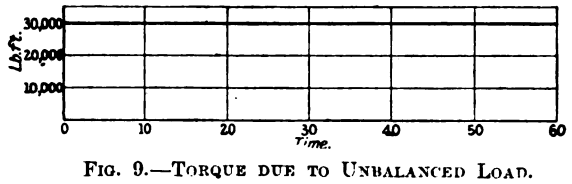

FIG. 9.—TORQUE DUE TO UNBALANCED LOAD.

is set off below the datum line. The resultant torque due to the ascending and descending cages (found by subtracting 32,500 from 62,500) is equal to 30,000 lb.-ft., and is represented by the line *jk* in the diagram, Fig. 9.

Torque to Overcome Friction.—The combined weight of two cages, two sets of tubs and the load is 2(4,000+2,500)+6,000 =19,000 lb., and the force to overcome friction=0·075×19,000

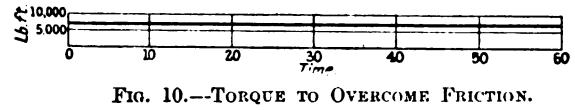

FIG. 10.—TORQUE TO OVERCOME FRICTION.

=1,425 lb. Hence the torque required to overcome friction =1,425×5=7,125 lb.-ft., and is plotted in Fig. 10.

Resultant Static Torque.—By combining the resultant torque due to the ascending and descending ropes, Fig. 8, with the resultant torque due to the ascending and descending cages, Fig. 9, and with the torque to overcome friction, Fig. 10, the resultant static torque due to the ropes, cages, tubs, load and friction is obtained. The torques referred to are combined in Fig. 11.

With the exception of the accelerating and retarding moments, all the moments have now been determined.

Acceleration and Retardation.—These moments are found from the total inertia and angular acceleration.

Inertia* of two drums	40,000
Inertia of two sheaves	2,000
Travelling part=(6,000+8,000+5,000 +5,400)5²÷32·2	=19,000
Inertia of motor armature=285×8·2²	=19,150
Total inertia	80.150

Angular velocity=$2\pi N \div 60 = 2\pi \times 38{\cdot}4 \div 60$ =4·0 radians per second.

Angular acceleration $\omega = 4 \div 10 = 0{\cdot}40$ radian per second per second

Angular retardation=4÷10=0·40 radian per second per second.

Therefore,

Accelerating moment, $M_a = 80{,}150 \times 0{\cdot}40$ =32,060 lb.-ft.

and Retarding moment, M_r=32,060 lb.-ft.

These moments are marked off above and below the datum line respectively, as shown in Fig. 12.

Total Torque.—By combining Figs. 11 and 12 the total torque diagram depicted in Fig. 13 is obtained. This is the diagram asked for in the example.

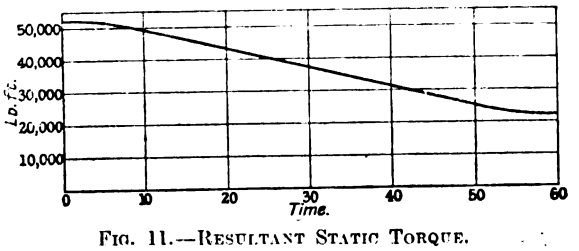

FIG. 11.—RESULTANT STATIC TORQUE.

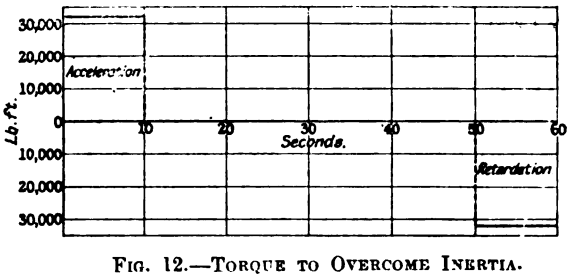

FIG. 12.—TORQUE TO OVERCOME INERTIA.

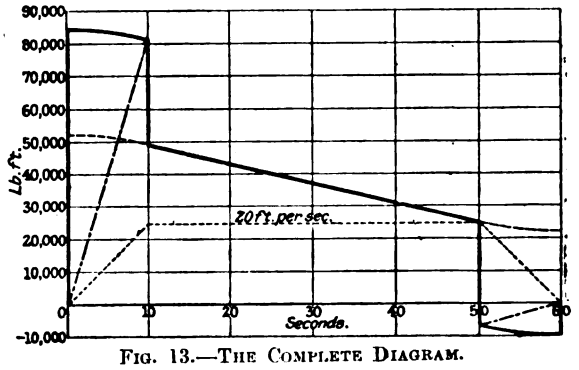

FIG. 13.—THE COMPLETE DIAGRAM.

The interested reader, having the necessary time at his disposal, is advised to substitute the given values into equations (12) to (17), and to make certain that the cardinal points of both diagrams are identical.

In practice one would never take the trouble to draw the curves, Figs. 6 to 12, for a balanced cylindrical drum winder. The author gives them at this stage because he has found that young engineers experience difficulty not only in grasping the principles, but also in applying them. This section of the work, it should be remembered, is written expressly for those having little experience to guide them.

(To be continued.)

* Inertia=$WR^2 \div g$, where W is the weight in lbs., R is the radius of gyration in feet, and g=32·2. Throughout the article we shall adhere to this definition.

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Contract Prices During Demobilisation.

The following is an account of a discussion which took place before the Manchester Local Section of the Institution of Electrical Engineers on Capt. Digby's Paper on the above subject. An abstract of the Paper appeared in THE ELECTRICIAN of Aug. 9.

The Chairman (Mr. C. J. BEAVER) said that the paper should receive just as efficient a discussion as that usually given to technical papers. This paper was exclusive to Manchester, but in London it had been arranged that a Committee should discuss the whole subject, with the object of determining what action the Institution shall take to promulgate the views of the Author.

Mr. FRANK WALKER agreed that the subject of costs and selling prices and their adjustment in accordance with the fluctuating conditions was of vital importance. The statistics given in the first and second sections of the paper, while of interest, could not be of national service. The campaign lasted only about 6 months, and the French indemnity was paid within 3 years and would not pay for one week of the present war. So great and complex were the forces at present involved that any forecasting of conditions after the war must be attended with a large element of uncertainty. After the war the cost of labour would remain high, while costs of the main materials presumably would be kept stable for a reasonable time by Government control. Much work ordered before or during the war would remain to be executed after its termination. The speaker referred to four phases of the problem, viz.: (1) Adjustment of basis selling prices concurrently with changing costs; (2) Alterations in cost that occur during execution of contracts; (3) After the war completion of contracts now deferred; (4) Machinery for regulating contract prices. The speaker then proceeded to discuss labour costs in some detail. In considering the cost of labour it was necessary to take into account not only the actual rate of pay, but also the quantity of work produced. Care must be exercised to include not only productive labour booked to the job, but also labour included in material, in drafting and erection, and in "oncost." "Standing charges," such as rent, rates and insurance, constituted actually only a very small proportion of oncost. Oncost expenses had increased equally with, if not more rapidly than productive labour. The following table showed three sets of increases in labour rates due to Government Awards:—

	Aug. 1914	Jan. 1917	Jan. 1918	Total increase + by 0·9
Skilled day workers .	39/-	46/-	66/4	73/6
Comparative %	100%	118%	170%	189%
Unskilled day workers	21/0	28/0	46/2	51/2
Comparative %	100%	133·3%	219·5%	244%
Women day workers .	15/0	19/8	30/0	33/4
Comparative %	100%	132%	200%	222·2%

Thus the increase during 1917 was more than double the total increase during the previous war period. The last column showed present-day comparative costs, assuming the output per man-hour reduced to 90 per cent. of its pre-war value, which probably represented a maximum ratio of output since the rush of recruitment in the first 6 months of the war. The cost of wholly or semi-finished parts, brought outside, or even made on "side orders" in the manufacturer's own works. Similar rapid increases have occurred in "raw materials," though stability in the prices of the metals mentioned has been effected and maintained by Government control. Owing to these increases the actual manfacturing costs during war had greatly exceeded the estimated amount on which the contract prices were based, so that losses had occurred on work already completed or still in progress. Similarly home and export contracts made before and during the war totalling millions of pounds could only be completed at costs exceeding the estimated costs not infrequently by as much as 100 per cent. The question of responsibility for this great excess cost was of great importance. Examples of the sliding scale suggested by Capt. Digby were the purchase of coal according to its calorific value, the variation of charges for electrical energy according to the price paid for coal, and the sale of large electrical machines and surface condensers subject to variations in the current prices of copper and of condenser tubes and plates. The extended application of this principle should be practicable where the quantity of any one material included in the product is sufficient to warrant its use, but this condition did not often apply to electrical and allied apparatus. During the last few months manufacturers had adopted the variable price clause, the essence of which was that "for each one shilling per week by which the rate of labour is increased by authorisation of the Government the contract price shall be increased by an amount corresponding to 1½ per cent. of the contract value or pro rata. Such increase in the contract price is to be in the same proportion as the unexpired period of the contract is to the total contract period." A considerably greater percentage would, however, be necessary for use in connection with pre-war costs.

Mr. STUBBS said that in regard to the terms under which tender prices may be adjusted provision should be made for adjustment as from the date of the tender and not from the "date of contract," which might be a month or two months or even more. Another case where the date was important was in relation to the Priority Certificate. From his experience he agreed that the increase in wages paid had exceeded the increase in the family food budget of all save the middle classes. In fact, he believed that the standard of consumption had risen.

Mr. S. L. PEARCE agreed that it would be necessary for the functions now exercised by the Priority Department of the Ministry to be continued by a Priority Department of some other branch of the Ministry. An extension of the sliding scale would have its advantages, but also its limitations. All articles could not be subjected to a sliding scale, and if contracts were formulated on that basis there could not be any very great divergence in the prices that would be submitted by different firms. The tendency would be practically to drive all manufacturers of a certain class of electrical goods into an association. A system of contracts on a sliding scale would have to be made compulsory. It would have to apply to all or else the aim of the author would not be secured. Whilst prices had gone up something like 80 or 90 per cent. or even higher, the price of electrical energy had not gone up in anything like the same proportion.

Ald. WALKER said that many tenders now contained a clause giving a very short period of acceptance. By this means the manufacturer could compel the purchaser to decide within a reasonable period instead of delaying for months, during which prices would change. A purchaser might prefer a firm price to an indefinite sliding scale. That would entirely depend upon whether all the components affecting the price were brought into the scale. The author specified "rates prevailing in the tenderer's district." That apparently would penalise certain districts where wages were always high. Other counteracting factors must also be considered. The inevitable result of the adoption of the sliding scale system would be the bringing together of the manufacturers, but this might be an advantage. The purchaser could prevent it being carried to an extreme degree. The scheme would be well worth consideration, but would have to be considered by a Committee representative of all the interests concerned. Various points would arise. For example, supposing one firm had purchased sufficient raw material to cover all its manufacturing requirements for a considerable period ahead, and in the meantime the price rose, was that firm not to take advantage of having purchased at an extremely low rate one of the principal components, say copper, entering into the contract?

Mr. FURNISS agreed that any honest trading firm must welcome a sliding scale scheme for prices of electrical machinery, which was comparatively easy on standard plant, but difficult to apply to special quotations. He thought that the enormous safeguard against machinery gambling during the period of demobilisation warranted the extra work that would be necessary.

Mr. LL. B. ATKINSON referred to the question of the whole basis of index numbers based upon an assumed gold currency. It had been suggested that after-war prices should be forced down by creating an artificial scarcity of currency. It was perfectly true that prices rose or fell in relation to large and small quantities of currency, and it was generally assumed that these were related as cause and effect. This, however, was not entirely true. Prices rose because the demand was large, not because there was a large amount of currency in circulation. The currency was in circulation *because* the supply and demand were large.

Mr. MAWDSLEY said that the author's suggested application of sliding scale contract prices to the engineering industry would relieve the manufacturer of a good deal of risk and therefore closer prices could no doubt be quoted. The adoption of a sliding scale system would have to be made obligatory, otherwise it would not work for any length of time: for the purchaser also would not wish to take risks, and if one manufacturer quoted a firm price, and another manufacturer a price subject to a number of indefinite factors the firm price would secure the order, and the sliding scale system would soon go by the board. This question could not be treated in an insular fashion. Other nations had also largely increased their manufacturing facilities and would want business after the war, and even if they adopted a similar system of sliding scales they would not be likely to stipulate for the same percentages. The most disturbing factor would probably be German competition. The problem of the future resolved itself into reduction of costs, taking into account the practical certainty of a continuing high level of wages. High wages, to be permanent and economically sound, must be associated with high production, and a campaign to bring this home to Labour was very necessary.

Capt. DIGBY, in reply, said he was aware that with any sliding scale basis there were difficulties. Mr. Walker's information on labour rates was interesting, but he (Capt. Digby) did not quite follow the reservation by the manufacturer that for each 1s. per week by which the rate of labour is increased by Government authorisation the contract price shall be increased by 1 per cent. or 1½ per cent., dependent on the class of material. Supposing a Government award gave a 5 per cent. increase to men getting 50s. and 3 per cent. to men getting 30s. during the progress of a contract, how was that going to affect the bill which the manufacturers would render? Mr. Stubbs's remarks had reference to the various dates concerned, the date of tender, the date of acceptance of contract, the date of the issue of the priority certificate and "the date of the priority certificate becoming operative." Between the date of the tender and the date of the contract two or three weeks might easily elapse: between the acceptance of the contract and obtaining the priority certificate three or four weeks might elapse, but between the issue of the priority certificate and that certificate becoming operative one could not say how long would elapse because under the rationing system one could not say how long a manufacturer might have to wait for his material. He was not quite sure whether the introduction of the sliding scale system would tend to strengthen what he might call the ring system of tendering. To apply the principle of the sliding scale to some things, such as condensers, water-tube boilers, turbo-alternators or big power-house transformers, was easy, but in the case of switchboard instruments and so forth, where material was negligible and labour

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the main cost, the sliding scale would follow that of labour rather than that of materials. He was also not certain that the sliding scale system would have to be compulsory. A purchaser might ask for tenders on a sliding scale basis and a firm might prefer to gamble in regard to price. The sliding scale would give a closer price than the other system. Ald. Walker had referred to the question of rates prevailing in the manufacturer's district. One could not avoid that expression. Increases in wages rates for two classes in London, Birmingham, Manchester and Glasgow were by no means simultaneous or equal. Ald. Walker also raised the question of firms with big stocks. If a firm has a big stock purchased judiciously, he saw no reason whatever why they should not make a profit from it. It might be assumed, however, that merchants' stocks and works' stocks throughout the whole country would be low.

Crystalline Wire and Its Application to the Incandescent Lamp.*

By F. SCHROTER.

The alterations of structure which take place in metals as a result of various mechanical operations have been examined by Tammann.† He explains the increase in mechanical strength which takes place in hammered or drawn metals by showing that the crystals undergo a kind of homogeneous deformation in the direction of their sliding surfaces and that this goes on till any further deformation requires very great force. He considers that a cold-drawn wire has a laminated structure, the various layers being displaced with regard to one another in the direction of least resistance. The greatest part of the work of deformation overcomes this internal friction, but a part remains latent in the material.

In the incandescent lamp we have an outstanding case of the use to which a metal can be put at high temperatures. In this case the rate at which re-crystallisation takes place is very noticeable. A drawn tungsten wire has in the cold a structure consisting of parallel fibres; it therefore has considerable elasticity. But after it has been exposed for a short time to a temperature of 2,300°C., irregular crystals are seen to be formed. At the temperature of the half-watt lamp, this re-crystallisation takes place in a few minutes. When this re-crystallisation is complete, all the valuable properties which the tungsten acquires as the result of the drawing process are lost. Fragility results from the irregular crystals and the gaps between them; this is very similar to the case of the old squirted type of filament.

The firm of Julius Pintsch has lately developed a new process to overcome these difficulties; their ideas are due to Schaller, Orbig and Elstner. They started with squirted filaments, having an addition of 2 per cent. of thoria, which was supposed to constitute an improvement on the use of pure tungsten; still they were fragile in places, in spite of great care in the manufacture and in the choice of raw material. It was then recognised that there was still a partially crystalline structure. Etched wires showed the crystals by reflexion, and under the microscope, prisms with eight surfaces were seen, the same thing being visible in broken sections. It was, therefore, necessary to devise a practical method of producing wire of a suitable length out of one single crystal, and not out of a row of loosely connected crystals. The old plan of sintering by passing current was abandoned; in place of this, a very short length of squirted filament, containing the requisite amount of thoria, was suddenly heated to a temperature of 2,400 or 2,600°C., and moved through the heating apparatus at a speed slightly less than that at which the crystalline structure is formed. Thus fresh lengths are brought into the heating zones, and become crystalline; this continues till the whole length of the wire is crystalline. This process of formation is carried out in an atmosphere of hydrogen. The wire is moved at a speed of about 2½ metres an hour, and it is then wound without undergoing any further process direct in the lamp.

This wire is formed comparatively at a slow rate at high temperature, and it must therefore be stable. This is true both in thermodynamic and crystallographic considerations. In squirted and unformed filaments, we have a homogeneous mixture of microscopic crystals of tungsten and thoria. If we take a polished part of a partially formed filament, and examine it under the microscope by reflected light, the following observations can be made. The unformed part remains equally bright as it is turned round under the microscope. But the complete crystal, which has grown up in the micro-crystalline material, becomes twice dark and twice bright in the course of one revolution. This shows that the smallest parts of the finished crystals have their reflecting surfaces in the same direction, while in the original structure the crystals lie so irregularly that in each position the same amount of light is reflected into the eye. The process of crystallisation in the new filament consists in directing all the crystals along the length in the same direction, and it therefore appears that it should have the ideal structure from the point of view of elasticity. The behaviour of the filament at high temperatures is quite different from that of the drawn wire, which softens and bends; when bent, the new type retains its structure uninjured. Thoria is considered to be of importance inasmuch as it affects the nature of the crystalline structure. The crystallisation on this process takes place far below the melting point, and consists in the absorption of the smaller crystals by the larger ones; it depends on the instability of very small crystals below a certain size. This instability is explained by supposing that microscopic and sub-microscopic crystals are only in equilibrium with the surrounding solution when their shapes correspond to a minimum of surface energy, which is not the case with the smallest crystals. It may be supposed that at the high temperature of reaction of our system, the tungsten atoms volatilise at considerable speed from the particles of smallest size and then become attached to the structure of the larger particles and becomes directed in a similar sense. The following question may perhaps be raised. Seeing that all the particles of the raw filament reach the hot zone in quite irregular positions, how does it arise that the main axis of the resulting crystal is in the direction of the axis of the filament? As a matter of fact, crystals form at first in all sorts of directions; all those, which lie at an angle to the axis of the filament, fall at once into their natural position on the wall of the filament. Only in the precise direction of the axis of the filament can the crystal continue to grow, and as it has the capacity for absorbing all crystals of limited size, the result is a single crystal, running in the direction of the axis. The form in which the thoria appears in the finished product and its effect on the process is at present somewhat uncertain.

Practical experiment shows that this type of filament is highly stable and specially suitable for its work. The breaking stress is 164 kg. per square millimetre; this is higher than steel wire, but less than that of drawn tungsten wire, so long as it is not re-crystallised. Drawn tungsten wire is also harder. The new type of filament can be wound round a pin, and this can be done after it has been incandesced for a length of time. Life tests have also been carried out by the testing laboratory of the Union of German Central Stations, and their report has been published in their official publication. The radiation of the crystalline filament does not appear to show any marked effect from the admixture of thoria. The original article contains a photograph of the apparatus in which the formation-process is carried out, but no detailed description of this apparatus is given.

* Abstract of an article in the "Elektrotechnische Zeitschrift," Heft 43, 1917.)

† "Zeitschrift für Elektrochemie," p. 584, 1912.

The Normalising of Carbon Steel.

A pamphlet issued by Automatic & Electric Furnaces (Ltd.) deals with the essential factors in normalising carbon steel for the production of gauges and similar articles of fine dimensions. Good quality annealed carbon tool steel having a high carbon content of 1·2-1·5 per cent., with a minimum amount of manganese (under 0·5 per cent.), is recommended for such work.

The most essential element in hardening steel gauges, however, is to obtain the exact temperature in the furnace previous to quenching. Any material departure from this value gives a coarse crystalline grain, difficult to work and uncertain to harden. The method by which the exact temperature is determined in the Wild-Barfield furnace with pyroscopic detector has been previously described in this journal.* Another point of interest is that cooling in air results in the formation of a thin skin of oxide, which has a prejudicial effect on the tool used for finishing. This skin can be conveniently removed by lapping with carborundum powder and vaseline. The steel then cuts smoothly and easily, and the wear on the tool is reduced to a minimum.

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"Magnetic Measurements and Experiments (with Answers)." By A Risdon Palmer, B.Sc. (London: Murby & Co.) Pp. 124. 1s. 6d. net.

"Electrical Experiments." By A. Risdon Palmer, B.Sc. (London: Murby & Co.) Pp. xii.+115. 1s. 6d. net.

"Selwyn's Metric Conversion Tables." Edited by W. E. Dommett. (London: J. Selwyn & Co., Ltd.) Pp. 49. 2s. 6d. net.

"Year-book of Wireless Telegraphy and Telephony, 1918." (London: Wireless Press.) Pp. lxxxii.+1154. 6s. net.

"Institution of Civil Engineers, List of Members." (London: Institution of Civil Engineers.) Pp. 267.

* THE ELECTRICIAN, Vol. LXXIX., p. 629, 1917, and Vol. LXXX., p. 721, 1918.

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Electricity Supply Undertakings and the War.

The effect of the war on electricity undertakings has been a source of anxiety to many engineers in this country, and it is, therefore, of interest to watch the corresponding effect in America. In the United States war conditions have only been in existence for rather more than a year, whereas we have had this unfortunate experience for four years. Nevertheless, marked changes are already noticeable. The most immediate effect is seen in the increased cost of labour and fuel. In regard to wages and salaries it is noticeable that the salaries of officers, managers and general superintendents have not increased seriously. That is one of the characteristics of the present day, and it undoubtedly entails considerable hardship, but it is observed throughout the engineering profession and in many others. It is due, of course, to the fact that the class affected is weak numerically. On the other hand, the increase in wages has been heavy. According to a Paper read by Messrs. L. S. Goodman and W. B. Jackson in January of the present year, before the American Institute of Electrical Engineers, the average increase in wages has been about 25 per cent. In Great Britain the percentage is, of course, much higher.

Although the increase in cost of labour is serious, the increase in the cost of fuel has been far greater. Normally, the cost of fuel is, say, 60 to 65 per cent. of the generating costs, but varies with the size and locality of the station. It has now assumed a higher proportion. The increase in the cost per ton is put down by Messrs. Goodman and Jackson at 100 per cent. In this country the increase has probably been even greater. Moreover, it must be remembered that the price per ton does not tell the whole story. Owing to the fact that coal now used contains a much higher proportion of ash than formally, the figure now amounting often to 20 per cent. or more, the price per B.Th.U. has been enhanced much more than is shown by the price per ton. Unfortunately, money is spent in the transport of ash content which is not desired, and still more money is spent in removing ashes to the extent of three or four times what these used to be in pre-war days. Moreover, there is lower efficiency, due to the reduction of thermal value, and the output of the plant as a whole becomes smaller.

Not much is conveyed by figures of totals for a whole country, but the following figures (expressed as millions of dollars) given by Messrs. Goodman and Jackson are interesting as showing the extent to which the various increases are responsible for the whole effect :—

Increased salaries and wages chargeable to operating ...	19·0
Increased cost of fuel	60·0
Increased cost of other materials and supplies	30·0
Increased taxes	7·5
	116·5

The conclusion is reached that when these various increases are taken into account the net effect is the wiping off of two-thirds of the sum which would otherwise have been available for interest, dividends and reserve. As far as undertakings in this country are concerned we need not express the effect quite in these terms, as our conditions of working are more elastic, and it is a comparatively simple matter to pass the greater part of these increased costs on to the consumer, up to a point. This course has generally been taken and in some cases the legal limit has been reached. In order to deal with this situation legislation has recently been introduced, of a character not wholly beneficial (as we have recently pointed out). Although the raising of prices is not a satisfactory procedure, this is all that can be done at the moment, and we can only hope that conditions will readjust themselves with some rapidity after hostilities are brought to a close. It may be doubted, however, whether war bonuses and similar concessions will be readily given up, or whether the cost of coal will fall to pre-war figures for a very considerable time.

There is another item which is becoming increasingly important as time goes on and that is the high capital cost of new plant. In the case of those undertakings which are giving low tariffs for power, capital charges form a most important proportion of the total. Many of these undertakings have necessarily increased their capacity or are so doing, notwithstanding the fact that the cost of plant has advanced by, say, 50 per cent. This means that the capital charges on this new plant, which may be carrying a large proportion of the total load, are increased by 50 per cent. from this cause alone. Further, in the case of local authorities, money is probably raised for the purpose of purchasing this plant upon terms which are by no means so advantageous as hitherto. Consequently, the capital charges are again increased. It appears to us that in such cases the Government should offer some relief to those undertakings on account of plant so purchased ; otherwise the consumers for some years to come will necessarily suffer, due to plant which has been required to meet war needs. This aspect of affairs will be modified very considerably, and will lose its importance to some extent, if a national system of electricity supply is developed on the lines put forward by the Board of Trade Electric Power Supply Committee. Although we hope that such a scheme will come into being at a very early date, it is well in any case that we should not lose sight of abnormal capital expenditure as a factor in increasing the cost of electricity supply.

Review.

The Theory of Electricity. By G. H. Livens, M.A. (Cambridge : University Press.) Pp. vi.+717. 30s. net.

Any new book on the mathematical theory of electricity and magnetism produced by the Pitt Press is certain to arouse considerable interest among students. One cannot, however, avoid some sense of disappointment after reading this work, as one has the feeling that most of the ground has been covered so often before in a manner only slightly different ; for instance, to mention another book from the same publishers, Jeans' " Theory of Electricity and Magnetism " covers a large part of the matter with which this author deals, although the treatment in Jeans' book differs somewhat from that in the work under review in that the latter uses the methods and notation of vector algebra freely. It is, perhaps, difficult to criticise fairly any book of this type, since it would be likely to appeal more strongly to the physicist with a good working knowledge of mathematics than to a pure mathematician, who would probably prefer Jeans' book. Here much of the mathematical analysis has been omitted, whilst there has been insistence on fundamental physical principles ; but it is possible that the author would have done well to have concentrated his attention on the last four chapters, as there is a distinct need for a fairly complete book on this branch of the subject, using somewhat less advanced mathematics than is usually employed, and he shows that his methods are well adapted to do this. At the same time much of the above-

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mentioned overlapping would have been avoided, though this overlapping is inevitable in a series of books all founded on Maxwell's "Electricity and Magnetism," if the whole ground is to be covered in each.

The subject matter and general arrangement of the book are well chosen, and in particular the author is to be congratulated on the mathematical introduction with which he begins his work. This deals largely with vector algebra, and should be quite sufficient to enable a mathematical reader who has not yet studied this notation to follow the rest of the book easily. He then proceeds to develop the subject logically along the usual lines, starting from Faraday's researches and dealing first with electrostatics. Special reference should be made to the chapter dealing with the theory of polarised media. This is admirably clear and suited to one reading the subject for the first time, as it attempts to give some physical meaning to the arguments, and does not consist merely of a mathematical discussion of theory. Many students find great difficulty in following the latter type of treatise, and one could wish that more authors would attempt to give their readers a concrete idea of the mechanism of the phenomena to which the theory applies, though this does not necessarily imply any reference to actual experiments. In the same way, when dealing with magnetostatics, considerable attention is paid to the mechanical aspect of the theory of ferromagnetism, though it is strange that in this connection no mention is made of Ewing's molecular theory of magnetism as a working hypothesis which explains the nature of the forces which control the motion of the molecular magnets.

It is in the remainder of the book, dealing chiefly with electrodynamics and electromagnetic effects, that most novelty is to be found, for the author introduces the electronic theory as early as possible, and hence in this case also is able to give concrete illustrations to his arguments, though here he makes more use of actual experimental data; the chapters on electric waves are particularly noteworthy, and include some interesting results on the energy distribution in radiation fields. Finally, there is a short account of the effects to be expected in connection with moving media, with a very brief reference to Einstein's principle of relativity, though this section is hardly long enough to be of much value. This ends the subject matter proper, but from the point of view of the student who is reading for examinations the addition of over 300 excellent examples will prove very useful.

A word of praise must be given to the officials of the Cambridge University Press for the admirable way in which they have produced the book. It only need be said that it is fully up to their usual high standard to imply that it is clear and "readable" in every way.

F. J. DYKES.

The Construction of Abaci.

By A. B. EASON.

The object of this article is to explain how to draw up abaci for use in solving various common engineering problems, without using tables and slide rules. The abaci mentioned herein assist one in finding:—

1. (i.) The resistance per unit length of (ii.) any gauge of wire, (iii.) of any material. (*See* Fig. 3.)

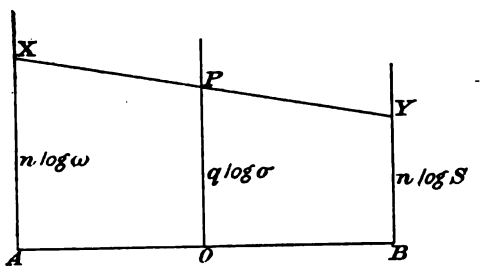

FIG. 1.

2. (i.) The resistance of (ii.) any length of (iii.) any gauge of wire, (iv.) of any material. (*See* Fig. 4.)

3. (i.) The approximate current to give 100°C. temperature rise in any gauge of wire of (iv.) any material. (*See* Fig. 5.)

4. (i.) The loss of pressure in a pipe of (ii.) any diameter when air is flowing at (iii.) any velocity. (*See* Fig. 6.)

Of the three or four quantities involved, anyone may be the unknown. This unknown quantity is found on a three-line abacus by drawing a straight line (or placing a straight edge) across the chart through the points representing the two known quantities and by reading off the unknown quantity where this line cuts the third scale. In the five-line abacus one draws a line between two known quantities, which line will intersect the middle line XY at a point, say P; a line is drawn joining P to the point representing the third known quantity, and the fourth unknown quantity is read off where this line cuts the other scale.

As examples of problems to be solved, consider the following:—

1. What is the resistance of 700 yards of 23 S.W.G. copper?

In Fig. 4 join 700 yards on the length scale to copper on the material scale. Join 23 S.W.G. on the size of wire scale to the intersection on XY and produce it to meet the resistance and read the resistance 35 ohms at 0°C.

2. A 3 ohm resistance is needed to carry 30 amperes with a 100°C. rise. What length and gauge of iron wire are suitable?

From Fig. 5 we see that some gauge less than 14 S.W.G. will be required. From Fig. 4 joining 14 S.W.G. to 3 ohms, and joining the intersection on XY to iron shows that 130 yards or 120 metres will be required. If 12 S.W.G. is used 150 metres would be required.

3. A resistance of 75 ohms to carry 1 ampere is required, and about 30 ft. or 900 cm. is the suitable length. What material and gauge will be suitable?

The ohms per centimetre are approximately 0·083. From Fig. 3 it is seen that in iron 40 S.W.G., or in german-silver 35 S.W.G., or in manganin 32 S.W.G. would do.

These are merely typical examples; those dealing with copper wire could, perhaps, be easily solved from tables, but for other wires the tables may not be to hand. In the following examples, in which fractional powers of the velocity and of the diameter enter into the formula, the abacus is of real use in reducing labour.

What is the loss of pressure in an 8 in. air-duct 130 ft. long when the air velocity is 30 ft. per second?

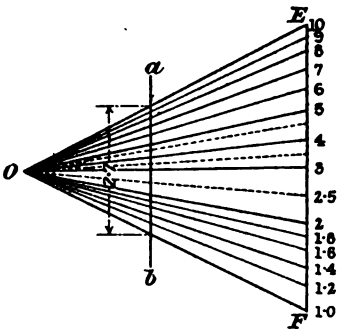

FIG. 2.

On Fig. 6 join the 8-in. point to $u=30$ ft. per second and read off the pressure per 100 ft., *i.e.* 0·72. This is multiplied by 1·3 and the result is 0·94 in. of water.

EXPLANATION OF THE ABACUS.

Any equation of the form $x^n y^b = u^n v^q$ can be represented by an abacus. We shall first explain how to make one to represent the simple fact,

$$\text{resistance per centimetre} = \frac{\text{specific resistance per cm. cube}}{\text{area in square centimetres}},$$

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or $\omega = \sigma/S$, where ω=resistance per centimetre, σ=specific resistance, S=area in cm.^{2}. Then

$$\log \omega + \log S = \log \sigma.$$

Look at Fig. 1, in which AX, OP, BY are perpendicular to AOB and $AO=OB$. Make $AX=\log \omega$, to a scale where $1=n$ inches; and make $BY=\log S$ to the same scale.

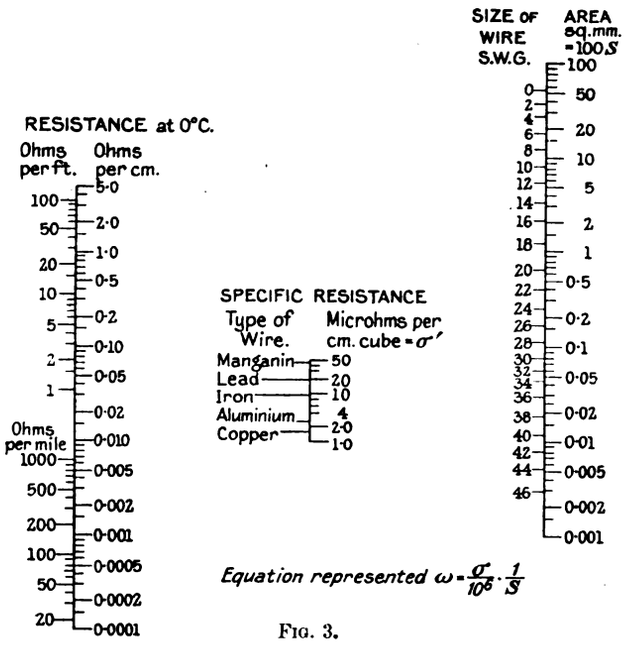

Fig. 3.

We know that $AX+BY=2OP$, and OP to some scale $q=\log \sigma$. Using geometrical length in inches.

$$n(\log \omega + \log S) = 2OP, \text{ but } OP = q \log \sigma.$$

Therefore $q=\frac{1}{2}n$ and the centre scale is half the side ones. On Fig. 3, where the unit for the side scales is $\log 10=1=2$ in., it is 1 in. on the centre scale.

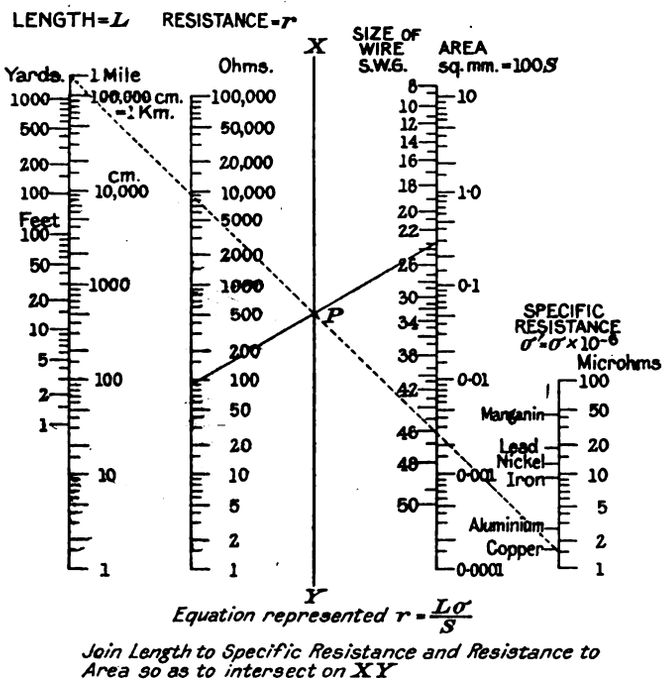

Fig. 4.

If the equation is $\omega^n=\sigma^b/S^c$ the same method is employed, but instead of plotting $\log\omega$ one plots $a\log\omega$ and the scales become na, nc, and $\frac{1}{2}nb$. Having plotted the points for 1, 10, 100, &c., at the distances, O, na, $2na$, &c., one has to divide the distance between these points logarithmically. This may be done by calculation and direct measurement, but it is more convenient to use the device shown in Fig. 2. On tracing paper divide a suitable length EF logarithmically; join an origin O to the points 1·0, 1·2, &c., on EF; any line parallel to EF will be divided logarithmically by the lines from O. Now suppose the distance na on one of the abaci scales is 2·7 in. Place the tracing paper on the abacus with EF parallel to the scale and move it till 2·7 in. (say ab) is intercepted between OE and OF; then prick through the lines on to the abacus scale.

Notes on the Abaci.

Fig. 3 gives the resistance of wires; the scale gives ohms per centimetre and also ohms per foot and ohms per mile; if it happens that the scale in desired units does not happen to be at the point required, it is quite easy to run the eye up or down the scale and notice what the resistance should be in required units by dividing or multiplying by 10 or a multiple of 10.

The scale giving the area of the wire in square millimetres enables one to work with Brown and Sharpe gauge, or with the metric gauge.

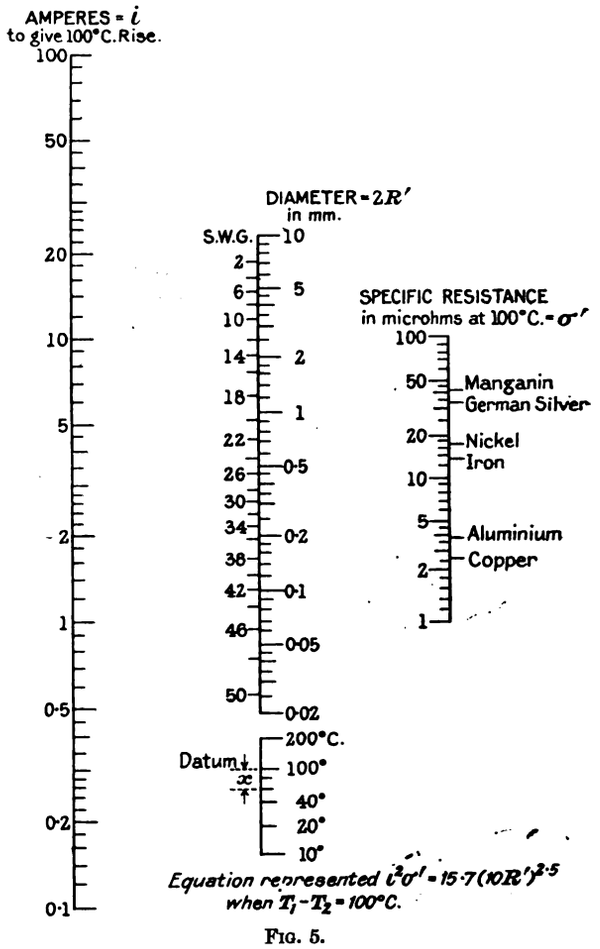

Fig. 5.

Fig. 4 gives the resistance for any length of wire, instead of per unit length; but then the user must draw two lines intersecting in XY instead of a single line. Fig. 4 is plotted similarly to Fig. 3, from the equation, $\log L+\log\sigma=2PY$ =log (res.)+log S. The same unit is used for each scale.

Fig. 5 deserves attention because of the possibility of finding currents to give various temperature rises by the use of correcting factors. The amount of temperature rise depends entirely on the conditions in which the wire is placed, and thus the amount of heat emitted from a wire is not known very accurately; but some idea of carrying capacities of wires may be gained from Fig. 5.

The equation used (radiation being neglected) is :—

Watts per centimetre $=B(4\cdot183)(T_1-T_2)R^{0\cdot5}=i^2\sigma/(\pi R^2)$, where B may vary from 0·00063 to 0·00170. For references, *see* "Journ." Post Office Engineers, Vol. X., p. 106, 1917.

Then $i^2\sigma = (0\cdot00264 \text{ to } 0\cdot00710)(T_1-T_2)\pi R^{2\cdot5}$.

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We choose the value 0·005 for the constant (B=0·00120) and put σ' as microhms, R' as millimetres, then

$$\frac{i^2\sigma}{10^6}=0{\cdot}005(T_1-T_2)\pi\frac{(100R)^{2\cdot5}}{10^5},$$

$$i^2\sigma'=0{\cdot}157(T_1-T_2)(10R')^{2\cdot5},$$

and

$$2\log i+\log\sigma'=\log 0{\cdot}157(T_1-T_2)+2{\cdot}5\log(10R').$$

The zero point, or log 1, on the centre scale must begin at a point $\log 0{\cdot}157(T_1-T_2)$ above the datum line, where i=1, σ'=1. We have chosen a 1½ in. scale as log 10, so that we use a 3 in. scale for i, 1½ in. for σ', and ½ (1½) (2·5) for $10R'$.

We get the following values :—

T_1-T_2 Deg. cent.	0·157 (T_1-T_2).	Log ditto.	Length on scale = 0·75 log ditto.
20	3·14	0·497	0·373
40	6·28	0·798	0·598
60	9·42	0·974	0·730
80	12·56	1·091	0·825
100	15·70	1·196	0·896
200	31·42	1·497	1·121

The position of the scale for diameters depends on what values of the constant and of T_1-T_2 are chosen. In Fig. 5

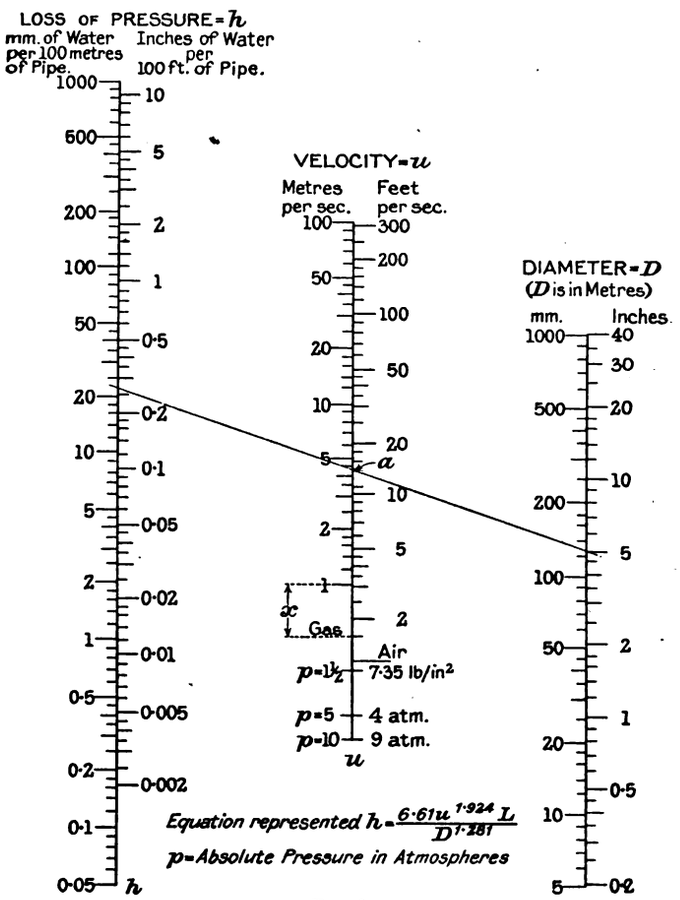

FIG. 6.

the constant has been chosen as 0·005 and T_1-T_2 as 100°C. Now suppose we can only allow a 60°C. rise, then the S.W.G. points must be dropped by the distance between the 100°C. and the 60°C. rise. viz., X (*see* the correction scale on Fig. 5). Suppose we want the current carried by 16 S.W.G. copper for a 60° rise. Join copper to a point distance x below 16 S.W.G. and read off the amperes on the third scale.

Again B varies from 0·00063 to 0·00170. This can be allowed for thus : If convection is poorer than 0·001200 then the rise will be increased in proportion of $0{\cdot}00120/B$; if convection is large, then the rise will be reduced by $0{\cdot}00120/B$; if we expect B=0·00150 and want only 40°C. rise, then the rise to allow in Fig. 5 is $\frac{0{\cdot}00150}{0{\cdot}00120}\times40°\text{C.}=50°\text{C.}$; the wire gauges should be lowered by the distance between 100°C. and 50°C. accordingly.

So far no mention has been made of the increase of resistance with temperature. In Fig. 5 the specific resistance σ' has been taken as 1·4 or $[1+100°(0{\cdot}004)]\times(\sigma'$ at 0°C.) for materials copper to nickel. The temperature coefficient of resistance wires is negligible for our purpose. In Figs. 3 and 4 σ' at 0°C. has been taken ; σ' at 60°F. or 15·6°C. could equally well be chosen, and the names of the materials plotted at points $(1+15{\cdot}6\alpha)$ σ' instead of at σ'.

The values of σ' chosen for these figures are :—

Copper	1·57	German-silver	33·0
Aluminium	2·65	Manganin	42·0
Iron	9·5	Eureka	47·0
Nickel	12·0	Rheotan	52·0

All in microhms.

Fig. 6 gives the loss of pressure in air ducts for various air velocities. Metric and English units are given on each scale. On the centre scale $x=\log 6{\cdot}61+0{\cdot}852\log s$, where s is the specific gravity of the fluid compared to air. For coal gas s has been taken as 0·5 ; for compressed air as 1½, 5, 10 at ½, 4, 9 times atmospheric pressure above atmosphere.

To use Fig. 6 for gas flow, the centre scale readings must be lowered the distance between "Gas" and "Air" ; for instance, if we require the fall of pressure in 100 ft. of 5 in. pipe when gas flows at 20 ft. per second, we join 5 in. to a point a below 20 such that distances, "air to a"="gas to 20," and the loss to pressure will be 0·26 in. of water per 100 ft. If air was flowing in the pipe the loss would be found by joining 5 in. to 20, loss=0·54 in. The correction for compressed air works similarly only in the opposite direction, as the loss of pressure will be greater than for free air flowing at the same velocity.

An abacus for use with steam flow is given in the "Electric World," Vol. 68, p. 1143 (1916), and an abacus for compressed air flow is given in Amer. Inst. Mining Engr., "Bulletin" 126, p. 969 (1917).

The British Scientific Products Exhibition.

On Monday last a meeting of the Circle of Scientific, Technical and Trade Journalists took place at the British Scientific Products Exhibition, at the invitation of the Executive Organising Committee, an address being delivered by Prof. R. A. Gregory on the "Aims and Objects of the Exhibition."

Mr. L. GASTER, who presided, briefly opened the proceedings by a few remarks emphasising the importance attached to technical research and education. Deficiencies had been revealed by the war, and it was right that these should be understood in order that they might be remedied ; but it was also helpful to survey the advances made, and of these the Exhibition would afford encouraging evidence. The British Science Guild, who were responsible for the organisation of the Exhibition, had done much pioneering work on education which was now bearing fruit. It should be the task of technical journalists to widen the circle of those engaged in such work until the whole country was imbued with the scientific spirit and with a proper appreciation of its value to industry.

Prof. R. A. GREGORY remarked that industrial advance seemed to depend upon three main factors : The work of the creative investigator, who discovers new properties and relationships ; the inventor of industrial researches, who applies such knowledge to useful ends ; and the artisan concerned in its construction or technical use. Each of the three processes had an essential part in national life.

Surveying the tendencies of the past four years, Prof. Gregory pointed out that, while the value of scientific work had become better appreciated by the public, the man of science had also learned much ; intelligent co-operation was becoming more general, and there was less of the spirit of distrust which formerly existed between scientific workers and manufacturers. The British Scientific Products Exhibition illustrated this growing "entente cordiale" between science and industry. The aim of the Exhibition was to stimulate public interest and confidence in the capacities of British science. Original scientific work was by no means a German perogative ; this country had been pre-eminent in scientific pioneering work, but deficient in application.

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Prof. Gregory proceeded to give many instances of progress in the industrial application of science since the war, many of which were illustrated in the catalogue of the Exhibition. The work of the Institute of Chemistry and Sir Herbert Jackson on many special glasses; the newly-developed processes for obtaining potash; the way in which chemical manufacturers had succeeded in meeting demands for organic drugs, such as aspirin, phenacetin, salvarsan, &c.; the development of hard porcelain for electrical fittings; the production of tungsten for special steels, incandescent lamps, &c.; and the progress of the magneto industry—all these were examples of what British industry could accomplish when urgent need required.

There were naturally many brilliant advances in the form of applied science for naval and military purposes to which allusion could not be made; and there were some industries whose progress could not adequately be illustrated in the Exhibition. Much remained to be done. But the Exhibition afforded an object lesson of the strength and adaptability of British industries since the outbreak of war, and the results already achieved were most creditable to both scientific workers and manufacturers. In the latter part of his address Prof. Gregory pleaded for a wide view of science, illustrating how the pursuit of knowledge leads eventually to many useful applications unsuspected by the inquirer. He quoted figures to show that the position of higher scientific education in this country is still behind that allotted to it in other countries, and urged that the provision of generous facilities in this respect was the very essence of industrial progress.

A vote of thanks to Prof. Gregory was moved by Mr. Gilbert Wood and seconded by Mr. W. A. Standring and carried with acclamation, after which the gathering broke up in order to visit the Exhibition.

As was naturally to be expected, there were portions of the exhibits incomplete, and finishing touches were being put on many others; but there is already much to be seen of interest. The aircraft models and accessories excited general interest, and the sections devoted to dyestuffs, nitrogen products, textile specialities, and optical glass ware are of a representative character. One of the most interesting sections of the exhibition promises to be that dealing with minerals, metallurgy, many special products, such as those obtained from the ores of tungsten, molybdenum, ferrochrome, ferrovanadium, and examples of special steels produced by Hadfields and others being shown; in this connection electrical methods of production play a part, and various electric furnaces, electrical welding outfits and electric heating appliances are on view. Special sections are also devoted respectively to electrical and electromagnetic and to optical appliances.

We propose to refer in greater detail to individual exhibits later, but we may add that the descriptive catalogue, containing a series of contributions by experts summarising progress in various sections is a creditable production, which in itself is well worth study We understand that a series of lectures is also being arranged.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.
Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.
Orders for the Week.

Captain of the Week.—Capt. E. G. Fleming.

Next for Duty.—Capt. W. Hynam.

Monday, Aug. 19.—Demolition Lectures, 5.30 and 7.30. Signallers, 6.30.

Tuesday, Aug. 20.—No. 3 Company Entrenchments, 6.30. Lecture: MarchDiscipline, Officers and N.C.O.s at 6.30. Recruits' Drill, 6.30.

Wednesday, Aug. 21.—No. 1 Company Entrenchments, 6.30. Recruits' Drill, 6.30.

Thursday, Aug. 22.—No. 2 Company Entrenchments, 6.0. Recruits' Drill, 6.30. Signallers, 6.30. Ambulance Section, 6.30. Band Practice, 7.0.

Friday, Aug. 23.—Range, 5.30-6.30 and 7.30-8.30. Lecture: Railway Transport, Officers and N.C.O.s, 6.30.

Special Notices.—All drills will take place at headquarters unless otherwise stated.

The medical officer will attend for the examination of recruits on Thursday evening at 6.30 p.m.

Swedish Hydro-Electric Schemes.—The "Journal" of the Swedish Chamber of Commerce says new electric undertakings recently formed in Sweden are the Sundals Ryrs Kraft Aktiebolag at Sundals Ryr, with a capital of £11,000, and the Ulf Elektriska Aktiebolag, Ulföhamn. Both will establish hydro-electric stations in their respective districts.

Commercial Topics.

Advertising in Technical Journals.

Some time ago a circular was issued by one of the engineering associations making certain suggestions in regard to advertising by engineering firms. These suggestions aroused a good deal of misgiving at the time, and the sequel to the affair is to be found in a memorandum which has now been issued of a conference held on the 9th ult. The memorandum reads as follows:—

At the end of April a circular-letter, headed "Notes on Advertising," was circulated by the British Engineers' Association and the British Electrical and Allied Manufacturers' Association, which Associations are amongst the founders of the Industrial Publicity Service, Ltd.

At a conference on July 9 between representatives of these Associations and the British Association of Trade and Technical Journals, Ltd., it was pointed out that certain statements in this letter were considered to be prejudicial to the trade Press of this country. As this was contrary to the intention of the circular-letter in question, it was agreed to make the following joint supplementary announcement:—

1. That although the paper situation is serious there is no intention to publish trade journals fortnightly instead of weekly.
2. That the cost of printing has now increased by 75 per cent., and the price of paper by 600 per cent. or 700 per cent., and the increase to the cost of production fully justified the proprietors raising the advertisement rates or reducing the size of space.

The trade Press of this country is acknowledged by the Ministry of National Service to be of National importance, and in this respect is classified with the daily newspapers. It is in the interest of British manufacturers that trade journals maintain their publications at their present high level, in view of the important part which they must necessarily take in the renewal of commercial enterprise and reconstruction at the close of the war.

* * * *

Industrial Efficiency and Fatigue.

At the welfare conference, convened by the Ministry of Munitions at Oxford last week, Dr. H. M. Vernon stated that the present time offered unrivalled opportunities for obtaining information concerning the subject.

Dr. Vernon laid down that the hours must not be so long as to reduce the health of the workers, for in such a case efficiency diminished and output went down. Over fatigue in women was observed at a fuse factory where 75 hours a week were worked, and the women's accidents were three times more numerous than in the subsequent 10-hour day period.

* * * *

Depreciation and Obsolescence of Plant.

A memorandum has been issued by the Board of Inland Revenue on the subject of allowances for depreciation and obsolescence of plant and machinery, &c.

Sec. 12 of the Customs and Inland Revenue Act, 1878, authorises a deduction in the assessment of profits of such an amount as the Income Tax Commissioners "may think just and reasonable as representing the diminished value by reason of wear and tear during the year of any machinery or plant used for the purposes of the concern." This deduction is in addition to the allowance made in respect of the cost of repairs. There is no statutory limit to the amount which the Commissioners may allow in any year, but the aggregate amount of the deductions from first to last must not exceed the actual cost of the machinery and plant to the person by whom the concern is carried on. The assessment on the profits of a trader for a particular tax year may be nil, or less than the amount of the wear and tear allowance for that year, so that he cannot get the full deduction from that year's assessment to which he would otherwise have been entitled: in such a case that part of the allowance to which effect cannot be given is carried forward and added to the allowance for the next year, and so on for succeeding years.

Although no fixed scale of allowance is prescribed by law, definite rates of depreciation on different classes of machinery have been agreed upon for uniform application in a number of important industries as the result of applications by representatives of the industries to the Board of Inland Revenue. Although these allowances have been generally adopted and accepted by the taxpayers, the power to appeal to the Board of Referees from the Commissioners, which is given by sec. 24 (1) of the Finance Act, 1918, will not be affected by such agreement. Application in such a case has first to be made to the Commissioners of Inland Revenue, and these refer the case to the Board of Referees. If the Board of Referees are satisfied that the application is made by or on behalf of any considerable number of persons engaged in any class of trade or business, they consider the case and determine the amount of the allowance.

The authorities concerned with wear and tear allowances are the Commissioners of Inland Revenue, the Income Tax Commissioners and the Board of Referees. After explaining the duties of each of these authorities, the report points out that, in addition to the allowance for wear and tear of plant and machinery, there has been in operation since 1897 an allowance for obsolescence, and this allowance has been made statutory by sec. 24(3) of the Finance Act, 1918. Accordingly, where new machinery is introduced in place of machinery not wholly worn out, an allowance is made, as a deduction from the profits of the year, of so much of the cost of replacement as is equivalent to the written down value of the machinery replaced less any sum realised by the sale of it, the balance of the cost of the new machinery being an addition to the capital of the business.

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Examples are given of the effect of the allowances for obsolescence and for wear and tear.

As an alternative to the allowance for wear and tear and obsolescence of plant and machinery, the cost of renewing plant and machinery may be claimed as a deduction in the computation of income tax liability under schedule D. When this course is preferred by the taxpayer, the amount to be allowed is the actual cost of the new plant and machinery (excluding any part of such cost which is attributable to additions or improvements—*i.e.*, to an increase in capital) after deducting the scrap value or realised price of the plant and machinery replaced. Although this method of allowance is alternative to the wear and tear allowance for the same class of plant, the two principles may run concurrently for different classes of assets in the same business. For example, the wear and tear allowance may apply to fixed machinery, while the renewal method is used for loose plant.

In the computation of the profits of his business for assessment under schedule D, a trader is allowed to deduct as a trade expense his whole outlay on repairs, maintenance and insurance of his trade premises.

It is pointed out that, with the exception of the rates relating to the motor omnibus, saw milling and steel industries, the rates of depreciation given in the schedule to the report were agreed upon under pre-war conditions. Cases have arisen, especially since the commencement of the war, in which machinery is suffering exceptional wear and tear, owing, for example, to extra hours of running, the difficulty of obtaining material for effecting repairs, the rougher usage to which the machinery is subjected owing to the employment of unskilled labour and the fewer opportunities available for having the machinery overhauled. In such cases applications for special rates of depreciation have been entertained, but generally speaking the circumstances of individual cases have been found to vary so widely as to render it impracticable to fix a uniform scale, and each application has been dealt with on its own merits.

Where machinery or plant has been temporarily out of use through circumstances attributable directly or indirectly to the present war an allowance for depreciation is granted on the same lines as if the diminished value had actually been caused by "wear and tear during the year."

In the case of "controlled" concerns under the Munitions of War Act, 1915, the income tax allowance has been temporarily extended (by the Finance Acts of 1916 and 1917) to include the deductions for "exceptional depreciation or obsolescence of buildings, plant or machinery" which are allowed for excess profits duty and munitions levy purposes. This allowance prevents the hardship that would otherwise arise owing to the circumstance that 'controlled establishments," being held at the disposal of the Government, may be required to alter completely the course of their business and to undertake exceptional expenditure which may be of little or no post-war utility to them—*e.g.*, on machinery which may never be replaced, and to which, therefore, the ordinary obsolescence allowance would not be applicable. The Income Tax Commissioners are authorised to revise the income tax allowance so as to enable a deduction to be made from profits of the difference between cost and post-war value of installations and extensions (including buildings) which would not have been undertaken but for the war and the express requirements of the Government.

From the schedule it appears that the rate per cent. allowed on the cables of electric supply undertakings is 3 per cent., and of plant and machinery 5 per cent., of the written down value. It is doubtful whether these allowances, especially the latter, are adequate for electricity works under present conditions, and, apart from the question of obsolescence, which is very important for supply authorities, generating plant and machinery are subject to exceptional wear and tear owing to the war.

On motor omnibuses the rate is 20 per cent.; but this rate, which does not apply to commercial motor vehicles, is to be reconsidered at the expiration of four years commencing with 1916-17. On tramways an allowance is made per mile of track based on the estimated life of the permanent way, 3 per cent. on the written-down value of cables, 7 per cent. on cars and other rolling stock, and 5 per cent. on general plant and machinery, including standards, brackets and workshop tools. Steel manufacturers are allowed 15 per cent.—*i.e.*, 5 per cent. for normal wear and tear and 10 per cent. for additional wear and tear arising from war conditions.

Electricity Supply.

General.

Chelmsford.—The Electric Supply Corpn. has applied to the Board of Trade for an Order to increase the maximum price of electric current to 9d. per unit, and the Town Clerk has been directed to make representations to the Board against the application. The present maximum is 6d. a unit.

Dublin.—A conference of local manufacturers was held last week in order to consider the proposal of the Corporation electricity department to curtail the supply of electricity for power purposes.

The general opinion was that the closing down of factories between 4 p.m. and 5 p.m. was an impossible proposition, as in many cases it would entail the entire closing down of industrial concerns in Dublin. Therefore it was decided to ask the Electricity Supply Committee to receive a deputation to urge that there be no curtailment of the supply of electric current to manufacturers.

Electric Power Supply.—At Newcastle last week there was a conference of representatives of electric supply undertakings on the north-east coast, the Lord Mayor of Newcastle (Sir George Lunn) presiding.

The conference was called to consider the report of the Board of Trade Electric Power Supply Committee, and the general opinion was in favour of the principle of a super-power station, but the meeting was strongly opposed to the idea of such station being in private hands, and a memorandum was considered with a view to representations being made to the Government in favour of control by a public electricity board. Eventuallly the proceedings were adjourned for a fortnight in order that a report on the same subject from the Law Committee of the Municipal Corporations Association may be considered.

Erith.—The Urban Council will take a supply of electricity in bulk from the West Kent Electric Co.

Swansea.—The Executive Committee of the Harbour Trust has entered into an agreement with the Corporation for an additional supply of electric current for the King's Dock.

Water Power Development in Wales.—Last week the Cardiganshire County Council adopted a recommendation of its Finance Committee, with reference to a scheme for generating electricity from the resources of the rivers Rheidol, Ystwyth, Aeron and Teify.

The clerk has been instructed to communicate with Radnorshire County Council with regard to constructing a road between Cwmystwyth and Rhayader and with Breconshire County Council for a road between Tregaron and Abergwesin.

Consideration is also being given to a scheme for the construction of a light railway along the coast from Aberystwyth to Cardigan.

Water Power of the Empire.—During the week there has been issued a preliminary report of the Water Power Committee of the Conjoint Board of Scientific Societies, which was appointed to report "on what is at present being done to ascertain the amount and distribution of water-power in the British Empire."

The report states that to enable the Empire to recover with any degree of rapidity from the financial burden imposed by the war, it will be necessary to develop in a much greater degree than heretofore the Empire's latent resources. The wealth embodied in its mineral resources, its wheat areas, its forests and the hundred products of its tropical dependencies, is almost incalculably great. But it must be realised that without an ample supply of cheap energy much of this wealth must always remain latent. The available sources of energy are, for practical purposes, few in number. They comprise our fossil fuels, our oil-fields and oil shale deposits, and our water-powers. In considering the relative value and importance of these sources of energy it is to be remembered that while the solid and liquid fuels are convenient to handle, can be transported easily and cheaply to any convenient locality, and in many cases form, at present, the most convenient and cheap source of power, yet their supplies are strictly limited and their ultimate depletion is assured. In view of this the utilisation to the utmost possible degree of the water power of the Empire becomes of paramount importance. Excepting the comparatively small and inconvenient supply of energy obtainable from vegetable growth, either by direct combustion or through the medium of alcohol, these at present provide our only practical perennial source of energy.

The following estimate of the power now being used throughout the world is given:—

In world's factories (including electric lighting and street railways) 75,000,000 H.P., railways 21,000,000 H.P., and world's shipping 24,000,000 H.P., or a total of 120,000,000 H.P.

Of the 75,000,000-H.P. used for factories and general industrial and municipal activities a rough approximation of the most probable distribution would appear to be:—United Kingdom 13,000,000 H.P., Continental Europe 24,000,000 H.P., United States 29,000,000 H.P., British Dominions and Dependencies 6,000,000 H.P. and Asia and South America 3,000,000 H.P.

Between fifteen and sixteen millions of the world's industrial horse-power is at present developed from hydraulic resources; and here the United Kingdom is the most backward of all the countries listed (except Russia), its 8·3 per cent. comparing very unfavourably with the 43·4 per cent. of Germany.

So far as the United Kingdom is concerned, Scotland, and especially the Scottish Highlands, offer greater water power possibilities than any other part of the country. Over a considerable extent of its area the rainfall exceeds 60 in. per annum, and this area is studded with natural lochs, which form excellent storage reservoirs at considerable elevation. Moreover, no part of this area, which is 12,000 square miles in extent, is more than 20 miles from some arm of the sea, or from the Caledonian Canal. Assuming that 28 in. of the total rainfall is available for power it is calculated that a total of some 235,000 continuous horse-power is available.

While in England there are larger rivers than in Scotland, there are fewer natural lakes, and such powers as are possible would of necessity be in comparatively small units, and must be developed without storage by utilising the natural river flow, as has been done on the Dee at Chester. Ireland's possibilities of power, like those of England, appear to be in her great rivers: while there are possibilities of development in the mountainous district of North Wales, where two installations, developing some 12,000 E.H.P. have already been installed. It is the Board's conclusion that, while the possible water powers of the kingdom are comparatively small, yet, occurrring as they do at no great distance from industrial regions, they are relatively valuable, and every effort should be made by close investigation to ascertain their commercial value at an early date.

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After a survey of the possibilities of the whole Empire, the following conclusions are drawn :—

1. That the potential water-power of the Empire amounts in the aggregate to at least 50,000,000 H.P. to 70,000,000 H.P.

2. That much of this is capable of immediate economic development.

3. That, except in Canada and New Zealand, and to a less extent in New South Wales and Tasmania, no systematic attempt has as yet been made by any Government Department to ascertain the true possibilities of the hydraulic resources of its territories, or to collect the relevant data.

4. That the development of the Empire's natural resources is inseparably connected with that of its water-powers.

5. That the development of such enormous possibilities should not be left to chance, but should be carried out under the guidance of some competent authority.

The Committee recommend that the Government should take steps to form an Imperial Board or Commission, to include representatives of all the Dominions and Dependencies, to investigate the matter, and advise the State as to developments which it might assist or initiate.

Electric Traction.

Newport (Mon.).—In order to economise electrical energy the Tramways Committee has decided to abolish 39 stopping places.

The borough electrical engineer (Mr. A. Nichols Moore) has reported that the Admiralty recently asked the Tramway Committee to consider the question of extending the tramways from Messrs. Lysaght's works to the Channel Dry Docks, so as to convey workmen to that district. A double track would cost £34,517 and a single track with loops £28,517. The Committee has agreed to contribute the pre-war cost of the line and the cars, and to bear 50 per cent. of the working costs provided the track, equipment and cars become the property of the Corporation.

The male staff of the tramways undertaking have received an increase of 5s. per week, making a total increase of 25s. per week over pre-war wages.

Pontypridd-Rhondda Tramways.—A Board of Trade inquiry will be held into a scheme for linking-up the Pontypridd and Rhondda tramway services.

Southport.—The salary of the Corporation tramways manager (Mr. T. J. Kendrew) has been increased from £300 to £400 per annum.

Sunderland.—The Council are recommended to stop the tramcar service at 9 p.m. (instead of 10.30 at present) as from Oct. 3, to double the penny fares and to abolish the transfer system.

Imperial Notes.

Australasia.—Sydney Electricity Committee has removed the restriction upon new connections, the Railway Commissioners having made available for the Corporation use 1,000 H.P. to 1,500 H.P. of electrical energy from their power station.

Metal Manufactures (Ltd.) has spent over £100,000 upon the equipment of works for the manufacture of copper wire at Port Kembla (N.S.W.).

The Commonwealth Government is experiencing great difficulty in obtaining material for telephone extensions. Some classes of instruments previously imported are being made in the workshops of the Post and Telegraph Department.

A representative meeting of delegates of the various engineering and scientific societies of the Commonwealth recently passed tentative resolutions relating to the construction of a Federal institution embracing the whole of the societies. The resolutions will be submitted to the several societies for approval.

The Australian Electric Steel Co. will shortly open branch works at Midland Junction (W. Australia) for the conversion of scrap into steel ingots, electrical energy (1,000 kw.) being taken from the Government power-house at East Perth, 10 miles away. Mr. R. O. Law is the local director. Mr. Wm. Padbury has erected a flour mill which will also be driven by electric power from the Government power-house at East Perth.

Hydro-Electric Power in Canada.—The St. Lawrence River Power Co., a subsidiary company of the Aluminium Co. of America, has applied to the International Joint Commission for further power rights on the St. Lawrence River at Long Sault Rapids, near Cornwall.

Rhodesia.—Subscriptions were recently invited for a loan of £12,000 for an electric light scheme for the town of Umtali.

Foreign Notes.

A Norwegian Electrode Factory.—A new factory at Frederikstad, Norway, for the manufacture of carbon and graphite electrodes is operated by the A. S. Norske Elektrodeverker.

The capacity of the works is 4,000 tons of carbon or 1,000 tons of graphite electrodes a year. The same general standards and sizes of graphite electrodes are to be manufactured as those used throughout the United States. American engineers are employed and the machinery is almost exclusively of American manufacture.

Metal Filament Lamp Sales in U.S.A.—According to "The Engineer" 165,000,000 tungsten filament lamps were sold in the United States in 1917. This figure is exclusive of miniature lamps, of which 75,000,000 were sold. There was a great falling off of the use of carbon filament lamps, which last year only amounted to 12 per cent. of the total.

State and Municipal Electricity Supply in Prussia.—The State of Prussia recently decided to erect a steam station at Hanover. The leading principle in the programme of the Minister of Public Works will be that the State will confine itself to the generation and wholesale distribution of electrical energy. There is to be close co-operation with the existing municipal electric supply stations and the municipal unions.

According to "Engineering," municipal or private undertakings are not expected to discontinue operations, but it is surmised that these undertakings will take the current supplied by the State, as they will be able to obtain it at a lower cost than that of their own current. On the other hand, a certain degree of State interference or control may be looked for, as far as the free development of private and municipal electric works is concerned, more as regards the erection of new stations than the working of those already in existence. The State scheme is also to prevent the building of new inadequate stations, and provides a rational delimitation of the distribution areas.

The Union of Electricity Works, which principally comprises municipal generating stations, has given expression to certain opinions of the scheme. The Union raises no objection to the Prussian State having decided to participate in the supply of current, but in the interests of the national industry any opposition should be avoided between the new State owned stations and the existing ones of fair capacity. The Union therefore hopes that the State authorities will pay attention to the following views:—

1. The development of existing electric stations of fair capacity should not be interrupted by being made dependent upon State permission for their extension, either in regard to generating plant or to distribution.

2. The State electric stations to be erected should be limited to the generation of current and its transmission in bulk; they should not supply large consumers, inasmuch as the supply of current to such consumers is the revenue of the existing electric stations.

3. In the planning and erection of new State electricity works, the question of their real necessity should be most carefully gone into, and State electricity works should not be erected when existing municipal and private undertakings already adequately provide the area in question with current.

Miscellaneous.

Alien Enemy Property.—In the annual report of the Public Trustee, who is custodian under the Trading with the Enemy Acts, it is stated that returns of property in this country held by British persons for enemies, and of debts due by British persons to enemies, show a number approximately of 40,000, while the total number of returns received by the Public Trustee in respect of claims by British subjects against enemies (including those in occupied territory) reaches a total of about 49,000. The total value of all property (including debts) vested or transferred by Orders of the Court and of the Board of Trade amounts approximately to £18,153,694.

British Industries Fair.—The second Glasgow British Industries Fair, which is being held in the Kelvin Hall of Industries, was opened on Monday by Sir Arthur Steel-Maitland.

Engineering Trades Unions.—A conference to consider the question of amalgamating the Unions representing the engineering, electrical, metal workers, scientific instrument makers and other trades will be held on Sept. 11 and 12.

Inquest.—An inquest was held last week at Newcastle on Stanley D. Bavin, an apprentice plater, who was killed at the Neptune Works of Messrs. Swan, Hunter & Wigham Richardson on the 2nd inst.

It appeared that Bavin and others were engaged in punching a longitudinal shell bar at an electrically-driven punching machine when he received an electric shock.

Anthony Vashkevich, foreman electrician, who examined the machine after the accident, found that the terminal wires, as a result of the vibration of the machine, had become bare and dropped on to the compensator box, on which there were signs of burning. The copper wire that had been connected from the compensator box to a water pipe for earthing purposes had become defective.

A verdict of accidental death was returned, and the jury expressed the opinion that the means used to earth the machine were defective.

Radium Control Order.—The Minister of Munitions on Tuesday issued an Order prohibiting the sale or purchase without a permit of radio-active substances, luminous bodies or ores, except uranium nitrate or other radio-active substances which formed an integral part of any instrument at the time of the Order.

Trading with the Enemy.—Recent additions to the list of persons and firms with whom trading by persons and firms in the United Kingdom is prohibited include the following :—

Cuba, Alfredo Holz, representative of Orenstein & Koppel, S.A. (Havana); *Spain*, Jaime Schwab, Electricite (*Madrid*).

Tyneside Fire.—A serious fire broke out on Sunday morning at the electric trainsheds of the North-Eastern Railway Co. at Heaton, Newcastle.

It is reported that 38 electric coaches and the sheds were destroyed, the damage being estimated at over £100,000. There were over 90 coaches in the sheds when the fire was discovered, but 53 of them were taken out undamaged.

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Wireless Telegraphy in Canada.—It is reported that the trustees of the late Lord Rhondda contemplate linking-up Peace River, Fort Vermilion and Fort Smith on the Lower Athabasca river, Edmonton, Alberta, by a series of wireless stations. The Dominion Government will be asked to sanction the scheme and to contribute £9,000 towards the cost.

Imports.—The following are official values of electrical machinery material and apparatus imported into this country (*a*) during June, 1918, and (*b*) the aggregate figures from Jan. 1 to June 30, with increase or decrease compared with corresponding periods of 1917 :—

Electrical machinery, (*a*) £4 ,489 (decrease £62,127), (*b*) £40,8212 (decrease £321,945); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £6,117 (decrease £8,658), (*b*) £66,965 (decrease £55,582); and electrical machinery unenumerated, (*a*) £34,372 (decrease £59,469) (*b*) £341,247 (decrease £266,363); telegraph and telephone cables other than submarine, (*a*) £272 (decrease £33), (*b*) £727 (decrease £4,853); telegraph and telephone apparatus, (*a*) £8,968 (increase £6,142), (*b*) £23,663 (increase £6,066); other electrical wires and cables, rubber insulated, (*a*) £55 (decrease £1,944), (*b*) £657 (decrease £25,398); with other insulations, (*a*) £272 (decrease £33), (*b*) £727 (decrease £4,863); carbons (*a*) £3,418 (decrease £1,690). (*b*) £22,502 (decrease £20,394); glow lamps, (*a*) £11,753 (increase £9,980), (*b*) £63,724 (increase £1,917); parts of arc lamps and searchlights (other than carbons), (*a*) £3,635 (decrease £12,332), (*b*) £43,039 (decrease £20,481): primary and secondary batteries, (*a*) £4,195 (decrease £12.814), (*b*) £92.463 (decrease £72,176); meters and measuring instruments, (*a*) £2,340 (decrease £1,171), (*b*) £7,847 (decrease £8,520); switchboards, (*a*) nil (decrease £47), (*b*) £266 (increase £219); electrical goods and apparatus unenumerated, (*a*) £81,186 (increase £45,459), (*b*) £258,033 (decrease £577). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £115,822 (increase £31,550), (*b*) £514,767 (decrease £194,242).

Exports.—The exports of electrical machinery, material, &c., (*a*) during June, 1918, and (*b*) from Jan. 1 to June 30, with increase or decrease compared with corresponding periods of 1917, were as follows :—

Electrical machinery, (*a*) £114,539 (decrease £8,684), (*b*) £548,408 (decrease £174,070); including railway and tramway motors, (*a*) £5,022 (increase £4,484), (*b*) £20,102 (increase £8,414); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £73,129) decrease £8,904), (*b*) £327,033 (decrease £107,252); and electrical machinery unenumerated, (*a*) £36,388 (decrease £4,264), (*b*) £201,273 (decrease £75,232); telegraph and telephone cables, submarine, (*a*) £17,200 (decrease £2,960), (*b*) £342,231 (increase £228,690); other than submarine, (*a*) £39,250 (decrease £6,068), (*b*) £138,440 (decrease £280,159); telegraph and telephone apparatus, (*a*) £13,799 (decrease £903), (*b*) £100,112 (increase £4,795); other electrical wires and cables, rubber insulated, (*a*) £6,662 (decrease £28,306, (*b*) £33,523 (decrease £120,380); with other insulation, (*a*) £45,24 (decrease £16,912), (*b*) £36,724 (decrease £144,177) carbons, (*a*) £509 (increase £268), (*b*) £3,029 (increase £11,662); glow lamps, (*a*) £6,273 (decrease £3,726), (*b*) £42,176 (decrease £29,397); arc lamps and searchlights, (*a*) £1,552 (increase £830), (*b*) £11,729 (increase £359); parts of arc lamps and searchlights (other than carbons), (*a*) £1,815 (decrease £11,498), (*b*) £10,730 (decrease £19,844); primary and secondary batteries, (*a*) £9,484 (decrease £1,002), (*b*) £52,593 (decrease £34,470); meters and measuring instruments, (*a*) £10,359 (decrease £4,060), (*b*) £59,532 (decrease £5,052); transformers (*a*) £4,012 (decrease £4,082), (*b*) £14,535 (decrease £22,755); switchboards, (*a*) £2,988 (decrease £209), (*b*) £17,632 (decrease £2,015): electrical goods and apparatus unenumerated, (*a*) £33,567 (decrease £20,013), (*b*) £212,489 (decrease £136,353). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £151,994 (decrease £92,303). (*b*) £1,075,475 (decrease £572,420).

Educational.

The New Education Act.—The Royal Assent was given to this Ac on Thursday last. Among the more important changes made by the Act are the following :—

Abolition of exemptions from attendance at school between the ages of 5 and 14, and local authorities may increase the age of compulsion by a by-law to 15; the introduction of compulsory day continuation schools for young persons (unless they are being otherwise educated) up to the age of 16, and after seven years from the appointed day up to the age of 18. The maximum hours of attendance at continuation schools have been fixed at 280, and after seven years at 720. No child under 12 shall be employed. Local authorities may make provision for supply or maintenance of holiday or school games centres, for physical training, &c. There are also a number of provisions relating to the duties of local authorities, the distribution of Government grants, &c.

The National Education Association has issued a pamphlet which gives a useful summary and explanation of the Act.

University of Durham (Armstrong College).—In the department of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, &c., there are complete courses of instruction in preparation for degrees of the University of Durham. The next session commences on Sept. 23, and particulars of the courses may be obtained from the secretary (Mr. F. H. Pruen, M.A.), Armstrong College, Newcastle-on-Tyne.

University of Manchester.—In the physics department there are lecture and laboratory courses, preparing for both the ordinary and honours degrees, and particulars may be obtained from the Registrar. Prof. Sir E. Rutherford will meet intending students on Oct. 3.

University of Edinburgh, Engineering Department.—The next session commences on Oct. 8, and the preliminary or entrance examination is held in September. The University provides complete courses in civil, mechanical and electrical engineering, qualifying for the degree of B.Sc. Eng. Particulars from the Matriculation Office, The University, Edinburgh.

Manchester College of Technology.—The prospectus of the courses for the 1918-19 session is now available.

The head of the electrical engineering department is Prof. Miles Walker, M.A., B.Sc., M.I.E.E., and the mechanical engineering department is under thhe charge of Prof. G. Gerald Stoney, M.A.I., M.Inst.C.E., while each is assisted by a large staff of lecturers and instructors, and there are well-equipped laboratores for practical work. The course of study for a degree (B.Sc.Tech.) or a certificate of proficiency extends over three years. A new degree of doctor of philosophy has been instituted in order to encourage advanced study and research. Its standard will be higher than that of the M.A., M.Sc. and M.Sc.Tech.

Northampton Polytechnic Institute.—The full day courses in civil, mechanical and electrical engineering will commence on Sept. 30.

The courses in civil and mechanical engineering give a thorough grounding in engineering work, and, in the third and fourth years, include specialisation in various directions, such as automobile and aeronautical engineering. In electrical engineering, with similar grounding, the specialisation is in the direction either of heavy electrical engineering or of telegraphy and telephony, including radio telegraphy. The entrance examinations will be held on Sept. 24 and 25, at which three entrance scholarships will be offered. There are full and part time courses in technical optics, and an Aitchison scholarship (value £38) will be offered in this department at the entrance examination.

Tenders Invited and Accepted.

Transformers.

The VICTORIAN RAILWAY COMMISSIONERS invite tenders for the supply of 800 lighting transformers for signal system. (Contract No. 31,597). Specification from the Victorian Railway Commissioners, Spencer-street, Melbourne, to whom tenders by 11 a.m. Sept. 4. A copy of the specification, &c., may be seen at the Department of Overseas Trade, 73, Basinghall-street, London, E.C.

GILLINGHAM.—The Council has accepted the tender of Banks, Warner & Co. for the supply and erection of a 640 B.H.P. Diesel set.

CALCUTTA.—The Municipal Council has accepted the tender of the Russa Engineering Works for wiring the markets on the Henley system, at Rs.11,494.

Appointments Vacant and Filled.

A technical engineer is required to assist in control and manufacture of wireless telegraph apparatus in London. *See advertisement.*

Hammersmith (London) Borough Council require an engineer-in-charge. Commencing salary £175, rising by annual increments of £12. 10s. to £200 per annum, plus war bonus of 20s. weekly and 12½ per cent. *See advertisement.*

An assistant electrical engineer is required for the Welsh Metropolitan War Hospital, Whitchurch, near Cardiff. Application to Clerk and Steward. *See advertisement.*

An advertiser requires a competent man as electrical engineer assistant in the business of patent agency in an office in London.

Mr. R. S. Pilcher, manager of the Aberdeen Corporation tramways, has been appointed as tramways manager to Edinburgh Corporation.

Mr. F. Golding, chief electrical engineer for Victoria in the Post and Telegraph Department, has been appointed chief electrical engineer on the central staff of the Commonwealth Postmaster General's Department at £900 a year.

Mr. Henry Cecil Desch, D.Sc., Ph.D., F.I.C., F.C.S., has been appointed to the Chair of Metallurgy in the Royal Technical College, Glasgow, in succession to Prof. A. Campion, who recently resigned.

Mr. L. Bradburn, of Mansfield, has been appointed engineer-in-charge at Ashton-under-Lyne.

Business Items.

On and after the 17th inst. communications for the Concordia Electric Wire Co. (Ltd.) should be addressed to the company's new works: Trent Mills, New Sawley, Derbyshire. Telephone: Long Eaton 249.

Dictagraph Telephones.—Dictagraph Telephones, Ltd:, of 7, Southwark-street, London, S.E. 1, is issuing a new booklet of 16 pages describing the Dictagraph interconnecting system.

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Companies' Meetings and Reports.

BROWN, BOVERI & CIE. (SOC. ANON.)—At the meeting on the 5th inst. the directors' report stated that there were great difficulties in obtaining prime materials. The turnover for the period under review had increased, but the quantities of materials manufactured remained still below the figures during the last year of peace. The increased utilisation of electric energy in Switzerland greatly favoured the selling of the company's products in the home market, in spite of the serious difficulties to be overcome in connection with the construction of new hydro-electric power stations. The present events proved how erroneous were the ideas preached about 15 years ago—viz., that for aesthetic reasons the country's waterfalls should not be used for the generation of electricity. Consequently the private initiative, which would have secured for Switzerland cheap electric energy, was stopped. Power stations, the erection of which was contemplated, simply remained projects, and now their absence was not only cruelly felt, but those schemes would never again be carried out under such favourable conditions as prevailed at the time. Forced by events, the Swiss Federal Railways have started with the electrification of the Gotthard line and other parts of the railway system. They have undertaken the construction of two large power stations on the Gotthard, and they have decided to order 24 electric locomotives for the Gotthard line. In regard to the tests of a new driving system for electric locomotives, carried out by M. Tschanz, chief traction engineer of the Swiss Federal Railways, these are being proceeded with on the Loetschberg, and have come up to expectations.

The export trade to some of the neutral countries was quite favourable, although business was considerably restricted, partly owing to the difficulties in obtaining raw materials and to the rules and regulations covering their use, but mainly due to the difficulties connected with the transit of materials through the territories of belligerent countries. The export of machinery to destinations in countries at war was fairly satisfactory, but a decrease in export to belligerent countries was, however, noticeable, due to the fact that they did not manufacture any war material. Their business relations with Russia had completely ceased, and considerable losses on outstanding accounts would be sustained. The prudence observed for a considerable time in regard to the increase in the risks connected with business in Russia would help them to sustain those losses without considerably affecting the balances.

Their associated companies realised fairly satisfactory profits, but they were somewhat less favourable for the company owing to the heavy losses on exchange. The Motor and the Alioth Electric Companies had been able to maintain their dividends (*i.e.*, 7 and 5 per cent. respectively), although they were both suffering from the prevailing unfavourable exchange rates, and the Société Electrique of Baden, one of the oldest in Switzerland, had gone into liquidation after having sold its works to the Baden municipality. Their interests in foreign undertakings had been reduced to a minimum. The trading account showed a gross profit of fr.8,826,734.37, compared with fr.6,247,926.72. Their industrial depreciations, which had largely increased owing to important purchases of machine tools and the erection of new installations, amounted to fr.1,646,124.51, compared with fr.736,992.54. Since the beginning of the war the replacement of machine tools had been entirely insufficient, and it would be necessary to spend in the near future considerable sums on new tools, &c. The total of the balance-sheet exceeded for the first time fr.100,000,000; most of the figures corresponded to those for the previous year, but the figures of the materials and stock accounts (half complete and complete machines) gave sufficient proof of the high price. In 1913-14 these accounts amounted to fr.13,833,090.92, but the total for the past year was fr.40,547,667.03. Increased cost of living compelled the company to give new increases of salaries, allowances or bonuses to the staff and workmen. The increase of the share capital from fr.32 millions to fr.36 millions was decided upon at the last meeting. The net profit for 1917-18 was fr.4,375,043.27, and after placing to ordinary reserve fr.500,000 and paying interim dividend of 5 per cent., the balance is fr.1,964.459.70. A super-dividend of 4 per cent. was declared, fr.200,000 were carried to workmen's fund, and fr.300,000 were paid in bonuses.

PERNAMBUCO TRAMWAYS & POWER CO. (LTD.)—The gross receipts for 1917 were £302,476 (against £215,905 in 1916) and working expenses £209,836 (against £150,392), net receipts being £92,640 (against £65,513). After adding £15,469 brought forward, deducting debenture interest, &c., the balance is £40,542. The directors have placed £10,000 to renewal and general reserve and £1,500 to amortisation account, and recommend a dividend on the 7 per cent. non-cumulative participating preference shares at the rate of 3½ per cent. (less tax), leaving £15,042 to be carried forward.

RANGOON ELECTRIC TRAMWAYS & SUPPLY CO. (LTD.)—The year's profit was £68,092, and £2,903 was brought forward. After providing for debenture interest, adding £12,500 to renewals fund and £3,000 to reserve for cables, writing £2,000 off issue expenses, and making other appropriations, the divisible balance is £24,568. A dividend of 3 per cent. (tax free) has been declared on the ordinary shares.

ZINC CORPN. (LTD.)—The Chairman (Mr. F. A. Govett) stated at the recent meeting that at the Company's mine they had not only the electrolytic process, but also the chloride process, which was approaching finality of proof, and two other processes. Serious trials were being made, and the processes would have to work out their comparative advantages. If successful, the chloride promised best, for it made a good extraction of the silver, and produced all the metals in a condition ready for established metallurgical processes. In England, beyond the expansion of existing works and progress with the erection of works at Avonmouth, nothing had been done.

City Notes.

BLACKPOOL & FLEETWOOD TRAMROAD CO.—An interim dividend of 4s. per share (tax free) has been declared.

BRISTOL TRAMWAYS & CARRIAGE CO. (LTD.)—Interim dividend for half-year to June 30, at rate of 6 per cent. per annum, has been declared on the ordinary shares.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—An interim dividend at rate of 7 per cent. per annum has been declared on the ordinary shares.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The units sold during the four weeks ended March 1, 1918, were 2,080,083, compared with 1,776,965 in the corresponding four weeks of 1917. The number of units sold during the four weeks ended March 29 were 2,440,756, compared with 1,941,311, and the number for the four weeks ended April 26th was 2,509,519, against 2,174,348.

ELECTRO-BLEACH & BY-PRODUCTS (LTD.)—An interim dividend of 3½ per cent. has been declared on the preference shares.

EVERED & CO. (LTD.)—The net profit for 1916 was £14,138, and a dividend of 5 per cent. was paid, leaving £5,601 to carry forward. For 1917 the net profit was £18,302, a dividend at rate of 3 per cent. was paid in April, leaving £8,058 to be carried forward.

W. T. HENLEY'S WORKS CO. (LTD.)—The directors have declared a dividend on the preference shares at rate of 4½ per cent. per annum for the half-year ended June 30, last, and also an interim dividend on the ordinary shares of 2½ per cent., less tax in both cases.

LANARKSHIRE TRAMWAYS CO.—An interim dividend at rate of 7 per cent. per annum (less tax) has been declared for half-year ended June.

LANCASHIRE DYNAMO & MOTOR CO. (LTD.)—The directors recommend a final dividend of 6d. per share on the ordinary shares for 1917 and an interim dividend of 1s. per share for 1918.

LONDON & SUBURBAN TRACTION CO. (LTD.)—The directors have decided not to pay an interim dividend on the preference shares.

OLDHAM, ASHTON & HYDE TRAMWAY (LTD.)—The directors have declared an interim dividend at rate of 5 per cent. per annum (6d. per share) on the ordinary shares for the past half-year.

ROYCE (LTD.)—The past year's profit was £6,760. A dividend of 5 per cent., tax free, has been declared on the ordinary shares.

The Round Table.

By "kVA."

THE POWER-HOUSE CLOCK.

Oh, station clock, that hangest on the wall
And markest hours that crawl while engines run,
Ticking delib'rate seconds as they fall
And chronicling the minutes, one by one.
With hand that slowlier o'er its dial plies
Than lumb'ring tortoise stalking sleepy flies.

Oh hang thee, clock, that thou dost not rotate
More turbine-swift, thy ticking one sweet purr:
Oh hang thee, that thou mendest not thy gait
But holdest me on duty far from HER.
Oh misery, that hearts should beat alone
Because thou footlest—dilatory drone.

Thou markest 7. How shall I survive
This last long hour until it's 8 o'clock?
Jehoshephat! the night shift men arrive!
And oh Jerusalem! A further shock—
De Vere against the switchboard hand-rail propped!
Confound the clock—the dratted thing had stopped.

P. BLAGG in "Glover's Almanac."

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, August 13, 1881.]

TELEGRAPHS ON THE HIGH ROAD.—The Tottenham Local Board have unanimously refused their sanction to an application from the Post Office for permission to erect telegraph poles along certain portions of the Enfield High Road.

S.S. "GREAT EASTERN."—This vessel, which has been so intimately connected with Atlantic cable work, is to be sold by Messrs. C. W. Kellock & Co., Admiralty brokers, on the 19th October next. She is still lying at Milford Haven, where she has laid idle for a long time.

REGULATING ELECTRIC LIGHT CURRENTS.—According to the "Dundee Advertiser," Mr. Joshua Horton, electrical engineer at Messrs. Denny & Co.'s Engine Works, Dumbarton, has devised a means by which "he is able to adapt the electric current exactly to the amount of lighting that may be wanted within the limits of the current-generating machine. Whether fewer or more lights are wanted, the power developed is always in accordance therewith, and in consequence 'coils' and all other forms of 'resistance' appliances are rendered unnecessary." As patent rights may be applied for, no details are given of this device.

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CONTENTS.

NOTES 347
Some Applications of Electromagnetic Theory to Matter. By A. C. Crehore 350
Oerlikon Three-Phase. Low-Speed, Variable-Speed Motors with Large Flywheel Effect, for Direct Coupling to Mine Ram Pumps. Illustrated 352
Electric Winding Engines and Mine Hoists. By H. H. Broughton. Illustrated.—*Continued* 354
A Modern Central Station Electric Kitchen 357
Pneumatic Riveting 357
WATER POWER IN THE BRITISH EMPIRE 358
REVIEW 358
British Scientific Products Exhibition. Illustrated 359
CORRESPONDENCE 361
The Labour Outlook. By a Special Correspondent 362
Industrial Reconstruction Council 362
Patent Record 363
Volunteer Notices 363
Commercial Topics 363
Electricity Supply 364
Educational 366
Tenders Accepted 366
Companies' Meetings and Reports 367

Notes.

The Labourer and His Hire.

THOSE who have the inclination to become technical teachers will do well to learn a lesson which is conveyed through the medium of recent announcements in the advertisement columns of the technical Press. Let us begin with Rugby. The Further Education Committee of this important industrial centre requires an Organiser of all Further Education, including the Evening Classes, and the salary offered is £400 per annum. Many a workman is, in these days, in receipt of a higher wage. The Middlesbrough Education Committee offers £275 to £300 a year (with £26 war increment) for a Headmaster possessing the B.Sc. in Engineering. For an Assistant Master, with *at least* Inter. B.Sc. and with qualifications in Physics and Chemistry, a salary of £180 to £250 is offered. For the Engineering Department of the Technical School at Barrow two men are required—one, the Head, and the other an Assistant Lecturer. The salary settled by the local education authority depends on the attainments and experience of the successful candidates. The maximum, however, is £300 for the head and £250 for the assistant. A "teacher of engineering science and practical mathematics for junior day classes and some senior evening classes," qualified to give "general assistance to the local director and to represent him ... during his absence," is required by the Kent Education Committee, the initial salary to be £200 to £250, according to qualifications and experience. Two "temporary form masters," with good qualifications in science, are required by the Plymouth Education Authority for a day junior technical school. Canvassing for these positions is prohibited, and the salary scale is said to be £120 to £340 per annum. Knowledge of the methods of education committees leads us to the conclusion that Plymouth is in want of two well-qualified men for £120 per year per man. If this be so the prohibition of canvassing is scarcely necessary. The education secretary to the Plymouth Education Authority must obviously be a man of "simple faith," if he imagines there will be a run of highly-qualified men after these salaried positions.

What is the Teacher Worth?

ASSUMING that the purchasing power of the sovereign is down to 10 shillings, the equivalent pre-war salaries offered by these impossible people for men of high qualifications and experience, with degrees in engineering and such like, is £200 per annum as a maximum and £60 as a minimum. Richly do those who offer men £60 per year for their full-time services deserve men who are only *worth* £60 per annum. Were the matter to end here no great harm would be done, but in our opinion men whose equivalent pre-war salary amounted to £100 per year or less are not fit persons to have charge of the education of the rising generation of engineers. It may be argued that education authorities are not in a position to pay adequate salaries. If such be the case it were better to close the schools till such time as salaries sufficient to attract really able men can be paid. Low-wage men are often men of little ability, and in our schools, above all, we want men of great ability. Many thought that the "Fisher" grant would be used for improving the lot of the teacher. In practice the grant has been used up in largely augmenting the salaries of well-paid officials. As an example, the salary of the clerk to the Education Committee of a certain town has been increased from £600 to £800 per year out of the grant, and the poor teachers, who in pre-war days eked out a hand-to-mouth existence, receive a three-shilling-per-week increase out of the grant. Our advice to highly-qualified men is to engage in industrial pursuits till such time as the State recognises that the teacher has as much right to live decently as his neighbour, and we hope that no self-respecting man will help to lower further the standard of education by applying for positions similar to those we have indicated.

What *not* to Invent.

WE have previously referred to the importance of giving inventors and scientists a lead in regard to applications of science to the war. It is essential that problems should be freely brought before leading engineers and scientific men by the authorities for solution. But it is at least equally important that there should be guidance on what *not* to invent. Well-meaning people are apt to spend a good deal of effort and ingenuity on problems already solved, or problems which it is no longer desirable to solve, or problems that it is impossible to solve. Such wasted effort is prejudicial in two ways. It is a nuisance to the experts to whom such devices are submitted and disinclines them to encourage invention by those outside the inner ring. It is likewise discouraging to the inventor, who does not understand why his device has been "turned down," and ultimately ceases to make efforts which, if properly guided, might lead to useful results. Some time ago we referred to a useful memorandum issued by the Naval Consulting Board in the United States, explaining why a number of popular ideas for the prevention of submarine attacks were impracticable. Next to submarines we imagine that aircraft is the most tempting subject to the amateur inventor, and we notice that a useful statement was recently drawn up and circulated, mentioning some of the fallacious inventions most frequently submitted to the Air Inventions Committee. Such schemes as those involving flapping wings

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or rotatory planes would in any case involve years of experiment and are hardly likely to be investigated for practical use during the present war. Many safety devices betray want of recognition by the inventor of the lightning speed with which accidents occur, or the difficulty of applying the device to a machine spinning downward at 150-200 miles per hour, possibly in flames. Many other proposals, *e.g.*, trailing bombs and grenades, have been long ago considered and replaced by better measures, and inventors generally are apt to overlook the fact that many obvious proposals, which might have been of service earlier in the war, are no longer serviceable now. Finally it must be understood that it is practically impossible, in the cases of manufacturing processes on a large scale, to introduce novel methods which would involve scrapping all existing designs—even if such methods could be proved to be advantageous. The above are a few considerations which the amateur or outside inventor should bear in mind, and we think the authorities would often save themselves a great deal of needless trouble if they would take measures to make them widely known.

Diminished Street-Lighting in London.

We notice that various Borough Councils have been proposing to economise fuel by a further diminution in public lighting during the summer period when, presumably, illumination is considered to be less necessary owing to the shorter period of darkness. Permission has been accorded by the authorities for the change to be made as an experimental measure, on the understanding that the conditions must be uniform, *i.e.*, that main streets must not be brought into undue prominence in comparison with side streets as a result of the change. It is further stipulated that the permission is conditional on the reduction of illumination not impeding the police in their duties, or leading to increased accidents or disorder. We are very glad that this stipulation has been made, for we think it will be generally agreed that the diminution of lighting in London has gone far enough. We imagine that the fuel-saving possible through further extinction of lamps is relatively small, and there are disadvantages which ought to be carefully weighed against any presumed economies likely to be made. Some of these drawbacks were pointed out in a report on the subject presented at a recent meeting of the London "Safety First" Council, and we hope that this body will continue to exercise a salutary influence in favour of moderation in these matters. If economies in this direction are to be sought, they might surely be most profitably made by adopting more scientific and efficient methods of complying with the requirements of the authorities as regards screening. The existence of so many heavily masked arc lights, emitting through their dark envelope but a small fraction of the total light produced, is certainly an anomaly in these days of economy.

Electrically Welded Ships.—The General Committee of Lloyd's Register have adopted the tentative regulations to which we referred in our issue of the 2nd inst. The classification will be subject to the notation "experimental," and the record "electrically welded" will also appear in the Register book.

Iron and Steel Institute.—The autumn meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers on Thursday and Friday, Sept. 12 and 13, when a number of Papers will be read. Among these we notice one by Mr. K. Honda, on "Magnetic Analysis as a Means of Studying the Structure of Iron Alloys."

Coal Conservation Committee's Report.—The Ministry of Reconstruction has now issued the final report of the Coal Conservation Committee, which was appointed to consider and advise as to the improvements which can be effected (1) in the mining of coal, (2) in the using of coal and (3) as to the extension of coal supplies. We hope to deal with this report next week.

Electrical Engineering Developments in India.—Some time ago we referred to the extensive schemes being developed in India for the use of water power, and it appears that the manufacture of electrical plant and apparatus is also making considerable strides in that country. A reference was made to this in the recent speech of Mr. Montagu when introducing the Indian budget. He stated that the plants for lighting Basra and Bagdad were nearly all drawn from India, which also furnished a large proportion of the agricultural and irrigating machinery now being introduced into Mesopotamia.

Royal Technical Institute in Milan.—The large amount of work carried out by experimental laboratories in Italy is rather apt to be overlooked in this country. For example, in the "Industria Revista Tecnico-Scientifica ed Economica" an account is given of the work of the Royal Technical Institute in Milan, which has increased very rapidly during recent years; in 1915 the average number of monthly tests was about 500, in 1916 about 2,000, and in 1917 about 3,000 per month. A great deal of work has been done for the military authorities, a special feature being the solution of many difficult problems with regard to materials for aircraft.

Organization of the A.E.G.—Those of our readers who were present at a meeting of the Institution of Electrical Engineers when Mr. L. B. Atkinson exhibited a lantern slide showing the extraordinary ramifications of the A.E.G. may like to know that this diagram has appeared in the "Morning Post" of the 17th inst. We should have been pleased to reproduce the diagram in The Electrician but for its large size (it occupies nearly a whole page of our contemporary). The source is a report of the Federal Trade Commission on Co-operation in American Export Trade. In notes accompanying the diagram some particulars are given of the numerous affiliations with banks and other enterprises and of the controlled companies.

Selenium as a Decolourising Agent in Glass.—In the "Journal" of the Society of Glass Technology an account is given of some researches undertaken in Germany on the use of a selenium as a decolouriser in glass manufacture. According to the author, Mr. W. Frowmel, glasses decolourised by selenium are more brilliant than those in which manganese or nickel oxide are used as decolourisers. The action of the selenium is due to the formation of minute particles, which give a red colour to the glass, neutralising the faint green caused by presence of iron. Selenium, however, is not a suitable decolouriser for lead glasses, and there is also the drawback that glasses thus decolourised assume a brownish tinge on prolonged exposure to bright sunlight.

Highest Telephone System in the World.—According to the "Telephone Engineer," Mr. G. D. E. Mortimer, a mining engineer of Point Loma, California, claims to have the highest telephone system in the world, the installation being at an altitude of 15,500 ft. above the sea level. This telephone system is located at Sonata, Bolivia, South America, where the installation of a telephone system for the Inca-oro Mines Co. between the various parts of the mine and the town of Yani has just been completed. The total length of the line is 10½ miles, all of the installation being at an altitude of 15,500 ft. Deep snows, snow slides and ice have to be contended with at the mines of the Inca-oro Co., while in the valleys of Bolivia the swollen rivers, terrific heat and the insects of the tropics are equally unpleasant.

Hauling Ice Electrically.—According to the "Electrical Review & Western Electrician" the electric vehicle has proved to be the most economic means of city transportation. Ice dealers are adopting such vehicles in increasingly large numbers, particularly in wholesale delivery. A Philadelphia manufacturer has developed a special type of electric truck for meeting conditions that cannot be economically handled with the ordinary 5-ton equipment, particularly where the time for loading and unloading is relatively great, and where short

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hauls and congested traffic are encountered. The special electric truck is arranged to drive on front wheels only, the large rear wheels being steel tired; the speed is lower and the battery smaller, resulting in a materially reduced first cost, and a reduction in amortization and interest. Maintenance is also greatly reduced, resulting in a total cost lower than the cost of doing the same work with horse equipment.

Electrical Power Engineers' Association.—On Thursday, the 15th inst., the London Western Section of this Association was inaugurated at Hammersmith. The chair was taken by Mr. G. C. Law, publicity secretary, and 19 undertakings were represented in the attendance of over 50 staff engineers. The chairman briefly outlined the history of the E.P.E.A., the advantages of its constitution and the recognition by the Institution of Electrical Engineers and similar authorities of the E.P.E.A. as the protective Association for staff engineers of the electricity supply industry. The phenomenal growth of the E.P.E.A. had necessitated a measure of decentralisation, so as to secure the democratic control of the affairs of the Association. All non-members present agreed to become members of the section. A strong Section Committee was elected, and meetings will be held on the first Thursday in each month. All staff engineers (lighting, power and traction undertakings) engaged or residing in the area 5 miles west, north and south, and 1 mile east of Hammersmith, who wish to become members should communicate with the Section hon. secretary, Mr. W. J. Wilcocks, 8, Willow-avenue, Barnes, S.W.18.

Use of High Grade Coal During Periods of Peak.—The development of war industries coupled with slow deliveries of equipment has made the problem of carrying winter peaks a difficult one in Iowa, U.S.A. In order to obtain the maximum rating out of the existing equipment only high-grade coal was burned during peak hours. The "Electrical World" describes the use of auxiliary bunkers of 3 tons capacity for the high-grade southern Illinois coal. They were constructed of wood and set almost against the fronts of the 500-H.P. boilers in an elevated position so that they could be emptied into the stoker hoppers during peak loads by operating a metal-bound wooden gate. The clearance between these bunkers and the boiler fronts was just sufficient to afford ventilation and to give space for operating levers. With underfeed stokers it was possible to get as much as 300 per cent. of rating out of the boilers with this arrangement, but with the chain-grate stokers 175 per cent. of boiler rating was about the limit that could be obtained. In another case 500-H.P. boilers with a sectionalised 17-ton bunker divided into two equal parts—one part for Iowa coal and one for southern Illinois coal—were used. During the peak, or at times when transmission line failure places extra load on the plant, it was possible to get at least 20 per cent. increase in rating over the best that can be obtained with Iowa coal. The saving of investment in one entire boiler equipment amounted to about $22,000.

Transmission of Light by Glasses.—Hitherto there appears to have been no generally accepted method of testing the transmission of light by glasses having more or less roughened surfaces, *e.g.*, etched, sand-blasted, pebbled, &c. The problem is complicated by the fact that all the light which fails to be transmitted is not lost; part of it is absorbed but part reflected. In addition, the amount of light transmitted and reflected respectively may be expected to vary according to the angle of incidence. Some data on such glasses were recently contributed to the "Journal" of the Franklin Institute by Mr. M. Luckiesh and Mr. L. L. Mellor. The specimens were tested in the form of flat plates, with one surface treated and the other polished. The transmission factor was determined both for a narrow pencil of light directed perpendicularly on the specimen and for highly diffused light. The factor was generally less in the latter case, as might be expected, and in the case of the narrow pencil of light the results varied considerably according as the smooth or rough side of the glass faced the light source. For certain ribbed glasses this difference was as much as 50 per cent.; while, with etched glasses it was only 5 per cent. In most cases the transmission factors were between 0·70 and 0·85. The nature of the apparatus is only roughly indicated in the summary presented, but the use of the integrating sphere is regarded as essential, presumably in order to collect and integrate the light transmitted at all angles.

Industrial Reconstruction Council.—An important series of conferences and discussions is announced by the Industrial Reconstruction Council, to be held at 6 p.m., in the Hall of the Institute of Journalists, at fortnightly intervals, alternately with the lectures at the Saddlers' Hall, of which particulars have already been published. The first of these will be opened by Mr. Robert Wilson, of the Ministry of Labour, on Tuesday, September 10th, with an address on Works Committees. On September 24th the subject will be Trade Boards, and the speaker, Mr. J. J. Mallon, of the Anti-Sweating League. The other conferences will deal in turn with Interim Industrial Reconstruction Committees, the Place of Conciliation and Arbitration in the Whitley Scheme, Women in Industry, the Trade Union of the Future, Functions of Industrial Councils, and Restriction of Output, the opening addresses being delivered respectively by Mr. W. Henderson Pringle, of the Ministry of Reconstruction, Mr. E. H. C. Wethered, Miss Lilian Dawson, Mr. George A. Isaacs, of the National Society of Operative Printers and Assistants, Mr. E. McGegan, of the Ministry of Labour, and Mr. Wilfrid Hill, of Birmingham. No tickets will be issued, but all those who intend to be present are asked kindly to inform the secretary, I.R.C., 2 and 4 Tudor-street, E.C. 4, who will be glad to send a full prospectus of the series on application.

The lectures on "Reconstruction Problems" at Saddlers' Hall, will take place at 4.30 p.m. on Wednesdays in October, November and December. On October 2nd the President of the Board of Trade will deliver a lecture on "Commerce and Industry After the War," and on October 16th Dr. Addison, M.P., will lecture on "Principles of Reconstruction." The other lecturers will be Mr. W. L. Hichens, Sir A. Steel-Maitland, M.P., Mr. E. J. P. Benn and Sir William McCormick.

Obituary.

H. L. MOYSEY.—The death of Mr. Hy. Luttrell Moysey, I.S.O., who was Postmaster-General and Director of Telegraphs in Ceylon until his retirement in 1906, occurred on the 15th inst. at Bexhill.

Personal.

Mr. H. H. Lincoln, assistant engineer and draughtsman in the Sheffield tramways department, has been granted three months' leave of absence on account of ill-health.

We regret to learn that Mr. J. A. Davidson, mechanical engineer to Belfast electricity department, has been compelled by ill-health to resign his appointment.

MILITARY HONOURS.—The following honours have been conferred:—

News arrives from Italy of the award to Capt. Wedgwood Benn, D.S.O., M.P., of the Distinguished Flying Cross. This new decoration for the Independent Air Force is only given for conspicuous gallantry in the air in the presence of the enemy. Capt. Benn has probably experienced more actual contact with the enemy than falls to the lot of most civilian soldiers. The present award is the third distinction that he has earned for active fighting work. The D.S.O. was secured by him on the occasion of the sinking of the "Ben Machree" in January, 1917, when the official despatch records that he went away in a boat to search for men who were missing and was exposed to very heavy shell fire.

Acting Capt. W. J. S. Baird (R.F.A.), a former science student at Edinburgh University, and only son of Mr. A. H. Baird, scientific instrument maker, has been awarded the Military Cross.

Lieut. (acting captain and adjutant) V. C. Russell (Suffolk Regiment), younger son of Mr. Stuart A. Russell (works manager of the India Rubber Co.) has been awarded the D.S.O. He had previously been awarded the Military Cross and a bar to the same, and had been twice mentioned in despatches and twice wounded.

Driver E. Catherall (R.E.), formerly employed on the Burnley tramways, has been awarded the D.C.M. He enlisted at the age of 16.

WAR CASUALTIES.—The following casualties are reported:—

Lieut. Alex. Marshall (R.E.), M.C., who was formerly an electrical engineer to the Bannock Coal Co., has been gassed.

Pte. H. T. Davenish (Cheshire Regt.) and Pte. E. Spooner (Northants Regt.), formerly in the service of the India Rubber Co., are prisoners of war in Germany, and Corp. T. Purchase (R.F.A.), who was also formerly engaged with the India Rubber Co., has been wounded in Italy.

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Some Applications of Electromagnetic Theory to Matter.*

By A. C. CREHORE.

It is the interpretation of physical observations that has engaged the speaker's attention for several years, and it has seemed to your committee that the time is ripe to present to you certain conclusions that have resulted.

Throughout the history of science we have seen one theory giving place to another sometimes in rapid succession. This has had a very depressing effect upon a certain class of people, who do not comprehend the real trend of it. I would impress upon you that this is one of the chief earmarks of progress. We cannot attain the realisation of the ultimate gaol at once, and, therefore, the only way to approach it is by a series of successive approximations. Each nearer approach involves of necessity some changes in preceding ideas.

It even seems probable that the fundamental hypothesis of atomic structure as composed of electrons, positive and negative, is entirely correct, and that the reason why we are not yet able to account for more of the observed phenomena is because we have not discovered the proper processes to follow in reasoning from the simple to the complex. I suspect that this is the truth of the matter, and, when you comprehend more fully the complexities of most of the processes involved, you will experience no difficulty in agreeing with me.

The discovery of the electron and the isolation of it, so that its properties might be measured, marked a new era in our conception of matter. The fact that each electron always carries an electrical charge of the same amount is most significant. It has led by natural steps to the present electrical theory of matter. It was also most natural to begin to apply to these electrons, as representing electrical charges, the electromagnetic theory that is known to apply to other electrical charges, a theory that has been developed by a generation of men long before the electron was known, as the chief exponent of which the name of Maxwell stands pre-eminent. This was done of course, but it was soon found that the existing form of electromagnetic theory was inadequate to cope with single isolated charges moving with considerable velocities through space.

Electromagnetic theory itself, therefore, became the object of much more careful study. The result has been that we have witnessed, even in our day, a gradual evolution of electromagnetic theory. Maxwell would hardly recognise the form in which electromagnetic equations are expressed to-day. The new thing that has been introduced into the theory is the conception that the effects of a charge moving through the ether are propagated out in all directions from it with a velocity which is characteristic of the ether, the same velocity as that of light. This introduces important differences into the equations, sometimes referred to as "retarded potentials."

Some progress was made by the use of this theory in interpreting atomic phenomena, but there were certain observations, particularly connected with radiation from gases, that simply refused to be brought into line in any way that could be conceived. On the strength of this Max Planck proposed what is now known as his "quantum theory." It stands to-day as one of the boldest proposals ever suggested in physics. He originally arrived at the theory through a consideration of the radiation of energy from gases, but it has since been shown to have a very general application in all atomic phenomena. The boldness of his proposal may be seen from the following. Finding that electromagnetic theory was inadequate, as he conceived of it, he proposed to lay it aside and not use it. He then gave reasons for his proposal that, whenever energy is radiated anywhere from matter, the energy is transferred in units, or in quanta, so that the total energy transferred is some integral multiple of a fixed minimum of energy, the quantum.

Let it suffice to say that the application of Planck's quantum theory to radiation straightened out the difficulty immediately. Perhaps it would be better to say transferred the difficulty from one place to another, for difficulty there is and will be until the fundamental cause of the necessity for units or quanta of energy is comprehended. However, progress by the use of this new idea was very marked in every direction as regards atomic phenomena. The value of the unit or quantum of energy has now been experimentally determined. It is excessively small, but, when a quantity can be measured at all, its existence is not questioned. Its existence is now regarded as experimentally established.

The present trend of physicists is to generalise this idea, and to say that energy is essentially of an atomic nature, being composed of units in the same way as matter is so composed This generalisation implies that no flow of energy ever takes place that does not go in exact multiples of this unit. It seems to the speaker that there is danger in thus generalising in advance of definite proof, or, at least, in letting our thoughts be guided as though this general proposition were true. A similar generalisation was made without proof some years ago in physics. I refer to the principle of the conservation of matter, which has been published in most textbooks on physics of the older school. We have latterly been obliged to retract this. We do not know now that it is true. We cannot assert, however, that the contrary is true, namely, that matter is being created and destroyed. We simply do not know. We do know that the individual atoms do not remain intact as they were formerly thought to do, and that some of them are actually going to pieces, giving out parts of themselves and losing weight. Whether or not the electrons that they give out always enter into some other piece of matter, and thus make for the ultimate conservation of matter, it is not possible to say. We cannot say that the sum total of electrons in the universe remains constant.

You will easily comprehend that the effect of Planck's theory has been to divert attention from electromagnetic theory, since he was forced to lay it aside. This very act, and the fact that substantial progress was made by so doing, naturally brought electromagnetic theory into disrepute, so far as its application to electrons in atoms is concerned. It is fortunate that he had the courage to do it, because the result has been that we are in possession of valuable information about the atoms, which would otherwise now be unknown.

It must be admitted, however, that it will never be satisfactory to the human intellect to leave the situation in the state we find it to-day. The solid foundations upon which we must seek to found an atomic hypothesis should in some way be connected with the properties of the electron and its connection with the ether of space. These are fundamental parts of electromagnetic theory, which expresses in mathematical language just this connection between an electrical charge and the ether, that is, between matter and the ether. It seems even possible, nay, indeed, probable, that some good reason for the existence of a quantum of energy may yet be discovered by the help of electromagnctic theory, as being connected with the very constitution of the atoms themselves. This hope alone is sufficient incentive to urge us to continue the search by the use of this theory, at least to such a point that it can be proved the search is vain, a most difficult undertaking.

II. Rutherford-Bohr Atomic Theory.

With this introduction you may be better prepared to listen to the following account of some applications of electromagnetic theory to matter. The Institute had the opportunity last year to hear an address upon topics of absorbing interest to physicists, which included some account of the Rutherford-Bohr theory of the atom. This theory is, no doubt familiar to you, but some of the chief features of it will form the starting point of my remarks to-night. According to their theory an atom is a structure composed in part of a charge of positive electricity, the centre of which is the geometrical centre of the atom. This charge is supposed to have small dimensions compared with the size of the atom, or even of the negative electron. Around this nucleus one or more negatively charged electrons are supposed to be describing approximately circular orbits, the radii of which are very large as compared with the radius of the electron itself.

There may be several electrons describing the same orbit at the same time. They would then distribute themselves at equal intervals around this orbit on account of the mutual repulsion they have for each other, thus forming a ring of electrons. The atoms may be composed of several such rings all circulating around the same nucleus. Atoms, in the ordinary states of matter, have no resultant charge, and it is supposed that in this case the sum of the negative charges of the electrons is equal to the positive charge of the nucleus, thus making the total zero, when the atom is said to be neutral. Under special circumstances atoms may be caused to lose or to gain one or more electrons than they have when neutral, and then the atom manifests a resultant charge, positive if electrons are lost, negative if gained. It has been observed that such atomic charges are always some exact multiple of the charge on one electron, but it may be either positive or negative.

* Lecture delivered before the American Institute of Electrical Engineers, slightly abbreviated.

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There are certain remarkable features in this theory introduced by Dr. N. Bohr, relating to the changes which take place in such an atom when it is disturbed by any cause. He finds that the radius of the orbit of the electrons changes from one fixed value to another, there being a series of possible radii; but, when the change begins, it does not stop until it arrives at one of the other possible radii, or, in other words, the radii must change by sudden jumps. This is a direct result of an application of the quantum theory above referred to to the atoms; for, by it, the change in energy must take place in quanta. Bohr has found as a result of his premises that there is a change in the kinetic energy of the electron in passing from one of these fixed orbits to another, and the size of the orbits has been calculated from *electromagnetic theory* by taking this change in the energy always as an exact multiple of the quantum of energy. The atom will then radiate energy when the electrons fall in towards the nucleus from one fixed orbit to another, and they absorb energy when they go outwards from the nucleus.

There are several assumptions that have been introduced in order to arrive at these results. First, there is no radiation of energy at all when the orbit remains in one of the series of fixed positions, although the electrons are in rapid motion. Second, the ordinary equations of electromagnetic theory apply to the electrons when they are in one of these fixed orbits not radiating energy, but that they do not apply when they are changing over from one radius to another and radiating energy. There have thus come to be recognised several states of the atoms, where the radii are fixed, known as the steady states, and where energy is neither radiated nor absorbed. All other states than these exist only during the radiation or absorption of energy.

III. Two Great Natural Divisions of Matter.

There is thus made a great natural division of all existing physical phenomena. The atoms are either in one of these steady states or they are not. To illustrate, we may consider that most of the matter in the solid crust of the earth is in the steady state, or, more strictly, it would be if it were at the absolute zero of temperature not radiating any heat. It is quite conceivable to think of the temperature of the earth as being lowered to the absolute zero without disturbing in any way the real constitution of the rocks of which the earth is composed, or of the temperature of a crystal being at the absolute zero. As an example of atoms not in the steady state, we may think of substances during the process of undergoing any chemical reactions, where a change of partners takes place with an accompanying transfer of energy among the atoms and molecules. This includes all vital processes in organic substances, where chemical reactions are continually taking place under certain special laws of guidance or causation. This latter class involving energy transfer includes most of the phenomena of the greatest interest to man, but the former class, the steady state, is of the utmost importance even if somewhat more restricted in variety. We owe to it the home in which we live, the solid structure of the earth. It also includes the large class of metals and building materials generally, in which the engineer is particularly interested.

It may be repeated, that, in this first class, the steady states, the Bohr theory, and other theories, assume that the ordinary electromagnetic theory is applicable to the electrons in an atom. The view is taken that it is not applicable to the second class involving energy changes in the Bohr theory, but it might be a better position to take to say that no one has as yet seen just how to apply the theory than that it is not applicable.

If we, therefore, confine our attention to those states of matter where there is no energy transfer, the first class, where the electromagnetic equations are said to apply even by those who indorse in every detail the Bohr theory of the atom, we ought to be able to make a beginning of progress in interpreting some of the physical properties of this class of matter by the correct application of electromagnetic theory. It is time enough to begin a consideration of the other necessarily more complicated class, where there is a transfer of energy, and where the applicability of the electromagnetic equations is at present in doubt, after we have achieved some sort of results in the simpler case. It seems as if this simpler case should naturally precede any consideration of the other, for one reason, because any success in the one is almost sure to shed some light upon the methods of procedure to be adopted in the other.

It is precisely to these steady states of matter, where the applicability of electromagnetic theory is admitted, that the speaker has been endeavouring during the past several years to apply the present form of electromagnetic theory in a more rigid manner than it has been applied heretofore, and it is to a consideration of some of the results of such application that your attention is directed in these brief remarks.

IV. Electromagnetic Theory.

To begin with a few remarks upon the current form of electromagnetic theory seem to be required. Engineers may be disposed to associate the words "electromagnetic theory" with that form of the theory which comes into the subjects of Electricity and Magnetism, as it is taught in the technical schools. There is a very great difference, however, between the general form of the theory and that part of it which is commonly needed for a complete understanding of all of the phenomena usually met with in electricity and magnetism. You will see at once the reason for the difference when you consider that you are always dealing with great numbers of electrons instead of with single isolated ones. An electric current is a continuous stream of electrons often moving in closed curves, which evidently simplifies matters very much, and in every practical case, you will find that a simplified form of the theory is all that you require. For this reason it seems fair to assume that most of you are not very well acquainted with the general form of the theory where single electrons are concerned. The example referred to by the use of the electric current may make the difference clear. Imagine a closed circuit of any shape carrying a steady current. There is a magnetic field set up in the whole region surrounding the circuit, and at each point of this field the magnetic force is a directed quantity, but the point I wish to make is that it is constant at each point of the field. Now, imagine all but one of the procession of electrons circulating around the circuit to be removed in some way, so that a single electron instead of a multitude passes around the same circuit. It is evident to anyone that the magnetic force at the point in question cannot be constant as before, but must be pulsating in character with a fundamental period equal to the time of revolution in the circuit. The equations of the general electromagnetic theory must be such that they will give a complete description not only of the variable magnetic force at the point in question with time but of the electric force as well, for, when a magnetic force varies, as it must, it is always accompanied by an electric component, which in such a case as cited, will also vary. The very great simplification in the force introduced by having the stream of electrons is, I think, made clear by this example.

The general electromagnetic equations in current use are of too complicated a nature to introduce into a talk of this kind, but I think that some things may be said of them which will serve our purpose. They are necessarily expressed in the language of vector analysis as always dealing with variations of directed quantities in space, and no attempt to put them into other mathematical language that we possess will ever be successful. In fact, until the vector language was developed it was hopeless to cope with such problems. Let us now try to get a definite picture of some of the fundamental facts of electromagnetic theory as applied to just two electrical charges, two electrons if you please. Imagine them isolated from the rest of the physical universe if you can. If each of them is at rest, the ordinary electrostatic force, with which you are familiar, is all that we have to consider, a repulsion in the direct line joining the charges inversely as the square of the distance between them and directly as the product of the charges. But, let them be set into motion. We may now picture a disturbance sometimes called an electromagnetic wave, as travelling out in all directions with the velocity of light from the charges. If the distance between the charges is considerable, it may be quite a time before the wave from the one reaches the other charge, eight minutes if one is in the earth and the other on the sun. In eight minutes the first charge will have moved a considerable distance if its velocity is great. If its velocity were 1/100th of that of light, it would have travelled 1/100th of the distance from the earth to the sun in this time. So, when the wave that left it in its first position actually reaches the second electron, the first electron is not very near to the place that it was. In what direction would the force on the second electron due to the first then be? Evidently not in the original direction it had when they were both at rest. Electromagnetic theory purports to tell us just what the force is at any time on the one charge due to the other, that is, the instantaneous force, for it is evidently continually varying.

You will, I think, see from this that the force on the second electron is entirely due to this electromagnetic wave which emanates from the first electron. This wave must travel in a medium, and so electromagnetic theory is founded upon the real existence of an ether fixed in space, and the force upon the second electron is really due to some connection that it has with the ether. One of the fundamental equations in electromagnetic theory expresses in mathematical language this fundamental connection that there is between an electrical charge and the ether. Much more might be added on this topic, but, if you are to hear the things I have set out to say, we must pass over this phase of it.

(To be concluded.)

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Oerlikon Three-Phase, Low-Speed, Variable-Speed Motors with Large Flywheel Effect, for Direct Coupling to Mine Ram Pumps.

Centrifugal and turbine pumps are making great headway for the raising of water from the pit bottom up to the surface, but in certain circumstances the hydraulic ram still offers decided advantages.

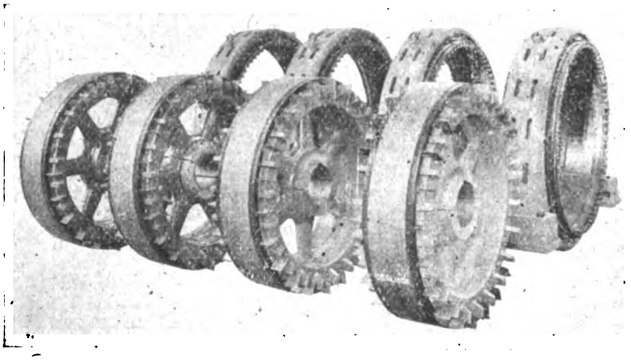

Fig. 1.—Stators and Rotors of Motors.

Either type of pump, however, has hitherto been hampered as regards its economic value when driven by three-phase induction

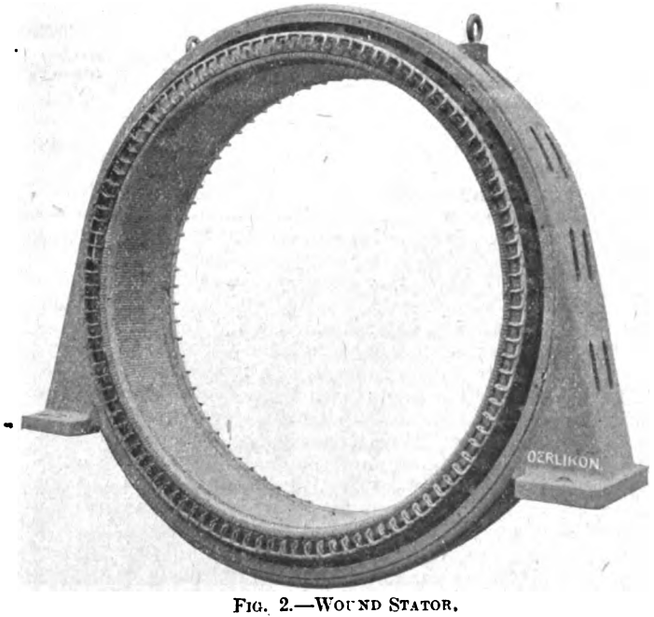

Fig. 2.—Wound Stator.

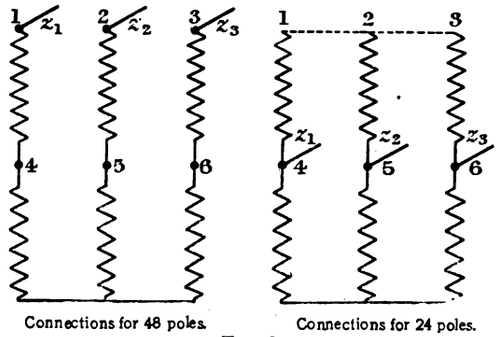

Fig. 3.

motors, as it was impossible to run these motors continuously under the most favourable speed conditions, and to suit the varying quantity of water to be raised. This is particularly the case with the ram pump, the output capacity of which is in direct proportion to its speed, and which therefore had either to run for only short periods, giving a low load-factor or at a greatly reduced output, with a correspondingly reduced efficiency.

The Oerlikon Works have applied their well-known variable speed three-phase variable speed motors in this field with eminent success, and have executed an order to the specification of the

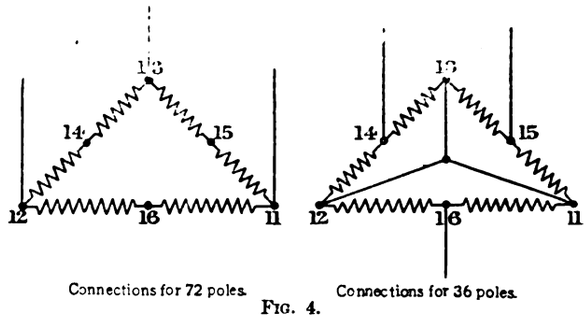

Fig. 4.

consulting engineers, Messrs. Wm. A. Scott & Partners, of 102, St. Mary-street, Cardiff, for an equipment for Messrs. the Dolcoath Mines (Ltd.), including four complete four-speed variable-speed induction motors, &c. The characteristics of this plant are as follows :—

Motors.—The motors—the stators and rotors of which are illustrated in Fig. 1—are of the squirrel-cage type, designed with a

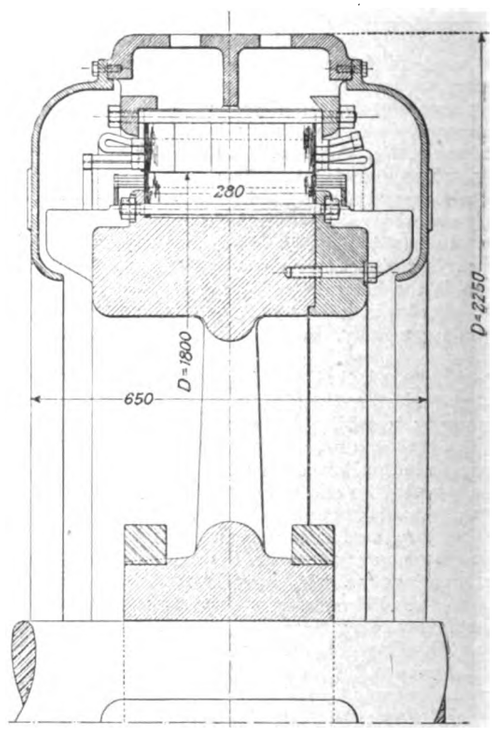

Fig. 5.—Half Section of Motor.

particularly heavy flywheel effect, for the purpose of equalising th uniformity of speed of the ram pumps.

The motors are built to the following specification :—

Speed step, No.	1	2	3	4
Output	35	55	72·5	110 B.H.P.
No. of poles	72	48	36	24
Speed per minute	38	60	82	118 revs.
Pressure	2,700/3,000 volts.			
Periodicity	25 cycles.			
Flywheel effect	8,500 Kgm.²			

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The motors are started by means of auto-transformers, combined with drum-pole change-over switches. The machines are guaranteed to start up with a pressure of 2,700 volts (normal 3,000 volts), and a torque equivalent to that corresponding to the normal load conditions The design and construction of the motors had also to take account of the particularly unfavourable temperature conditions

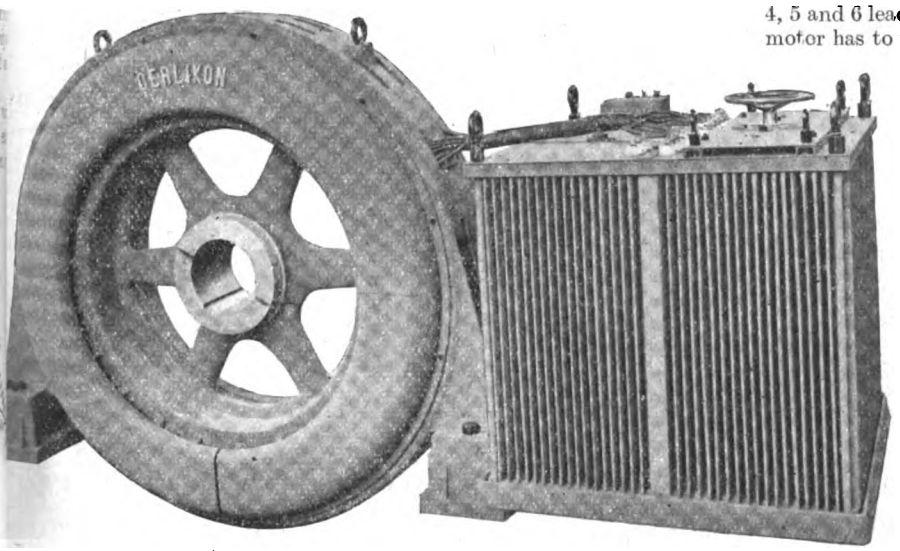

FIG. 6.—COMBINATION OF MOTOR AND LOAD TRANSFORMER.

(average temperature, 37°C.), and the exceedingly damp atmosphere (humidity, 80 to 85 per cent.) down in the pits. The windings had therefore to be particularly carefully insulated and impregnated.

It was first thought that it would be preferable to build the motors for the full voltage of 2,700 to 3,000 volts, but in view of the high standard of safety and reliability in operation necessary in

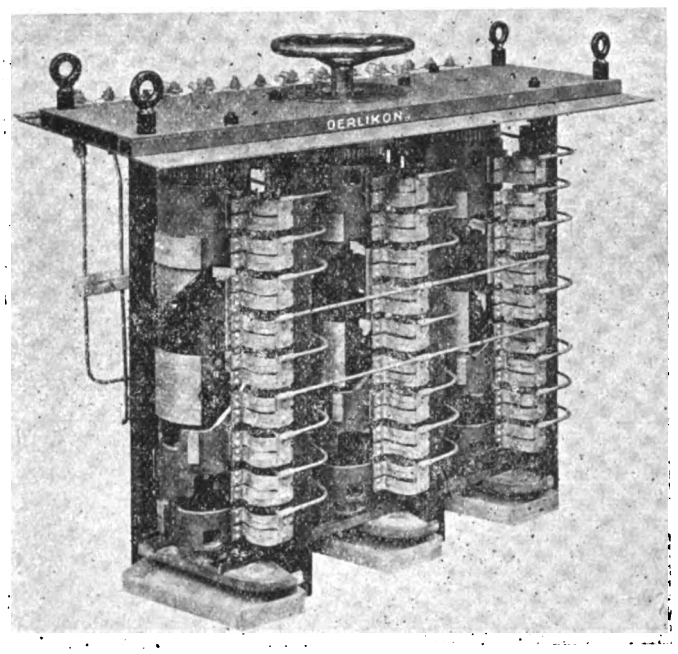

FIG. 8.—POLE-CHANGING REMOVED FROM TANK.

this case it was finally decided that the motors and starting transformers would represent an electrically and mechanically safer and less costly job if the auto-transformers were built to act as proper load-transformers, supplying the motors with current at a reduced voltage. The motor-stators are provided with two entirely independent winding systems, of which one is built for 24 and 48 poles, and the other for 36 and 72 poles. By combining the load-transformer and pole change-over device in one apparatus, it was possible to supply the two winding systems of any pole number with current at a voltage most suitable for the construction of the windings, which latter have been developed in the most satisfactory mechical form—viz., bar windings.

The extra cost of the load transformers, as compared with the cost of the auto-transformers, was easily compensated by the reduced dimensions of the low-tension motors and the simpler windings. Fig. 2 illustrates a wound stator. The windings are embedded in 432 slots. The system for the 24 and 48 poles consists of 48 coil-groups per phase, the connections of which are illustrated in Fig. 3.

Of the six connections of this winding system, those marked with 4, 5 and 6 lead the corresponding sets of 24 coil groups each. If the motor has to work with 48 poles the current supply is connected by means of the pole-change-over switch to 1, 2 and 3, whilst the tappings 4, 5 and 6 remain free. The motor works with 24 poles when the current supply is connected to 4, 5 and 6, and the terminals 1, 2 and 3 are short-circuited.

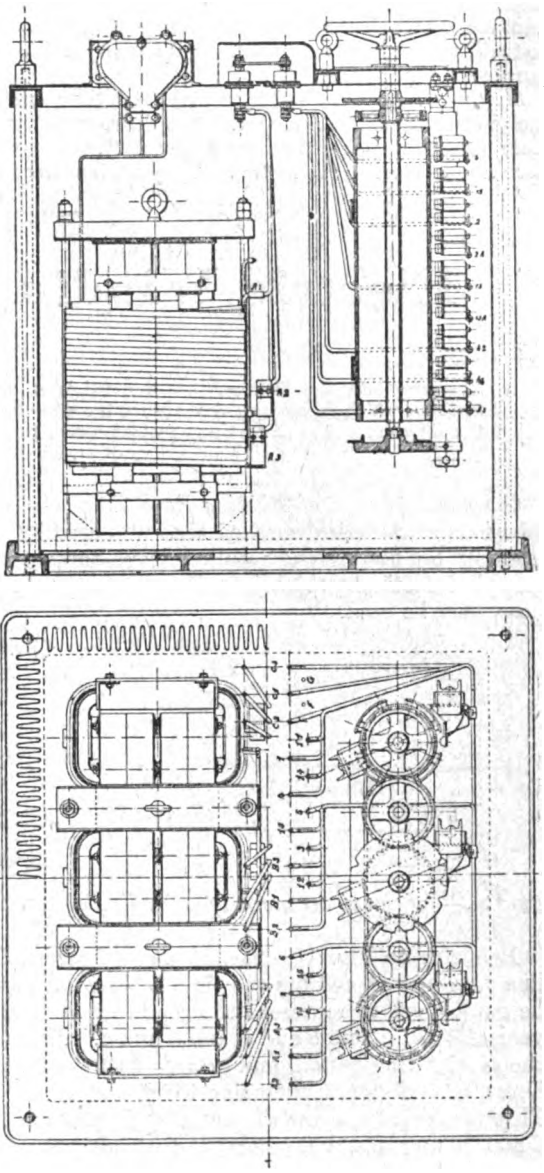

FIG. 7.—PLAN AND SECTION OF REGULATING TRANSFORMER

The winding system for 36 and 72 poles consists of 72 coils, and is embedded in the same stator slots, but next to the air-gap, and so arranged that the stray field of these windings, which naturally would be larger than that of the 24 and 48 pole windings, is appreciably reduced. Fig. 4 illustrates the connections of the coil groups. These windings also possess six terminals. With a grouping of 36 coils the connections marked 14, 15 and 16 lead to the pole change-over switch. If the motor has to run with 72 poles, then the three-terminals marked 11, 12 and 13 are connected with the current supply, whilst 14, 15 and 16 remain free. The motor works with 36 poles, if the connections 11, 12 and 13 are short-circuited, and the supply is connected to 14, 15 and 16. Such a variable speed motor has therefore in all 12 terminals.

As already stated, both stator windings are built on the "bar principle." Each winding system is represented by four bars per slot, each bar individually insulated by a seamless mica tube. The slot insulation against iron is also a seamless mica tube. The slots

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are half open, so that the former bent bars can be carefully insulated before they are embedded in the slots.

The laminated stator core is compressed by means of the usual press rings and bolts. The stator core is not sub-divided by means of ventilation divisions, as, at the lowest speed, corresponding to a rotor peripheral speed of 3·6 metres per second, the ventilation obtainable would be practically negligible. Even at the highest speed step the peripheral speed is only about 10·8 metres per second.

Fig. 5 illustrates a sectional view through the motor (the shaft and bearings of which were supplied by the pump makers). The rotor is keyed on to the crank shaft of the ram pump, and the specified flywheel effect of 8·5 TM^2 is provided by the rotor. The rotor lamination-core is composed of non-insulated sheet iron, and also compressed by the usual press rings and bolts. The windings are constructed on the squirrel-cage principle, and consist of non-insulated copper bars, embedded in 528 sewn-up slots. The ends of the bars are compressed into slotted copper rings and silver-soldered, so that the construction is mechanically strong and to all intents and purposes indestructible.

Starting Transformers.—Fig. 6 illustrates the combination of the motor and the load-transformer. In order to reduce the connecting-leads and lead-losses to a negligible quantity, the transformers have been erected close to the motors They are immersed together with the pole change-over device in an oil bath. The top of the oil tank is built in two parts; one-half covers the transformer, the other the complete pole change-over switch.

The leads of the transformer as also those of the pole change-over switch are connected to series of terminals. For inspection purposes the pole change-over switch can easily be lifted wholly out of the oil bath, without interfering with the transformer (*see* Fig. 8).

The pole change-over switch consists mainly of three cast-iron cylinders, inter-connected by means of gearing, and so arranged that they can all be operated easily by means of a hand-wheel. Each phase has its own contact drum, so that no inter-connections or cross-connections are required on the individual drums. The cast-iron cylinders are clamped on to square mica-insulated spindles, and the heavy copper contacts are bolted on to the cylinders. The contact fingers for each drum are all carried on a single, carefully impregnated wooden terminal board, and are easily exchangeable. In order to reduce the burning of contacts, and the number of contacts to be exchanged to the smallest possible figure, the current is only cut at a very few, easily exchangeable auxiliary contacts, so that only these latter require replacing as a consequence of the usual wear and tear, whilst the rest of the contacts remain intact.

(To be concluded.)

Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

(Continued from page 332.)

Summary.—In the first part of the article a convenient practical method of drawing the torque diagram is described. The method, which is used by the Author for all cylindrical-drum winders, leads to the rapid determination of the cardinal points of the diagram. The distorting effect of heavy ropes is briefly considered, and diagrams are given for the unbalanced cylindrical-drum winder and for the balanced winder with tail rope.

Graphical Method of Finding Rope Torque.—Instead of the laborious arithmetical method that was used in the preceding example for finding the resultant rope torque, the following graphical method, which is sufficiently accurate for the purpose, may be used.

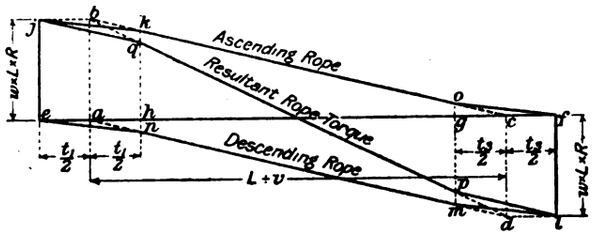

Fig. 14.—Graphical Method of Determining the Rope Torque.

Referring to Fig. 14, draw *ab* and *cd* perpendicular to the line *ac*, which represents the time L/v seconds, and let $ab=cd$ be marked off to represent the rope torque wLR to any convenient scale. Join *b* and *c*, and *a* and *d*. Make $ae=ah=$half the accelerating period, and $cg=cf=$half the retarding period. Draw *ej* and *fl* perpendicular to *ef* and equal to *ab* or *cd*. Through *h* and *g*, draw *nk* and *mo* perpendicular to *ef*. Join *j* and *k*, and *o* and *f*. Then the positive torque due to the ascending rope is represented by *jkof*. Similarly, the negative torque due to the descending rope is represented by *enml*. To find the resultant torque, join *b* and *d*. Let this line intersect *kh* and *gm* at *q* and *p* respectively. Join *j* and *q*, and *p* and *l*, then the resultant torque is represented by the ordinates bounded by *ef* and *jqpl*. The method is more readily applied than described.

Convenient Practical Method of Drawing the Torque Diagram.—The method just described for finding the resultant rope torque suggests the following graphical method of making the total torque diagram.

Transfer the lines *ef* and *jqpl*, together with the perpendiculars *ej* and *fl*, from Fig. 14 to Fig. 15. Along an extension of *je* mark off a length *er* to represent the torque *WR* to the same scale as that already used for the rope diagram. Also mark off *rs* to represent the torque M_f required to overcome friction and windage. Draw *st* parallel to *ef*. At *j* and *p* mark off lengths *ju* and *px* to represent to scale the accelerating and retarding moments respectively. Draw *uw* parallel to *jq* and *xv* parallel to *pl*. Then *suwqpxvts* is the total torque diagram, and the cardinal points, equations (12) to (17) are *u*, *w*, *q*, *p*, *x* and *v*.

This method also, like most graphical methods, is more easily applied than described. It gives the correct values at the cardinal points of the diagram. The method is used by the author in his own work, and it will be used for all the cylindrical drum winders in this article.

Effect of Heavy Rope on the Torque Diagram.—It is evident that the distortion of the diagrams, Figs. 13 and 15, is due to the moment of the unbalanced rope in the shaft, and the greater the ratio of the initial rope moment wLR to the load moment WR, or of the rope weight wL and net load W, the greater will be the distortion.

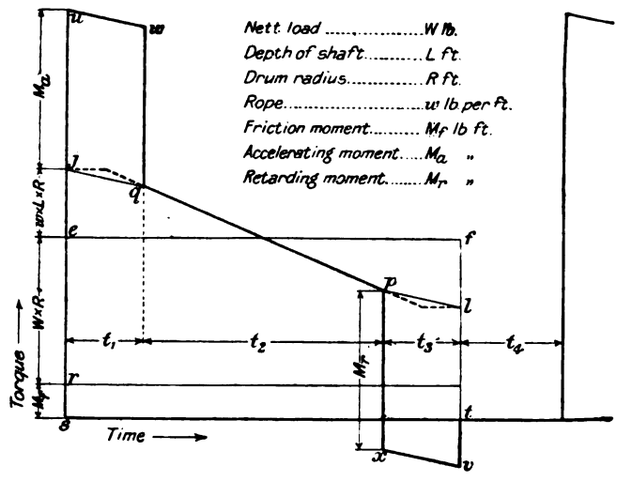

Fig. 15.—Graphical Method of Determining the Torque Diagram.

This is shown very clearly in Fig. 16, wherein is plotted the diagram for an 8,000-lb. winder hoisting from a depth of 4,000 ft. with a rope weighing 4 lb. per foot, the cylindrical drums having a diameter of 14 ft.

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In this case the initial rope moment is $4\times4,000\times7$ $=112,000$ lb.-ft., and the moment due to the nett load is $8,000\times7$ $=56,000$ lb.-ft. During the constant-speed period the resultant torque steadily decreases from 153,000 lb.-ft. at the beginning to 5,000 lb.-ft. at the end. Friction has been assumed to be equivalent to a force of 2,000 lb. at the drum radius.

The Load Diagram.—The power corresponding to the torque at any of the cardinal points, or at any other point, of the winding cycle is proportional to the product of torque and angular speed. If at a given instant the torque is T lb.-ft. and the speed is S revs. per min., then the angular speed is $2\pi\times S$ radians per min. and the corresponding horse-power

$$\text{H.P.}=\text{T}\times2\pi S\div33,000.$$

Since both torque and speed are known at any instant during the wind it follows that the horse-power at any instant can be calculated.

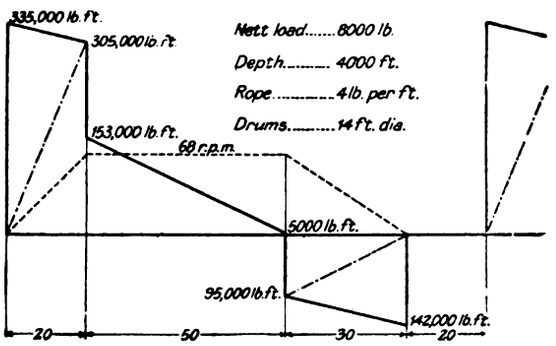

Fig. 16.—Effect of a Heavy Rope on the Torque Diagram.

To obtain the size of motor, the heating and the maximum torque required have to be considered. Although at the beginning of the wind, since the speed is zero, the power is zero, in the case of a cylindrical-drum winder the torque is a maximum and the current input, also, is a maximum at this point. The full-speed horse-power values of the *whole* of the cardinal points of the torque diagram must, therefore, be used for the purpose of determining the rating of the motor.

The question of rating will be discussed at greater length in a later section of the article.

Unbalanced Cylindrical Drum Winder.

The torque conditions in a winder of this type are entirely different from those set out above for the balanced winder, and although winders are usually balanced it may be necessary occasionally to work them unbalanced. In many specifications it is stated that the motor and control gear are to be sufficiently large to enable the winder to make two unbalanced trips under full load.

Beginning of Wind.—Using the same symbols as before, the torque at the commencement of the wind—*i.e.*, when the loaded cage is at the bottom of the shaft—is

$$M_1=(W+W_c+W_t+wL)R+M_f+M_a \quad . \quad . \quad . \quad . \quad . \quad (18)$$

End of Accelerating Period.—Just before the constant-speed period begins the torque has been reduced by an amount corresponding to the rope wound on the drum during the accelerating period. At this point, therefore, the torque will be

$$M_2=\{W+W_c+W_t+wL-(wVt_1\div2)\}R+M_f+M_a. \quad (19)$$

Beginning of Constant Speed Period.—As soon as full speed is attained the accelerating torque drops out, hence at this point the torque is

$$M_3=\{W+W_c+W_t+w.L-(wVt_1\div2)\}R+M_f. \quad . \quad . \quad (20)$$

End of Constant-Speed Period.—During the constant-speed period the rope is wound on the drum at a constant rate till there remains, at the end of this period, only the amount of rope corresponding to the distance travelled during retardation. The torque, therefore, at this point is

$$M_4=\{W+W_c+W_t+(wVt_3\div2)\}R+M_f. \quad . \quad . \quad . \quad . \quad (21)$$

Beginning of Retardation.—To bring the cage gradually to rest in t_3 seconds a retarding moment M_r has to be applied. When retardation begins the moment is

$$M_5=M_4-M_r$$
$$=\{W+W_c+W_t+(wVt_3\div2)\}R+M_f-M_r. \quad . \quad . \quad (22)$$

End of Wind.—During retardation, the length of rope $s_3=Vt_3\div2$ is coiled on the drum. At the moment of stopping, therefore, the torque is

$$M_6=(W+W_c+W_t)R+M_f-M_r. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (23)$$

The descent of the empty cage is controlled by the brakes, and it is necessary to determine the torque at the cardinal points during the lowering period, as, in some cases, this torque has an important bearing on the size of motor or controller required.

Beginning of Lowering Period.—Denoting the friction moment by M′, and the accelerating moment by M'_a, the effective torque at the drum shaft is

$$M_7=(W_c+W_t)R-M'_f-M'_a. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (24)$$

End of Accelerating Period.—When the accelerating period comes to an end, the torque has been increased because a length of rope has been uncoiled, and the resultant torque is

$$M_8=\{W_c+W_t+(wVt_1\div2)\}R-M'_f-M'_a. \quad . \quad . \quad (25)$$

Beginning of Constant-speed Period.—At this instant the accelerating moment drops out, and the torque is

$$M_9=\{W_c+W_t+(wVt_1\div2)\}R-M'_f. \quad . \quad . \quad . \quad . \quad . \quad (26)$$

End of Constant-speed Period.—The rope is uncoiled at a uniform rate till, at the end of this period, there is a length of rope $=L-s_3$ hanging down the shaft. The torque, therefore, is

$$M_{10}=\{W_c+W_t+wL-(wVt_3\div2)\}R-M'_f. \quad . \quad . \quad (27)$$

Beginning of Retardation.—During retardation the energy stored in the moving parts will be given up, and the torque is increased accordingly. When retardation begins, the torque is

$$M_{11}=\{W_c+W_t+wL-(wVt_3\div2)\}R-M'_f+M'_r. \quad . \quad (28)$$

End of Retardation.—When the cage reaches the bottom of the shaft, the torque

$$M_{12}=(W_c+W_t+wL)R-M'_f+M'_r. \quad . \quad . \quad . \quad . \quad . \quad (29)$$

Example 2.—The winder, of which the principal data are given in Example 1, is to be worked unbalanced. It is required to draw the torque diagram.

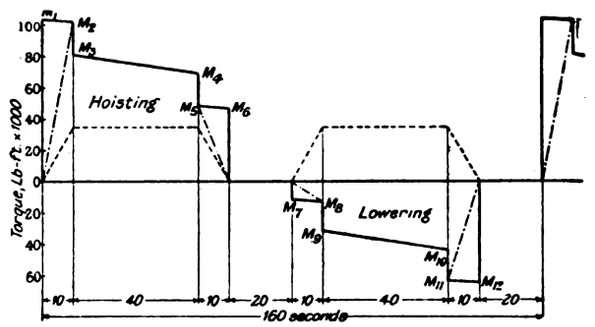

Fig. 17.—Torque Diagram of Unbalanced Cylindrical Drum Winder.

During the winding half of the cycle, the load depending from the rope is $6,000+4,000+2,500=12,500$ lb., and the assumed friction moment is $0{\cdot}075\times12,500\times5=4,700$ lb.-ft.

During the lowering half of the cycle, the load is 6,500 lb., and the friction moment is $0{\cdot}075\times6,500\times5=2,430$ lb.-ft.

Inertia.

Lifting.		*Lowering.*	
Drum	20,000	Drum	20,000
Sheave	1,000	Sheave	1,000
Travelling part $=\frac{15,500\times5^2}{32\cdot2}$	12,000	Travelling part $=\frac{9,500\times5^2}{32\cdot2}$	7,400
Motor armature	19,150	Motor armature	19,150
Total inertia	52,150	Total inertia	47,550

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The maximum velocity and the starting and stopping periods being the same as in Example 1, it follows that the angular acceleration and retardation during both halves of the cycle will be 0·4 radian per second per second. Hence, during the winding half of the cycle, both the accelerating moment M_a and the retarding moment M_r will be $0{\cdot}4 \times 52{,}150 = 20{,}860$ lb.-ft.; and during the lowering half of the cycle the accelerating moment M'_a and the retarding moment M' will be $0{\cdot}4 \times 47{,}550 = 19{,}020$ lb.-ft.

Substituting known values in equations (18) to (29) the cardinal points of the torque diagram are found to be .—

Lifting.

$M_1 = (6{,}000+4{,}000+2{,}500+3{,}000)5+4{,}700+20{,}860 = 103{,}060$ lb. ft.
$M_2 = (6{,}000+4{,}000+2{,}500+3{,}000-300)5+4{,}700+20{,}860 = 101{,}560$,,
$M_3 = (6{,}000+4{,}000+2{,}500+3{,}000-300)5+4{,}700 = 80{,}700$,,
$M_4 = (6{,}000+4{,}000+2{,}500+300)5+4{,}700 = 68{,}700$,,
$M_5 = (6{,}000+4{,}000+2{,}500+300)5+4{,}700-20{,}860 = 47{,}840$,,
$M_6 = (6{,}000+4{,}000+2{,}500)5+4{,}700-20{,}860 = 46{,}340$,,

Lowering.

$M_7 = (4{,}000+2{,}500)5-2{,}430-19{,}020 = 11{,}050$,,
$M_8 = (4{,}000+2{,}500+300)5-2{,}430-19{,}020 = 12{,}550$,,
$M_9 = (4{,}000+2{,}500+300)5-2{,}430 = 31{,}570$,,
$M_{10} = (4{,}000+2{,}500+3{,}000-300)5-2{,}430 = 43{,}570$,,
$M_{11} = (4{,}000+2{,}500+3{,}000-300)5-2{,}430+19{,}020 = 62{,}950$,,
$M_{12} = (4{,}000+2{,}500+3{,}000)5-2{,}430+19{,}020 = 64{,}090$,,

These points are plotted to a time base in Fig. 17.*

BALANCED CYLINDRICAL DRUM WINDER WITH TAIL-ROPE.

In order to equalise the torque diagrams the cages are sometimes connected by a tail-rope, as shown in Fig. 18 (*a*) and (*b*), and with main and tail ropes of equal size and weight it will be seen that the lifted and dropping ropes balance each other throughout the entire wind.

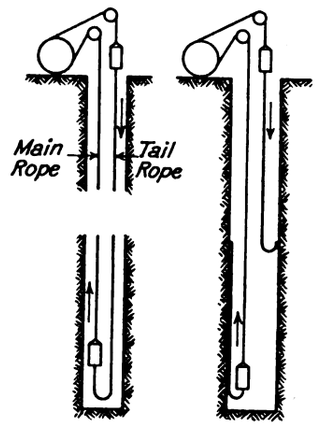

FIG. 18.—TAIL ROPES.

At the commencement of the wind the torque is

$$M_1 = WR + M_f^1 + M_a, \quad \ldots\ldots\ldots (30)$$

and, as this torque is constant from the beginning to the end of the starting period, we have $M_2 = M_1$.

At the beginning of the constant-speed period the accelerating torque drops out, and during the whole of this period the torque is constant. Hence

$$M_3 = M_4 = WR + M \ldots\ldots\ldots (31)$$

During retardation the torque is constant, therefore

$$M_5 = M_6 = WR + M_f - M_r \ldots\ldots\ldots (32)$$

Example 3.—A tail-rope weighing 3 lb. per foot is fitted to the winder of Example 1. It is required to determine the effect of this rope on the torque diagram.

The inertia of the travelling parts is increased by an amount equal to $(3 \times 1{,}000 \div 32{\cdot}2)5^2 = 23{,}290$, hence the total inertia will now be $80{,}150+23{,}290 = 103{,}440$, and the accelerating and retarding moments M_a and M will each be equal to $103{,}440 \times 0{\cdot}4 = 41{,}376$ lb.-ft. approximately.

The cardinal points of the torque diagram are

$M_1 = M_2 = (6{,}000 \times 5)+7{,}125+41{,}376$
$= 78{,}500$ lb.-ft.
$M_3 = M_4 = (6{,}000 \times 5)+7{,}125$
$= 37{,}125$ lb.-ft.
$M_5 = M_6 = 37{,}125-41{,}376$
$= -4{,}215$ lb.-ft.

and these points have been plotted to a time base in Fig. 19.

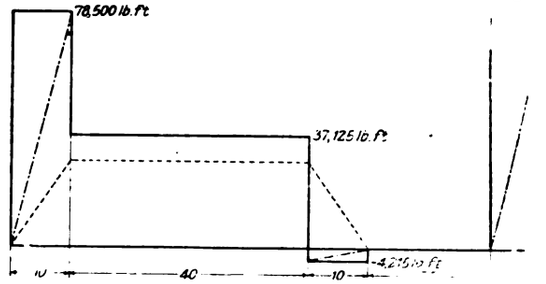

FIG. 19.—TORQUE DIAGRAM OF CYLINDRICAL DRUM WINDER WITH TAIL ROPE.

STANDARD SHEET FOR WINDER DIAGRAMS.

Ill-typed specifications or tenders accompanied by badly-folded and anæmic blue prints of various odd sizes betoken a degree of carelessness which is often noticeable in the finished product, and are liable to give a bad impression to a prospective customer. In every case where calculations have to be made they should be entered in an orderly manner, and should be so arranged as to facilitate checking.

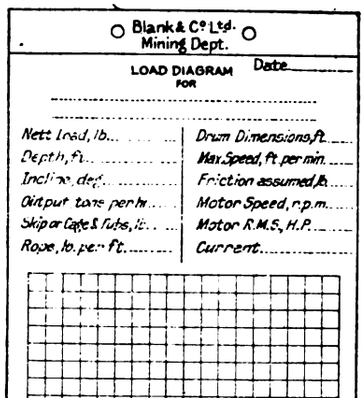

FIG. 20.—STANDARD SHEET FOR WINDER DIAGRAMS.

When winder diagrams have to be furnished they should be carefully drawn on sheets of a convenient standard size. A suggested standard sheet is depicted in Fig. 20. The sheet, which is made of thin, tough and semi-transparent paper, is foolscap size (13 in. by 8 in.), and is arranged for vertical filing.

(To be continued.)

* In this example no account has been taken of the efficiency of the gearing. The effect of the gearing is to increase the motor torque during the hoisting part of the cycle, and to decrease the torque during the lowering part of the cycle. If the efficiency of the gearing be 95 per cent., the actual torque values at the cardinal points M_1 to M_6 will be $1 \div 0{\cdot}95 = 1{\cdot}05$ times, and at the points M_7 to M_{12} will be 0·95 times those tabulated. Due allowance will be made in a later section of the article.

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"Studies in Electro-Pathology." By A. White Robertson. (London: George Routledge & Sons.) Pp. viii.+304. 12s. 6d. net.

"The New Moon." By Oliver Onions. (London: Hodder & Stoughton.) Pp. 312. 6s. net.

"List of Electrical Undertakings in India." (Calcutta: Government Printing Office.) 6s.

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A Modern Central Station Electric Kitchen.

The new electric cooking installation at the Fisk-street station (Chicago) of the Commonwealth Edison Co. is described in a recent issue of the "Electrical Review" (U.S.A.).

As far back as 1906 the kitchen at the station was equipped with apparatus for cooking electrically, but with the development of the generating station there was a large increase in the staff, and as it became necessary to extend the kitchen it was decided to modernise the equipment. In 1906 the largest generating set at Fisk-street was a 5,000 kw. turbo-generator, but now there are 30,000 kw. units in operation, and a 35,000 kw. set is on order. When completed the station will contain 14 generating units. At present over 200 and often 400 men obtain meals during the noon hour at Fisk-street, necessitating cooking some 600 pies, 2,200 loaves of bread and nearly 400 lb. of meat per month.

The service of the kitchen is a typical restaurant service, except that the peak is higher even than the usual restaurant, and after the peak has passed the output of the kitchen almost ceases except for preparation for the next meal. Meals are served between 7.45 a.m. and 8.30 a.m., 11.45 a.m. to 1.0 p.m., and again in the evening between 5.30 and 6.30. The noon-day meal is the chief one, there being comparatively few persons to be supplied in the morning and evening. For the midday meal there are three courses—soup, the choice of two different sorts of meat and dessert. In the morning, porridge, ham and eggs or steak, coffee and toast are served, and in the evening one form of meat (usually steak) and dessert, coffee and bread is served. The number of persons supplied on any day depends upon conditions in the plant. There are the employees of the company and contractors who always obtain their lunch at the station, and the transient patronage (contractors' men), varying between only a few to almost 100. The demand upon the kitchen is an extremely variable one, although at least one day's notice is usually obtainable before a severe peak occurs. Three dining rooms are maintained.

The present equipment of the kitchen is as follows :—

Apparatus.	Capacity in watts.	Approximate cost.
One G.E. range	17,000	$550
One Hughes bake oven	3,500	265
One G.E. broiler	5,000	125
One G.E. toaster	3,150	38
One Allsopp steam table	2,500	325
Three Simplex 20 in. disc stoves ..... each	2,700	354
Two Simplex coffee urns ..... each	2,000	180
One Simplex 18 in. by 24 in. griddle	3,000	40

The approximate cost of the electrical cooking apparatus was $1,877, while the total connected load is 46·85 kw., which, however, rarely is in use all at the same time. The cost of equipment approximates $40 per kilowatt of capacity. In addition to the above heating devices there is an electrically-driven refrigerating machine, driven by a 5 H.P. motor. The range is the G.E. hotel model, having two 18 in. by 26½ in. roasting ovens and eight 9 in. by 12 in. hotplates. The roasting ovens employ two lower heating units, giving two heats and consuming 1,000 and 2,000 watts respectively, and two upper heating elements giving two heats and consuming 500 to 1,000 watts, respectively. The four front hotplates are each equipped with one heating element, each consuming 1,000 watts, and the four rear plates with one heating element each consuming 800 watts. The front hot-plates are for rapid heating and high temperatures, the rear hotplates are for keeping materials on the boil and warm. All heating elements are of sheathed wire, which may be easily removed for cleaning. Each element is protected by a fuse and knife switch. All switches carry name plates to indicate which elements are in circuit, and the whole is protected by a two-pole circuit breaker.

The Hughes oven is of the No. 150 2-D type, consists of two compartments, and is capable of baking about 90 lb. of bread at one time. The oven is equipped with three heating elements, each of 1,165 watts capacity, and each capable of giving three different heats. By various combinations nine different rates of energy consumption are possible. The maximum energy consumption is 3,500 watts.

The steam table contains two entirely separate sets of heating units, one set in the upper section and one set in the lower section. The lower units consist of four 600-watt G.E. heating elements, the upper units being five Simplex immersion coils, each of 500 watts. Each heating unit is controlled by a three-heat switch. The table is able to steam two roast pans, three gravy pots and six 2-gallon vegetable pots. The table is constructed of planished steel with nickel trimmings; the roast pans are of solid tin, the gravy and vegetable pots of porcelain and iron and the shelves of the lower portion of galvanised iron and the top of copper. The broiler, known as the G.E D-78 hotel broiler, has an effective broiling area of 368 sq. in., the plate being 16 in. by 23 in. At full load it is possible to broil about 36 steaks hourly, each steak weighing 2 lb., and being of about 1 in. in thickness. The top chamber is provided with specially heavy insulation, about 2 in. in thickness, to prevent radiation of heat upwards. The unit is heated by one heating element that may be operated in its entirety or in half, the wattage consumed being 5,000 and 2,500 watts respectively

The toaster is the standard G.E. hotel toaster, capable of toasting six, three and two slices of bread at one time. There are seven heating elements, controlled by two controlling switches, by the manipulation of which either three, four or all seven heating elements may be connected in circuit The load, according to the number of heating elements connected in circuit is 1,350, 1,800 and 1,300 watts respectively.

The Fisk-street kitchen only measures about 19 ft. by 20 ft., and it has been found that the use of electricity for cooking reduces at once the amount of space, labour and time required. The refrigerating machine also reduces the amount of work and traffic in and out of the kitchen quarters. Electrically-driven fans and exhaust apparatus maintain the kitchen at pleasant temperature and free from odours at all times. The Commonwealth Edison Co. has another interesting but smaller electrical cooking installation in the Edison Building.

Pneumatic Riveting.

It is common knowledge that the present rate of output of merchant shipping falls far short of what is necessary and possible. Even if the two most obvious causes of this, viz., shortage of skilled labour and bad time-keeping, were removed, the output would still remain far below what is easily possible. The reason for this is that British shipyards make very little use of pneumatic tools. Thirty-one firms have recently asked for extensions or new installations of their plant, but this does not carry us far enough.

The pneumatic, compared with the hand-worked, tool is very much what a breach-loading gun is compared with a muzzle-loader. A few simple facts and figures will make this plain. The plates which form the shell or hull and deck of a steel vessel are held together by thousands of rivets. The limit of the output of ship-building may, therefore, be said to be practically the capacity of the riveter. According to information received from one of the leading East Coast shipyards, the best day's work on a shell with pneumatic riveting is 700 rivets of ⅞ in. diameter, and for hand-work 430. An average day's work, however, is considerably less than this, and may be taken as being 510 rivets with pneumatic riveters against 264 with a hand squad, the figures being taken for work on all parts of one ship. The number of rivets driven per day by a riveting squad varies according to the part of the ship worked upon and the size of rivet used. The following may be taken as indicating the difference in one day's work of a hand and pneumatic riveting squad :—On the shell, with ⅞-in. rivets, hand-riveting, 260 to 360 rivets, with pneumatic riveting, 500 to 550; on the deck, with ⅞-in. rivets, hand-riveting 450, pneumatic 700; on deck with ¾-in. and ⅞-in. rivets, hand-riveting 350, pneumatic 550.

The greatly increased output of work secured by the pneumatic tool is in itself sufficient to establish its enormous superiority over the hand method, but also fewer men are required to work it. A hand-riveting squad consists of three men and one or two boys. From two of these squads three pneumatic riveting squads can be formed, effecting a saving of 50 per cent. in labour alone. A third advantage of the pneumatic tool is that it gives both the other great advantages with less exertion and consequently less fatigue on the part of the men. The United States yards by their almost universal employment of pneumatic riveting tools have been able to overcome their shortage of skilled labour. Notwithstanding these indisputable advantages the pneumatic tool is greatly neglected in British shipyards, as will be seen from returns of 70 of the leading yards (with berths of over 250 ft. in length). The equipment necessary for the efficient working of a berth consists of a compressor plant of 1,000 c. ft. capacity (to supply the compressed air for driving the tools) and 60 pneumatic tools, of which 20 should be riveting hammers. Taking the 10 best equipped yards in the country, they have, on the average, compressor plants of 1,000 c. ft. per berth, but only 52 pneumatic tools, of which only 1½ instead of 20 are riveting hammers. The average of the remaining 60 yards is much below even this low standard, being only 21 tools per berth and 333 c. ft. compressor capacity per berth. Moreover, only about one-eighth of the very inadequate number of riveting hammers in stock in the yards are actually used, and the limit of output is practically the capacity of the riveter. There are 22 important yards in the country, with a total of 77 berths, which have no pneumatic plant whatever. Shortage of riveters is, without doubt, one of the chief causes, or the chief cause of deficient output at present. For the last eight or ten years the supply of riveters in British yards has fallen short of the demand; war and other causes have further reduced their number, while the volume of work has been increased. In some yards ships completely plated cannot be launched because they cannot be riveted. The solution of the problem is to be found to a very great extent in the greatest possible use of the pneumatic tool.

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Water Power in the British Empire.

There is an inclination on the part of many people to treat the available water-power in the British Empire as a matter of no great importance. At least, we may draw this conclusion from the fact that information upon the subject is very meagre; and, further, very little has been done in the systematic development of such power. In our last issue we gave a brief abstract of a Report of a Committee of the Conjoint Board of Scientific Societies upon this subject. We were unable to devote any considerable space to this Report, but we think it desirable to return to the subject in our present issue, as it is one which should be of increasing importance in the future.

After the war we shall be faced with problems of reconstruction on every side, and among these will be the question of financial recovery and the meeting of a huge indebtedness. This financial burden can only be borne by the Empire in a satisfactory way if its production is very much increased and if its latent resources are developed to the full. It cannot be gainsaid that there is plenty of latent wealth in the Empire, embodied in its mineral resources, in its wheat areas, in its forests, and in the hundred products of its tropical dependencies; but, as is pointed out in this Report, a great deal of this wealth cannot be realised without an ample supply of cheap energy. Our available resources of energy in the form of coal and oil are diminishing. On the other hand, our water-power remains a constant quantity. The real question is how far this water-power can be economically developed.

An estimate prepared by the Dominion Water-Power Branch of the Canadian Department of the Interior shows that Great Britain is very backward in the percentage of water-power that is utilised, the figure standing at 8·3 per cent. In fact, except for Russia, Great Britain is the most backward country in this respect. On the other hand, Germany stands at the top, with a figure of 43·4 per cent., the next highest figure being that of Switzerland with 25·5 per cent. In taking the Empire as a whole it must be admitted that any estimate of the total power available must be looked upon as merely speculative. The main water-powers are in Canada, India, New Guinea and New Zealand. The aggregate in these countries is undoubtedly high; say, of the order of 40 million H.P. When the resources of East, South and Central Africa, Egypt, Ceylon, Tasmania, Australia, British Guiana, Burmah and the Malay States are added, the total becomes extremely large (at least 50,000,000 H.P. to 70,000,000 H.P.), and it is a total which is barely tapped. Apparently this figure is based upon dry-weather flow. In many cases, however, it is worth while to consider the supplementing of water-power by steam plant, so that the water may be used to greater advantage. This mode of working is now receiving attention in the United States.

One very naturally enquires as to the cause of this apparent neglect. It appears to be due to a variety of causes, such as an abundance of coal in proximity to centres of industry, the necessity for heavy initial outlay in most cases of hydro-electric development, the lack of co-ordination between possible producers, users and financiers; the lack of markets for the energy, and the remoteness of most of the powers from present centres of activity. Yet the need for hydro-electric power is becoming increasingly evident. Developments in electro-chemistry have been enormous during the last 20 years, and transmission lines have become increasingly lengthy. Enormous quantities of power are being used in such industries as aluminium, calcium carbide, the fixation of nitrogen and electric furnaces. Thus in 1913 the calcium carbide industry is said to have required 400,000 continuous E.H.P., and in 1915 the power used for electric furnaces in the United States alone ran to 300,000 E.H.P. Again, the power used in Norway alone for nitrogen fixation was over 400,000 E.H.P., and in the near future there is no doubt that large quantities of power will be required in the production of fertilisers.

Water-power differs from other natural resources in that if the development of power is left to private enterprise it generally takes place with the object of meeting individual requirements as they arise and not with a view to securing the maximum output of power. For many purposes it may be sufficient to develop, say, 5,000 kw. in a certain locality, whereas 20,000 kw. could be secured by a more comprehensive scheme. Not only so, but the more modest scheme may render the more ambitious scheme impossible of realisation at a later date. While, therefore, it is desirable that private enterprise should handle these matters as far as possible, it is nevertheless true that unless some control is exerted the maximum useful result will probably not be obtained. For this reason the Committee suggest, and we think rightly, that investigations should be made by Government rather than by private enterprise, and that the whole subject should be handled by an Imperial Water-power Board if it is beyond the powers of any governing body. Such a Board should be able to take a broad and comprehensive view of the advantages to the Empire as a whole, and would be able to form a reasonable decision as to the relative advantages of such different schemes as might be brought forward in various parts of the Empire. It is also suggested that private capital might be attracted if the State, after careful investigation, were to guarantee a suitable minimum interest on the necessary capital, sharing at the same time any profits beyond the amount necessary to provide that interest. By so doing, private enterprise would be untrammelled and the management of the concerns so assisted would remain in private hands.

Review.

Engineering Mathematics. By C. P. STEINMETZ. Third edition. (London: Hill Publishing Co.) Pp. xix.+321. 12s. 6d.

This work is based on a series of lectures which the author gave at Union College to junior and senior electrical engineering students. It was primarily intended as an introduction to the author's treatises on electrical engineering. He discusses in an interesting way theorems in arithmetical philosophy, higher mathematics and advanced technical practice. An excellent chapter on empirical equations to curves is given which will be much appreciated by engineers, and all through the book useful practical suggestions are made. For instance, he divides engineering reports into three classes. There is first the scientific record of the investigation for the use of other competent investigators. There is next the general engineering report for the administrative engineers: and, finally, there should be the general report for the layman who is ignorant of technical terms. The technical man should be able to write all three kinds of reports.

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The book opens with a discussion of the general number, and by defining $\sqrt{-1}$ as an operator the author tries to persuade the reader that it is just as real a concept as -1. Most readers, however, will think that he evades the issue, and that no matter how many interesting things you can do by its help it still remains a mystery.

In the next chapter "potential," or, as we call them, "power," series are discussed. The author regards them with a very critical eye. For instance, although the series $1-\frac{1}{2}+\frac{1}{3}-\frac{1}{4}+\ldots$ is convergent, it is summarily dismissed on the ground that it does not give accurate numerical results "with a reasonably moderate amount of calculation." In fact, he says it is useless. It is very easy to see, however, that the convergence of this series is oscillatory. Taking the first 10 terms we see that the value of the series is greater than 0·646, and taking the next term into account we see that it is less than 0·736. The mean of these two values 0·691, is an approximation to the sum of the series. The true value is $\log_e 2$—*i.e.*, 0·693.... A fairly accurate value, therefore, can be easily obtained with very little difficulty.

As an illustration of the use of power series the author discusses the integral for the length of the arc of an equiaxial hyperbola. The integral is a well-known elliptic integral, and consequently "inconvenient for integration." He shows how it can be found in certain cases by expanding by the binomial theorem and then integrating, but he emphasises the fact that in certain cases this solution is of no use for engineering calculation. He leaves the reader with the unfortunate impression that this definite integral probably baffles the skill of even the expert mathematician.

In our opinion it would have been much better to point out that the process of integration between limits can always be effected by simply drawing the graph of the function and finding by the planimeter or otherwise a definite area. We need not even draw the graph. For instance, to find $\int y\delta x$ between the limits of b and c, where $y=f(x)$, we calculate y_0, y_1, $y_2 \ldots y_6$, the values of the ordinates when x has the values b, $b+(c-b)/6$, $b+2(c-b)/6, \ldots b+6(c-b)/6$. An approximate value of the integral is then

$$\{(b-c)/20\}\{y_0+y_2+y_4+y_6+5(y_1+y_5)+6y_3\}.$$

Every engineer can do this, and therefore every engineer can integrate anything.

Applying it to the example given we find that the length of the arc is 8·022. The true value found by Prof. Steinmetz is 8·0206. As the method is perfectly general it ought to be found in all mathematical engineering text books.

The author's practical illustrations of harmonic analysis are most interesting and instructive, but his method is crude. The Fourier integrals can be evaluated at once by the method given above, and the reviewer cannot see why this graphical method should not supersede for general use all other graphical methods.

A. RUSSELL.

British Scientific Products Exhibition.

As was announced in our last issue, the British Scientific Products Exhibition was opened to the public on the 12th inst., and was formally opened by the president of the British Science Guild, the Right Hon. Lord Sydenham, G.C.S.I., F.R.S., on the 14th inst. The opening ceremony took place before a large audience in the main lecture theatre of King's College, when Prof. R. A. Gregory, as chairman of the Organising Committee, called upon Lord Sydenham to declare formally that the Exhibition was open.

Lord SYDENHAM remarked that four years ago we were singularly unprepared for war. Probably it was just as well we did not know at that time how unprepared we were. Apart from the military aspect, we were not in a position to start up several essential industries. At the present time, however, owing to the efforts we had made, we were able to turn out products as good as those which we previously received from Germany, and even better. In the future it was essential that our "key" industries should remain purely British. Thanks to the work of our scientists we were now independent of Germany for such things as magnetos, chemical porcelain, dyes, &c. Few people realised, however, what had been done by our scientific men during the war, and on this account it was felt that an Exhibition of the kind organised by the British Science Guild would be useful. The thanks of the Guild were due to manufacturers, Government departments and the authorities of King's College for enabling the present Exhibition to be held. In this country science had not been sufficiently appreciated. He (Lord Sydenham) had made a great effort to get science specifically mentioned in the Education Bill, but he had been told that particular items could not be specified, and apparently science was looked upon as an "item," like spelling. In declaring the Exhibition open, Lord Sydenham expressed the hope that it would go far to promote the objects which the British Science Guild had in view.

The ceremony was brought to a close by a few words from Prof. A. K. Huntington, who remarked that the Germans had often been credited with great initiative, whereas the inventions with which they had been associated chiefly came from this country.

SCOPE OF THE EXHIBITION.

A brief inspection of the exhibits is sufficient to show that there is a great deal of interest to be seen, and we are glad to say that the public is showing its appreciation by a large attendance. We would offer our congratulations to the Committee of the British Science Guild, upon the success which they have achieved, and also to the organising secretary, Mr. F. S. Spiers, who must have put an enormous amount of time and energy into the work. A comprehensive catalogue has been issued, and is prefaced by 20 signed articles dealing briefly with various industries.

The exhibits cover a wide range, and therefore we can only deal in general terms with much that is to be seen. One of the most important sections is that dealing with aircraft, which is very instructive. From the electrical point of view the magneto is an important item of such equipment. In this connection we need not recapitulate at any length what is well known to many of our readers. When war broke out we were practically dependent upon the Bosch magneto for the equipment of our aircraft, military lorries and other equipment of that character. The position was very serious, and there were many difficulties to be overcome before this urgent demand could be met. At the present day, however, there are nine British firms engaged in this work, with the result that during the past four years 300,000 magnetos have been manufactured for war service alone. What is equally important is that the home-made magneto is now as good as, or even superior to, the previously imported Bosch machine. A comprehensive exhibit of magnetos is shown by the British Ignition Apparatus Association. Also B.L.I.C. magnetos are included in the exhibit of Vickers, and magnetos are shown separately by Simms Motor Units, Ltd.

As to other products for which we depended very largely upon Germany and Austria before the war, visits should be paid to those sections of the Exhibition in which examples are shown of optical glass, chemical porcelain and dyes. Although certain varieties of glass have always been manufactured in this country, those which are required for optical instruments and chemical work have chiefly been imported. The present position, however, is very different; a great deal of scientific work has been carried out during the last four years, as our readers are aware, with the result that we are able to produce in this country all the varieties of glass now required for these purposes. A number of specimens are exhibited by Messrs. Chance Brothers and there is a large exhibit of chemical glass and porcelain by the British Chemical Ware Manufacturers' Association. With regard to dyes, we may mention that a complete room is set aside for these exhibits, chiefly by Brotherton and Co.

Another direction in which we were particularly dependent upon enemy countries was in carbons for electric arc lamps. There was one firm, namely, the General Electric Co., which had the hardihood to start a carbon factory in 1902 on the initiative of Mr. Hugo Hirst. It was a difficult matter, for men with the necessary knowledge and experience were not to be found in this country. Moreover, there was the problem of educating workpeople and there was the supply of raw material to be organised. In time, however, the necessary quality of tar was obtained from English tar refiners, and after a number of years the Company put down a soot factory, so as to be independent of German supplies of lamp black, and this has now

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been running with excellent results for about six years. But there has been competition of the severest kind. German carbons were dumped so as to make the enterprise unprofitable, and for a certain standard quality and size of carbon the market price dropped from 40s. to 18s. after the factory was opened. Although prices continued to recede until the outbreak of war the General Electric Co., fortunately for this country, continued the effort notwithstanding the serious loss this entailed. Searchlight carbons had been developed for a number of years, and thus Government supplies were not cut off by the opening of hostilities.

Another direction in which carbons are required on an increasingly large scale is in the form of electrodes for electric furnaces. This is becoming a much more important industry and is now being developed in this country. A sample electrode, 14 in. in diameter, is exhibited by the Newcastle Alloy Co., who are also manufacturers of ferro alloys and electrolytic cuprous oxide. Such electrodes can be supplied up to a diameter of 24 in.

METALS AND ALLOYS.

In the entrance hall there is a striking exhibit of "Hadura" steel rolls, which are manufactured by Hadfields, Ltd. In pre-war days such rolls were imported. This firm also exhibits steel ingots made by the electric furnace according to the "Hadfield-Jack" process. There are examples of "Galehad" rustless steel and shields for military purposes, and a replica of a piece of 15-in. armour-plate which has been perforated by a 15-in. shell. Some slide-rules are also shown, which have been made for special purposes. For example, in one of these, by setting the arrow to the Steinmetz co-efficient, the loss in ergs per cycle can be at once read off; or by setting the frequency to the Steinmetz co-efficient the loss can be read off in watts per pound. Another slide-rule gives results for ballistic tests with shells, and a third renders easy the calculations that are necessary in the testing of hardness. An appeal is made by Messrs. Hadfield to manufacturers to take up the construction of these slide-rules, and we hope that this appeal will not be made in vain.

Pure nickel wire, compound metals, such as copper-steel, cupro-nickel-steel, cupro-nickel-copper and cupro-brass, are shown by Messrs. Henry Wiggin & Co. This firm is known in the electrical industry more particularly through the manufacture of resistance wires. Wires for this class of work before the war were largely imported from Germany. In order to meet the position, the Company's works have been largely extended and the output is now about four times the pre-war figure. A large number of grades are produced, to obtain which it was necessary to carry out much costly experimental work. Among the varieties may be mentioned that known as Ferry, several nickel-steel alloys and a nickel-chrome alloy containing a moderate percentage of iron which has been largely adopted for use at high temperatures. Altogether about 15 different grades are now made

High speed steel alloys are shown by High Speed Steel Alloys, Ltd., of Widnes. There are also metal powders, by Metal Powders, Ltd., an exhibit of magnesium by the Magnesium Metal Co., and an attractive display of rare chemicals by Johnson, Matthey & Co.

Among the metals of more than usual interest to the electrical industry must be classed the metal tungsten, which is now used in such large quantities in electric glow lamps. An exhibit of tungsten wires is shown by Duram, Ltd. This firm is now manufacturing large quantities and exporting to the extent of 600,000 to 700,000 metres per week. The smallest wire that is made has a diameter of only 12 microns. Notwithstanding the difficulties of manufacture in these days we understand that the prices have been reduced during the war in the proportion of 27 to 8. This firm is also making tungsten wire for use in valves for wireless telegraphy, and is supplying contacts for magnetos, induction coils and field telephones in large quantities.

The British Aluminium Co., Ltd., have a comprehensive display of products of the aluminium industry and applications of the metal. Samples of the various materials used in the industry are shown, from the principal ore, bauxite, to the finished aluminium, together with a number of interesting by-products such as red oxide, hydrate of alumina, sulphate of alumina, &c. Among the many applications of the metal are a number of interest to the electrical industry As is well known, aluminium is a serious competitor of copper in normal times for all classes of conductors, and in countries where overhead transmission of power is carried out on a large scale, many thousands of tons of aluminium cables have been installed. Samples of bare and insulated cables, for both low and high tension, are shown together with methods of jointing and supporting, &c. There are also shown samples of round rod, strip, busbars, and other material for internal work. Another interesting application is a field coil wound with bare aluminium wire, insulated by a thin film of oxide formed on the wire after winding. The famous Lauchhammer lifting magnets, made in Germany, were wound in this manner, which showed both a reduction in weight and much improved cooling, owing to the absence of organic insulating material Although no metal is at present available for electrical purposes, owing to the demand for more important munitions purposes, great developments in this line may be looked for after the war.

Thermit, Ltd., show samples of the well known Thermit process of welding and the Thermit compounds for various purposes. Apart from these two sections there is also a section of carbon-free metals and alloys. Some of these show by actual specimens the different steps in manufacture from the ore to the finished product. There is also a selection of special alloys and manufactured articles in which such alloys have been used. These include high speed tool steel, brass, bronze, cupro-nickel, &c. We may mention that the firm is now entirely British, and is owned by Nobel's Explosives Co., Ltd., having no connection with any other concern

REFRACTORY MATERIALS

There are several exhibits of refractory materials, and among these may be mentioned the beautiful work turned out by the Silica Syndicate, and a remarkable display of Vitreosil, by the Thermal Syndicate, which any of our readers interested in chemical work should not fail to see. The fused silica industry is essentially British.

IGRANIC EXHIBIT.

The Igranic Electric Co., Ltd., show a number of coils wound by their special method, so as to be self-supporting and also a self-acting electric motor-starting rheostat. The coils are wound by means of a "Leesona" winding machine, of which we give a description below.

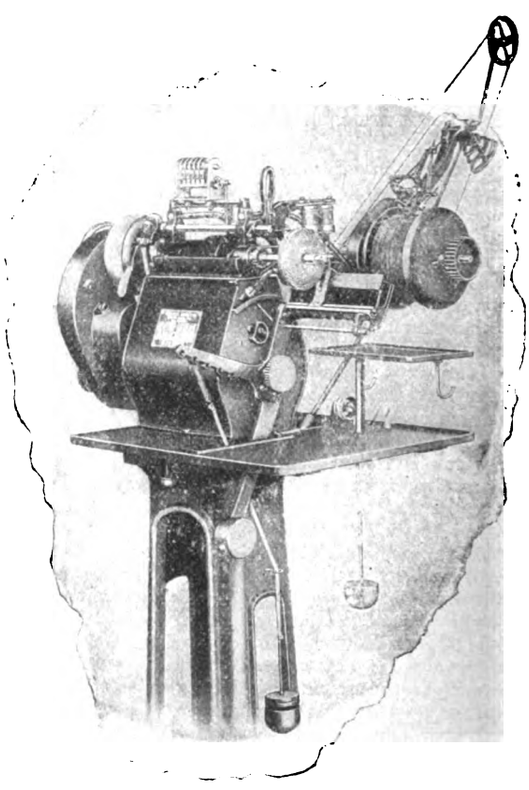

FIG. 1.—"LEESONA" WINDING MACHINE.

"Leesona" Universal Coil Winding Machines.—These machines are capable of producing a wide range of extremely reliable coils, having high space factor and being uniform in all respects. The coils are produced quickly and at low cost, and their construction is such as to render efficient impregnation a simple process. Most coils can be wound on one of the two machines here described.

The first machine (Fig. 1) winds cross-wound coils for magnets, &c. Cotton or silk-covered wire is wound in layers; each turn is laid at an angle to the axis of the coil, so that each layer is at an angle to the layer below. Fig. 2 illustrates a finished pancake coil, wound on this machine. The advantages of this method of winding are, first, practically zero capacity between the layers, which are a little less non-inductive, making an ideal coil for high voltages; second, this form of winding is entirely self-supporting, requiring no flanges or heads to support the coil either during winding or in use. Coils as narrow as 3/16 in. and several inches in diameter can be wound

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without the use of a side support; when finished, the windings admit of easy impregnation.

This machine is practically automatic; a device automatically controls the delivery of the finest wire from the supply spool to the coil, prevents kinking, entangling or stretching of the wire. A brake mechanism stops the winding spindle instantly if the wire breaks; also the spindle is stopped by an automatic counter when the desired number of turns have been wound. These automatic devices make it possible for one operator to control several machines.

The second machine is adapted for winding coils for meters, transformers and relays, as well as field coils, &c. The turns (*see* Fig. 3) are parallel to each other, and in a plane at right angles to the axis.

Fig. 2.—View of Finished Pancake Coil.

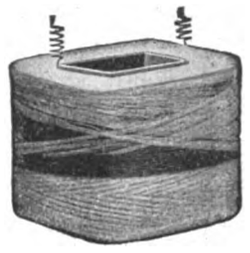

Fig. 3.—Finished Field Coil.

A fine cotton yarn is wound simultaneously with the wire. The yarn is interwoven with the wire, which may be either enamelled or insulated with silk or cotton; also the form and flanges are automatically built up of cotton during the winding process. The plane of the wire convolutions is at right angles to the axis of the coil, while the plane of the cotton strands lies at a different angle to the axis, the entire mass being bound or woven together so that the finished coil is practically indestructible either from internal or external stress.

Furthermore, during the winding the yarn is being distributed over the area of the coil at a faster rate than the wire; thus when a layer of wire is completed there is also a layer of cotton over it so that the next layer of wire is separated from the previous layer. This machine is equipped with the automatic device previously referred to, and consequently the coils may be duplicated with great facility.

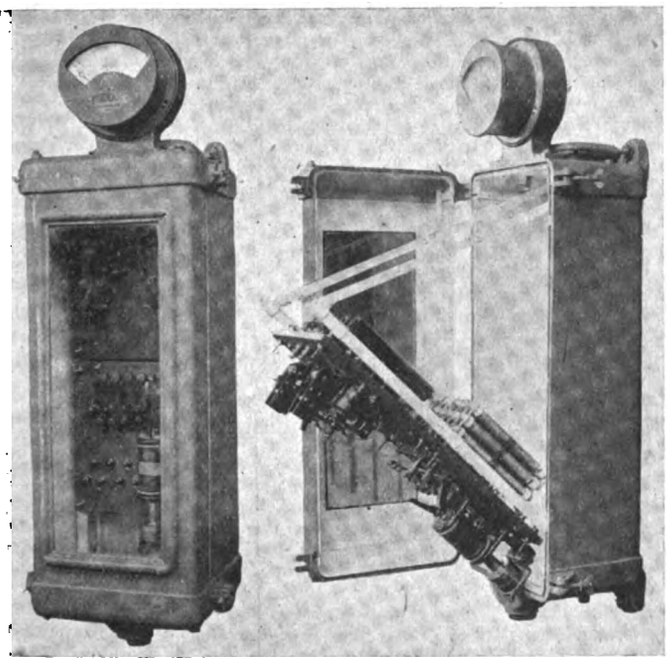

Fig. 4.—View of an Ironclad Motor-Starting Panel—Closed and Open.

Igranic Patent Ironclad Motor-Starting Panel.—This panel, which is illustrated in Fig 4, presents some entirely new developments in this class of apparatus. A self-acting motor starter of the multiple-finger pattern, and two single-pole main contactor switches are mounted together (and interlocked) inside a strong iron housing having a junction box at the base and an ammeter at the top. A large window in the front of the housing gives a clear view of the switch parts, but when a closer inspection is required, the whole front of the box can be swung open on hinges, thus enabling an attendant easily to clean or adjust the switchgear.

A specially valuable and quite novel feature is that access can be gained to the resistances and all internal parts of the apparatus by simply loosing two winged nuts on the top of the housing and pulling the panel forward, without the necessity of breaking any electrical connections. When pulled forward in this way the whole panel comes out of the box in the manner shown, thereby exposing the resistances and everything else that is mounted behind the slate. This makes inspection and repair exceedingly easy, and it is equally easy to replace the panel by simply pushing it back into the box and securing it by the two winged nuts formerly mentioned. This is a patented feature which has gained very general approval.

On the back of the exhibition panel a number of control devices are fitted to demonstrate the operation of the self-starter when employed for various purposes. These devices include automatic control by thermostat, float switch, pressure regulator, vacuum regulator and by push buttons.

(To be continued.)

Correspondence.

"ARMATURE WINDING."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Absence from London has prevented me from asking you before now to allow me to refer to the letter of Mr. A. A. Nims, which appeared in your issue of July 19th.

Mr. Nims' appreciation of my articles on continuous-current armature winding is very welcome—especially in view of his wide practical experience in armature design—and it makes me again regret THE ELECTRICIAN's unwillingness to face the difficulties which, at the present time stand in the way of the publication of the articles in book form.

There are many methods of analysing armature winding schemes, and I suppose every man thinks the most simple that particular method which he himself has most thoroughly mastered. Prof. S. P. Thompson favoured the method of the "reduced diagram," by which multi-polar schemes are reduced to their bi-polar equivalents, and it may well be that Mr. Nims is right in thinking highly of such methods. I should be greatly interested to have details of the particular method referred to.

I have not been able, from Mr. Nims' brief letter, definitely to understand what he means by "a wave winding which is also a parallel winding in every sense of the word, without being a series-parallel winding." If he means a multiplex wave winding in which the number of parallel paths is equal to the number of poles, such a winding falls, in my classification, under the heading "multiplex-wave or series-parallel windings," and I think it would lead to confusion if it were to be put into a special class of its own.

Perhaps Mr. Nims will add a further word of explanation.—I am, &c.,

London, Aug. 11. F. M. DENTON.

Photographic Records of Printed Matter.—Mr. H. O. Garland, in the "Electrical Review and Western Electrician," suggests a method of obtaining photographic records of printed matter that seems worth attention. One can, of course, obtain photographs of such matter by making a negative in the ordinary way, but in many cases the method suggested by Mr. Garland is much simpler. The printed page is merely soaked in petrol, which renders it temporarily transparent, and it is then possible to make a blue print in the same way as from a tracing. The petrol ultimately evaporates, leaving the sheet undamaged, so that the method could presumably be applied to the pages of books, &c., which it is important not to spoil. We commend the idea to the notice of our readers.

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The Labour Outlook.

BY A SPECIAL CORRESPONDENT.

The announcement that a conference on the question of the amalgamation of the various trade unions in the engineering industries will be held shortly draws attention to an important movement which is taking place in trade union circles, but one with which the outside world is hardly familiar. The amalgamation of trade unions is, of course, no new thing: the names of some old-established unions explain their history, as, for example, the Amalgamated Society of Engineers. In more recent times, however, the fusion of unions has taken place amongst larger bodies. One of the most notable examples was the foundation of the National Union of Railwaymen in 1913 from the union of the Amalgamated Society of Railway Servants, the General Railway Workers' Union, and the United Signalmen and Pointsmen.

During the war consolidation has been proceeding fairly rapidly, more especially since the passage of the Trade Union Act last year, which rendered amalgamation easier by reducing the majority of votes required in favour of amalgamation from two-thirds of the membership of the unions concerned to a 20 per cent. majority on a 50 per cent. vote.

One of the most significant developments of the war has been the growth in power and membership and the gradual consolidation of the general labour unions. This development illustrates the process which is taking place amongst the unions of skilled workers. The growth of trade unionism among the less skilled labourers, who are more difficult to organise than their better paid and more highly skilled fellows, indicates a real advance in the strength of the trade union movement.

The growth of membership of the chief general labour unions during the last few years may be grasped by a glance at the following table:—

	1910.	1917.
Workers' Union	5,016	270,000
National Union of General Workers	32,040	224,000
National Amalgamated Union of Labour	16,017	101,000
Dockers' Union	18,240	65,000
National Federation of Women Workers	6,046	50,000
Gas, Municipal, and General Workers	3,805	22,124

Some of these unions are affiliated to the National Transport Workers' Federation, but what is probably most important is that they are constituent bodies of the National Federation of General Workers, which has been formed during the war. Federation, whilst it allows for common action, preserves the independence of the unions which form the federation. Federation is obviously a step towards consolidation, and often precedes complete amalgamation.

But the movement has taken another step forward by the scheme of amalgamation between the National Union of General Workers and Dockers' Union and by a scheme for the fusion of the Workers' Union and the National Amalgamated Union of Labour. The position now is that something like 750,000 of the lesser skilled workers are now federated for certain common purposes, and that the units composing the federation are becoming larger and fewer by complete amalgamation.

Federation has been a pronounced feature of trade unionism during the war. The Miners' Federation of Great Britain (formed before the war) and the National Transport Workers' Federation (consisting of 30 societies) are well known. Forty trade unions operating in the woollen and worsted industry have founded a powerful federation under the title of the National Association of Unions in the Textile Trades. A National Federation of Foundry Unions has more recently come into existence, and has the object of ultimate amalgamation definitely in view.

Amalgamation is also proceeding apace in some directions. The Amalgamated Society of Carpenters and Joiners recently united with the Cabinet Makers. The new body will, it is expected, be fused with the National Amalgamated Furnishing Trades Association in the very near future to form the Amalgamated Society of Woodworkers. In other trades the same movement towards consolidation is taking place.

The general result of these developments is that the number of trade unionists is increasing, and that the trade unions, by federation and amalgamation, are becoming much stronger organisations. But probably the most powerful trade union body in the world is the Triple Alliance, consisting of the Miners' Federation of Great Britain, the National Union of Railwaymen, and the National Transport Workers' Federation. This alliance of coal-miners and transport workers, representing something approaching two million workpeople, has no elaborate organisation, but its tremendous power is undoubted.

It is clear that trade unionism is a force to be reckoned with, and that its position must be fully recognised.

Industrial Reconstruction Council.

The report for the six months ended June 30, 1918, states that since the date of the last report great progress has been made with the movement towards self-government for industry. It is now possible to say that there is general recognition on all hands of the need for organisation. Trade associations are experiencing a great accession of membership, due almost entirely to the belief that joint bodies will be formed.

It may be said that there is no trade that is not discussing its relation to the Whitley Report, and hardly any trade that has not accepted its underlying principles. The work of the Ministry of Labour in promoting Joint Standing Industrial Councils, and of the Ministry of Reconstruction in connection with Industrial Reconstruction Committees appears to be reaching out over the whole range of industries, and the prospects of the early establishment of a general joint advisory system for Government purposes seem to be extremely bright. So far as the trades themselves are concerned, it is obvious that the driving force behind this movement is a feeling of the need for organisation and co-operation with labour in order to gain strength for the work of the reconstruction period. In this connection the Council notices with regret a tendency among employers in certain quarters to restrict the function of joint bodies to what are known as "labour questions." These employers in the Council's view fail to realise the added strength which they could secure by co-operation with labour in any future discussion as to Government activities in connection with their trade. The Council has issued a manifesto (I.R.C. 4) dealing with this point, and claiming that the Government should in all trading matters consult only joint bodies.

Public meetings organised and held by the Council during the last six months include the inaugural meeting on Feb. 15 at the Guildhall, London, and the meeting at the Town Hall, Manchester (March 13), the Assembly Hall, Edinburgh (April 3); the Town Hall, Southwark (May 9); and the Town Hall, Birmingham (May 15).

As a result of these meetings local interest in the great problems of industrial reconstruction is being aroused, and the Council is anxious to encourage the formation of local reconstruction associations to carry on the good work.

Civic support was also given in connection with two lectures delivered by the chairman at the Municipal Buildings, Bristol, on Jan. 16, and at University College, Nottingham, on March 21.

The Council is arranging a series of lectures in the Saddlers' Hall, London, during the autumn and winter.

Some particulars of a series of conferences to be held in the Hall of the Institute of Journalists are given in another column.

The committee regard propaganda through other bodies as of extreme importance, and have developed a special department to deal with it. The Council is now in a position to deliver addresses to any bodies who will include the subject of Trade Parliaments in their programme of debates.

The report contains lists of societies to which addresses have already been given.

Propaganda through the publication of literature and in the Press is proceeding apace. There is a large and continuous demand for I.R.C. pamphlets, and a good deal of work has been done in the way of newspaper articles. The following may be found a useful list: I.R.C. 1, "Trade Parliaments: An Explanation of the Whitley Report"; I.R.C. 2, "General Statement of the Council's Aims"; I.R.C. 3, "Report for the Quarter ending March 31"; I.R.C. 4, "Capital and Labour and the Government," a manifesto issued to the Press on June 20; I.R.C. 5, "Reconstruction Handbook," for students and speakers: an introductory manual to the study of industrial reconstruction, 9d. net (published jointly by the I.R.C. and Nisbet & Co.); "Trade Parliaments and their Work," by Ernest J. P. Benn, C.B.E., chairman of the Council (a series of 12 articles which appeared in a number of trade papers, and have now been published in book form by Messrs. Nisbet & Co., at 1s. net).

Trade organisations and social bodies of all kinds continue to seek the Council's advice and assistance and great quantities of literature have been distributed through these agencies, and also to our troops in the field through the Y.M.C.A. The Council has received numerous requests from the Forces, even so far distant as Salonica, for copies of its literature. A campaign of propaganda abroad may also be said to have started, for parcels of literature have been sent in response to letters from the Canadian National Reconstruction Groups, the Montreal Brotherhood Federation, the Ottawa War Veterans' Association, industrial libraries in New York, the official Department of Labour and Industry of New South Wales and the United States Bureau of Labour Statistics.

The Department of Membership and Finances is now upon a sure foundation, Sir Alexander Roger having very kindly consented, at the request of the committee, to be responsible for this section of the Council's work.

The committee are more than ever convinced of the enormous possibilities of the movement, and of the urgent necessity for realising some, at least, of the ideals for which the Council is striving before the actual peace period arrives. No apology is made, therefore, for asking for funds to carry on this great work, and the Council knows that it can rely upon the support of all those interested in the welfare of our industries, and, therefore, of the nation and the Empire as a whole.

The development of the work has necessitated removal into new offices, and the Council has found a home in the building of the Institute of Journalists in Tudor-street. The Council expresses its thanks to the Institute for help in many practical ways, and its appreciation of the advantage of the use of the Institute's hall.

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Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 SPECIFICATIONS.

108,312 ELECTROLYTIC ZINC CO. Method of refining metallic zinc-bearing materials by the electrolytic process. (26/7/16.)
111,669 BENJAMIN ELECTRIC (LTD.) Lighting devices for motor vehicles (27/11/16.)
112,433 SOC. FRANCAISE RADIO-ELECTRIQUE. Telephone receivers. (7/12/16. Addition to 100,281.)
117,279 ROGERS & SMITH & SONS. Electrical switches for motorcars and other purposes. (12/5/17.) (Cognate application, 15,688/17.)
117,283 B.T.-H. Co. (G.E. Co.) Wireless signalling systems. (2/6/17.)
117,284 B.T.-H. Co. (G.E. Co.) X-ray apparatus. (6/6/17.)
117,285 DOWNS & FITT. Electrical appliance for the inspection of the interior of casks, jars or other vessels or chambers. (7/6/17.)
117,296 COOPER. Electric motors. (10/7/17. Addition to 17,292/16.)
117,298 WEST & Co. & WISE. Control of electrically-operated switches. (11/7/17.)
117,325 GUINNESS. Electrical couplings or connections. (4/8/17.)
117,330 B.T.-H. Co. (G.E. Co.) Electric transforming and converting apparatus. (21/8/17.)
117,336 B.T.-H. Co. (G.E. Co.) Phase convertors for polyphase distributing systems (30/8/17.)
117,339 IRELAND. Interrupters for electric circuits. (5/9/17.)
117,365 DOBELL. Subaqueous searchlights. (20/10/17.)
117,408 LENORMAND. Alarm for use in connection with the lubrication of the engines of motor vehicles. (13/2/18.)
117,418 THOMPSON. (Office Elettio Meccaniche.) Starting switches for electric motors. (1/3/18.)
117,435 SYKES INTEPLOCKING SIGNAL CO. & TARRANT. Electromagnetically-controlled signal reverser for use on railways. (7/5/18.)

1918 SPECIFICATIONS (open to public inspection for acceptance).

117,441 AUTOMATIC TELEPHONE MFG. CO. Automatic telephone systems. (9/7/17.)
117,443 BOSCH AKT.-GES. Double-current dynamos for wireless installations. (1/6/17.)
117,445 ATELIERS CUENOD SOC. ANON. Electrical installation systems. (21/6/17.)
117,447 AKT.-GES. BROWN, BOVERI ET CIE. Electric ignition apparatus. (16/6/17.)
117,449 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Differential electric relays. (19/6/17.)
117,450 ZORZI. Battery electrode made up of tapering cellular elements. (9/9/16.)

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

July 2, 1918.

10,789 MORRIS (LTD.), SMITH & ROBERTSON. Unit switches for opening power circuits.
10,791 SHEPHERD. Electrical generators and motors.
10,795 DAVIES. Electromagnetic separators.
10,799 DEARLE. Liquid electrical resistances.
10,806 VILLIERS ENGINBERING CO., FARRER & FUNCK. Flywheel magneto devices.
10,816 LATOUR. Use of audion lamp relay in telephony. (30/6/17. France.)
10,834 SUMITOMO CHUKOSHO(LTD.) Magnet steel. (10/7/17. Japan)
10,839 SIEMENS & HALSKE A.G. Telephones. (14/7/17. Germany.)
10,857 10,858 & 10,859 MOSSAY. Electrically propelled trucks, &c.
10,864 IMRAY. (R. Bosch A.G.) Regulating device for dynamo electric machines.
10,877 PRICE. Batteries.

July 3, 1918.

10,933 WESTERN ELECTRIC CO. Automatic switches.
10,944 MOTE. Protecting covers for accumulators.
10,945 CONRADI. Switch gear apparatus.

July 4, 1918.

10,962 H. SIMON (LTD.) & WILLIAMS. Electric cranes and hoisting appliances.
10,997 MARSH. Treatment of metals, &c., and tools and crucibles made thereof in electric furnaces.
11,013 IMRAY. (R. Bosch A.G.) Automatic regulator for dynamo electric machines.

July 5, 1918.

11,042 MCQUIRE. Electrical instruments and appliances for transmission of sound.
11,045 WESTERN ELECTRIC CO. Automatic telephone exchange systems.
11,048 GREVILLE. Undulating and controlling currents used for medical purposes.
11,067 HAYES. Electrical apparatus for lengthening and extinguishing gas burners.
11,076 SPLITDORF ELECTRICAL CO. Magnetos.

July 6, 1918.

11,110 MOON. Electric conductor connections and rendering same impervious to fluid.
11,113 MOON. Electrical apparatus.
11,115 LALBIN. Galvanic deposit of aluminium by cold process.
11,125 HEDINA. Electrical torpedo nets. (6/3/18, U.S.)

July 8, 1918.

11,177 DEAN. Gas generator for mercury interruption for X-ray, &c., purposes.
11,180 BOLTON & BRIGGS. Electrical connector arrangements.
11,181 MOND & ROBINOVITCH. Electric batteries.
11,186 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Bearings.
11,197 WILLIAMS. Accumulator grids.
11,201 BUTLER. Tramway, &c., rails.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Officer for the week.—Capt. W. Hynam.

Next for Duty.—Capt. W. Darley Bentley.

Monday, Aug. 26—Friday, Aug. 30.—Drills as usual.

Sunday, Sept. 1.—Commandant's Parade at Waterloo Station 8.45 a.m., opposite No. 9 Platform for work at Esher. Dress: Drill Order without rifles. Midday and tea rations to be carried.

SPECIAL NOTICES.—All drills will take place at headquarters unless otherwise stated.

The medical officer will attend for the examination of recruits on Thursday evening at 6.30 p.m.

Commercial Topics.

Foreign Capital in British Trade.

The report of Lord Wrenbury's Committee on Company Law Amendment was issued last week.

The report states that the Committee had to consider whether it is desirable to forbid the employment of foreign capital here in joint stock companies unless the alien character of the foreign owner is disclosed, unless the board, or a certain proportion of the board, is British, and unless a certain proportion of the shares are held by British subjects; also whether it is desirable to discriminate between one alien and another, and to legislate in that direction in the case of certain aliens and not of others. The Committee discriminate between (1) companies owning British shipping, (2) companies engaged in key industries, and (3) companies outside those classes. In the last case the Committee recommend that no restriction be imposed, as the requirement of disclosure of alienage might be thought to imply a stigma, which in the case of our friends might be injurious. The Committee, however, submits a scheme of enforcing disclosure if that policy seems to the Legislature to be right; but states that, although it would supply useful information to the Board of Trade, the price paid for that advantage would be too great, and that if it were adopted it is a scheme which could be evaded. The Committee think the true policy is complete freedom so far as the law of joint stock companies is concerned, and they make no discrimination between aliens of different nationality. In the case of shipping companies the Committee recommend that not more than 20 per cent. of the share capital should be held by aliens, and that these shares should carry not more than one-twentieth of the voting power, or, preferably, that the aliens' shares should carry no vote at all. The Board of Trade should have power to inquire as to whether a company is carrying on a key industry, and, if so, every member of the company and every holder of a share warrant should be required to make a declaration of nationality. The 1908 Companies Act should be amended so that the memorandum of association should state the objects (and not the powers) of the company.

Mr. A. S. Comyns Carr dissented from the Committee's conclusions with reference to companies owning British shipping or engaged in key industries, and to the provisions for disclosure of nationality.

* * * *

U.S.A. Electrical Exports.

The export of electrical plant, machinery and apparatus for April were valued at $4,572,953, against $4,740,902 in the corresponding month of 1917. There were large increases under the headings of batteries, dynamos or generators, transformers, fans, metal filament lamps, meters and measuring instruments, but there were decreases in the export of insulated wire and cables, motors and in telegraph and telephone apparatus.

* * * *

Fuel Economy in Canada.

Owing to the increasing demand for power, the question of providing an adequate supply of fuel and power has been referred by the Dominion Government to a special Power Board. The country has vast water-power and coal resources, but the coal is so located that it cannot be made available until transport and other problems are solved.

As the future progress of the country depends largely on the development and use of all available fuel-power resources, the Government has established a Dominion Power Board, comprising nine permanent officials of the various departments, who have become, as a result of their regular departmental work, recognised authorities on varied aspects of the fuel-power problems of the country. This Board has also been charged with the responsibility of co-ordinating all the investigation activities of the Government with regard to fuel-power resources. The Board will have two main functions: (1) The collection of information and (2) to advise upon the development and use of fuel-power resources of the country. The chairman of the Board is the Hon. Arthur Meighen (Minister of the Interior), and the following are the other members: Arthur St. Laurent (assistant deputy minister, Dept. of Public Works), C. N. Monsarrat (consulting engineer, Dept. of Railways and Canals), W. J. Stewart (consulting engineer (Dept. of External Affairs regarding International Waters), John Murphy (electrical engineer, Dominion Railway Commission), H. G. Acres (chief hydraulic engineer, Hydro-electric Power Commission of Ontario), O. Higman (chief electrical engineer, Dept. of Inland Revenue), D. B. Dowling (geologist, Dept. of Mines), B. F. Haanel (chief engineer, Fuel Testing Division, Dept. of Mines) and J. B. Challies (chief engineer and superintendent, Dominion Water Power Branch, Dept. of the Interior).

* * * *

Japan as an Electric Lamp Exporter.

Prior to the war Japan imported electric lamps of the annual value of £30,000. Great efforts were then made to provide for all local requirements, and so much progress was made that during the year 1916 the country was able to export lamps to the value of £67,000. In 1917 the value of exported lamps was estimated at no less than £250,000. It will be seen, therefore, that Japan is not only meeting the demands of her own country, but has developed a good export trade as well. Large modern factories have been erected during the past three or four years, and the business is developing in a very satisfactory way.

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Meaning of "End of the War."

In view of the number of contracts, business engagements, &c., in which the term "the end of the war" is employed, a Select Committee was recently appointed to define the phrase and other similar phrases in the war emergency statutes, &c. The first report of this Committee has been issued, and recommends that legislation should be passed to give effect to their suggestions—namely, to define the end of the war as the date when the treaty of peace is finally binding on the respective belligerent parties, that is to say when ratifications of the treaty are exchanged or deposited.

* * * *

S.A. Copper Statistics.

An advance statement of the U.S.A. Geological Survey shows that e smelter product in 1917 was 1,886,000 lb., or 2·18 per cent. less an that of 1916, and the value of the output (at average price of ·3 cents per lb.) was $514,910,956, against $474,288,000 in 1916. ie following table shows the copper production in the various States · the years given :—

	1914.	1915.	1916.	1917.
aska	24,985,847	70,695,286	113,823,064	84,759,086
izona	382,449,922	432,467,690	694,847,307	719,035,514
lifornia ...	29,784,173	37,658,444	43,400,876	44,933,846
lorado	7,316,066	7,272,178	9,536,193	10,054,951
orgia	—	—	803,699	930,691
aho	5,875,205	6,217,728	7,248,794	6,446,224
aine	—	—	—	34,872
aryland.....	12,248	15,426	126,965	291,501
chigan	158,009,748	238,956,410	269,794,531	268,508,091
ssouri	53,519	306,406	377,575	407,141
ntana	236,805,845	268,263,040	352,139,768	276,225,977
vada	60,122,904	67,757,322	100,816,724	115,028,161
w Jersey ...	—	—	4,115	—
w Mexico ..	64,204,703	62,817,234	79,863,439	107,593,615
Carolina ...	19,712	33,383	5,961	125,004
egon	5,599	797,471	2,433,567	1,105,097
nnsylvania	422,741	—	904	115,000
Carolina ...	—	—	—	210,000
nnessee ...	18,661,112	18,205,308	14,556,278	16,093,757
xas	34,272	38,971	86,463	2,061,129
ah	160,589,660	175,177,695	232,335,950	227,840,447
rmont	—	23,995	324,400	102,522
rginia	17,753	50,008	1,066,143	146,912
ashington .	683,602	903,661	2,473,481	2,051,416
yoming ...	17,082	351,871	1,784,351	2,019,767
idistributed	65,479	—	—	—
	1,150,137,192	1,388,009,527	1,927,850,548	1,886,120,721

The largest exporters of copper to the United States during 1916 d 1917 were Cuba, Canada, Chile, Mexico and Peru. The imports copper into the United States for 1916 and 1917 were as follows, e figures being copper content in lbs. :—

	1916	1917.
Copper in ore.....	124,878,905	116,500,532
Copper concentrates	32,753,874	38,197,532
Matte and regulus	17,155,075	21,048,943
Unrefined copper	268,927,315	355,598,036
Refined copper	8,411,230	6,751,958
Clippings	9,451,388	17,893,594
In other forms.....	758,193	429,702

Electricity Supply.

Extensions.

Coventry.—The Council das decided to acquire a site for new ectricity works at Foleshill, at a cost of about £8,000.

Sheffield.—The Treasury has sanctioned the proposed borrowing the Sheffield Corporation of £1,203,950 for the erection and equipnt of a power house at Blackburn Meadows, near Rotherham.

Last week the Corporation sanctioned the expenditure of about 0,000 upon plant, &c., required in connection with the scheme for the ension of the electricity undertaking, subject to the approval of the ance Committee.

General.

Dublin.—The Electricity Committee recently received a deputan in regard to the proposal to alter working hours with the object saving coal.

In reply to the deputation, who complained of the difficulties which uld be caused to traders by the proposed alteration of working hours save electrical energy, the chairman of Committee (Dr. Sherlock) said a gestion which had been made that the reduced output should affect nestic rather than industrial consumers would not meet the case, as cutting off of the whole of the domestic supply (about 2,000,000 out a total output of 10,000,000 units) would not effect a saving sufficient meet the proposed reduction in coal. Those interested should press ir claim upon the Coal Controller.

Extension of Time.—The Board of Trade has extended for one year the times limited for complying with the following Acts or Orders :—

Kingston-upon-Hull Electric Lighting (Extension) Order, 1914 (laying of mains, &c.).

Southport Corporation Act, 1913 (completion of electrical equipment and apparatus for the working of trolley vehicles).

Increased Charges for Electrical Energy.—The charges are being increased at the following places :—

Newport (Mon.) Electricity Committee recommend a further advance of 5 per cent., making 50 per cent. over pre-war rates. It is proposed to increase the charges to bulk consumers by 10 per cent.

Hammersmith (London) Council has increased its charges to 5d. per unit for lighting and by 12½ per cent. (making 25 per cent. increase over pre-war rates) for power.

Bermondsey (London) Council is increasing its charges by a further 7½ per cent.

Tunbridge Wells Council has decided to adopt the following charges in place of the old charges, shown in parentheses : 7d. (5½d., plus 10 per cent.), 6d. (5d., plus 10 per cent.), 6d. (4½d., plus 10 per cent.), 6d. (3½d., plus 10 per cent.), 1½d. (1d., plus 10 per cent.), 3 7/10d. (2½d., plus 10 per cent.).

Ipswich.—The Corporation last week decided to increase the salary of the borough electrical engineer, Mr. Frank Ayton, from £800 to £850 per annum.

Irish Water-power Scheme.—A scheme for using the water-power of the Liffey for the generation of electrical energy is now under the favourable consideration of the Dublin Chamber of Commerce, the Dublin Corporation and the Coal Controllers, English and Irish.

The Dublin & Lucan Electric Railway Co. are responsible for the project. Mr. D. McDowall Grosart, secretary, engineer and manager to the Dublin & Lucan Railway Co., broached the subject when he took up his position some five years ago. The directors now hold the opinion that they can abolish the use of coal for their line and effect an immense saving of coal in other directions.

The estimated cost of the scheme is £50,000. Already inquiries have been made for the supply of some 3,000 H.P.

By constructing a weir 300 ft. above the Salmon Leap the fall will be increased to 40 ft., and nearly 2,000 H.P. can be generated for six months in the year. Turbines and generators, one of 1,000 H.P. and two of 500 H.P. each, are to be installed. This would result in a saving of 16,464 tons of coal per annum.

The proposed station will assist the Corporation by supplying extra current in the winter months, and the Corporation will assist the railway company in a similar manner when the town's demands are less and the river at its lowest. It is proposed that the charge be 1d. per unit in each case.

The scheme should have an important bearing on the revival of the industries which once flourished on the banks of the Liffey.

The Dublin Port and Docks Board and the Council of the Dublin Chamber of Commerce are in favour of the scheme.

Electric Traction.

Dundee.—At a recent meeting of the Tramways Committee it was stated that the rearrangement of fares and the abolition of ½d. fares had resulted in increased revenue and mileage.

Mileage for the first three months under the new arrangement increased 3,634, passengers 404,258 and receipts £4,727.

Electric Vehicles for Coal Delivery.—In Boston (Mass.) over 35 electric trucks are employed in delivering coal.

Some of the trucks are (according to the American "Electrical Review") over six years old and are still doing their work with no sign of distress. During the severe weather of last winter when there were unprecedented demands for coal these trucks acquitted themselves admirably. Where the horse was unable to venture, the electric truck went, and overloaded Where the petrol truck broke down, could not be started because of the cold, or became unreliable because of the heavy loads, the long hours and want of overhauling, the electric truck delivered coal and kept on delivering coal often 20 hours a day.

The Edison Electric Illuminating Co. of Boston has a garage and battery service system by which a truck owner is able to exchange a battery in need of re-charge for one fully charged. Moreover, arrangements are such that the exchange may be made with only a short loss of time. One fleet of six trucks employed delivering coal is operated in this way, and during last winter, when the demand for coal was unprecedented, these trucks worked almost night and day making deliveries, batteries being changed as required. Great emphasis has been laid upon operating costs of various methods of coal delivery. Operating costs are important, but there are other phases of the matter that are also of considerable importance. Comparison between the petrol and electric trucks, apart from cost, embraces reliability, frequency of inspection, need for repairs and replacements. The petrol engine and transmission mechanism, with its many moving parts and high speeds, suffers with long hours of work and at best has small margin of overload. And even so, the maintenance required increases rapidly, while deterioration occurs, and shortened life. During busy seasons maintenance is usually neglected, and thus a petrol truck suffers breakdowns, high operating costs and shortened life. The electric is ideal for uniform sustained service, because of its few and rugged moving parts and its smooth acceleration and running characteristics. Moreover, abuse of

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the electric by an unskillful or ignorant driver is less deleterious than when the same occurs to a petrol truck. With some exceptions, the cost of energising the electric has remained stationary whereas the cost of horse feed and petrol have both soared and are not yet stable. From data supplied by truck users there is a reduction of 40 per cent. by the use of electric trucks compared with petrol trucks, and in many instances there is a greater saving. The electric truck is particularly fitted for coal delivery in town districts where streets are narrow, traffic dense and conditions congested generally. The electric truck is so quickly manipulated, turned in so small a space due to its comparatively short wheel-base, and accelerates so rapidly that its use does much to alleviate delays to traffic and the aggravating congestion that so often accompanies the manœuvering of large horse-drawn wagons and petrol trucks.

Leicester.—The salary of the engineer and manager of the tramways, Mr. T. R. Smith, has been increased from £550 to £600.

Manchester.—The tramway service, which has already been reduced by about 25 per cent. with the object of reducing the consumption of energy, is to commence in future at 10 instead of 8 a.m.

Omnibus and Tramway Employees' Strike.—Up to the time of our going to press nearly 20,000 omnibus and tramway employees in the greater London area were affected by the strike.

The Metropolitan Electric tramways and the London United tramways were affected, as were the Croydon, Ilford and Leyton employees, resulting in some disorganisation of the East and West Ham services. The London County Council tramways were only affected in the Bow and Hammersmith districts, where the services were much reduced. The strike had not spread amongst the tube railway employees to any great extent except on the Hampstead line. Strikes of tramway employees were also in progress at Brighton, Bath and Bristol.

Rochdale.—The Tramways Committee is applying for the sanction of the Board of Trade to increase fares.

It is proposed to add ½d. to all stages up to 2d. and 1d. to all stages between 2d. and 3½d.

Sheffield.—The Corporation is purchasing an electric vehicle chassis, to be fitted as a tower wagon.

Southport.—It has been decided to increase all fares on the Corporation tramways by ½d.

Sunderland.—A proposal to stop the tramcar service at 9 p.m. has been referred back, in view of the fact that workmen who return home from their work at that time have determined to cease work if the proposal is carried out.

The Tramways Committee has been authorised to increase the fares for existing penny stages to 1½d.

Telegraphy and Telephony.

Argentine Wireless Station.—It is stated that the wireless station which has been erected on the so-called English tower at Buenos Aires is now in communication with the stations at Arlington, Panama and Belmar (N.J.).

Radio-telegraphy in Holland.—The Minister of Waterways in Holland has placed an order with the Telefunken Company of Berlin for the erection of a wireless installation near Kootwyk, Gelderland, for communication between Holland and the Netherlands East Indies.

Imperial Notes.

Canadian Nickel Industry.—The report of the Royal Ontario Nickel Commission has recently been issued.

The report states that there is now an assured prospect of the erection in Ontario of large plants for the refining of nickel by the International Nickel Co. of Canada (at Port Colborne) and the British America Nickel Corpn. (probably at Sudbury) if a supply of electric power can be obtained. The output of these refineries, added to the nickel now being produced in the United Kingdom from Ontario matte, will meet, if not surpass, the entire requirements of the British Empire. The expropriation of the nickel deposits and plants of the Sudbury nickel area would probably cost not less than $100,000,000, and there is no good reason why the State of Ontario should be asked to run the risk involved in the purchase. There are three processes in use for refining nickel ore of the Sudbury type—(1) the Orford process employed by the Canadian Copper Co., (2) the Mond process, and (3) the electrolytic process. The cost of the three processes do not differ to such an extent as to give any one of the processes a material advantage over the others in competition. Ontario is fortunate in possessing abundance of water power, and in the report a comparison is made with Norway, where conditions as regards climate and the absence of coal-fields are closely similar to those prevailing in Ontario. Every important mining camp in Ontario is supplied with hydro-electric power, and the cost of this power is about one-third the cost of power obtained from coal or wood. The available water power in Ontario is 4,929,000 H.P., of which 722,000 H.P. has been developed. This abundant and cheap supply of water power enables the electrolytic method of refining nickel to be employed under advantageous conditions as to cost. The Hybinette electrolytic process is the one adopted by the British America Nickel Corpn. for the refinery it is to erect at Murray Mine, Sudbury. The proved reserves of ore in the Sudbury area are estimated at 70,000,000 tons, and the probable total reserves may be as much as 150,000,000 tons. The International Nickel Co.'s estimate of their ore reserves is 57,000,000 tons for three mines only. It may be doubted further whether anything but an arrangement of the market between the great interests can prevent the complete domination of the world's trade by the nickel industry of Ontario if the latter makes the best use of its exceptional resources. In view of the fact that practically no chemicals are required, that there is much more complete saving of the precious metals, especially platinum and palladium, and that electric power is cheap and abundant, the most satisfactory method of refining in Ontario will be the electrolytic method.

The large plant of the International Nickel Co. at Port Colborne recently started operations, and will produce annually from 20,000,000 to 24,000,000 lb. of refined nickel and 12,000,000 lb. of copper.

Toronto Hydro-Electric System.—The seventh annual report of the Toronto Electric Commissioners (for the year 1917) gives the following particulars:—

Gross income was $2,049,382 (an increase of $343,200, or 20 per cent.), and cost of current, expenses of operation, &c., amounted to $1,294,022 (increase $221,900), leaving surplus income $755,360. Interest, depreciation and sinking funds required $720,892, leaving surplus of net income $34,467. Units sold were 171,691,213 (increase 24 per cent.). Connected load was 169,818 H.P., compared with 125,840 H.P. in previous year, and peak load 56,562 H.P. (47,165 H.P.).

Owing to the heavy demands upon the Hydro-Electric Power Commission of Ontario, from which the power sold by the system is purchased, the system has ceased to canvass for new business and reduced the number of street lights. The power factor fell below the mark, and a heavy penalty was incurred, which compelled the Commissioners to insist upon the power factor clause in its contracts being observed. The purchase of the assets of the former Interurban Electric Co. was completed during the year. In view of its relation to the present and future interests of the Toronto Hydro-Electric system, the Commissioners call attention to the question of whether the charter of the Toronto & Niagara Power Co. can be utilised to enable the Toronto Electric Light Co. to maintain its poles in the streets of Toronto, or to serve as a basis for establishing a new distribution system without the city's consent. The charter of this company was granted by special Act in 1902, an if it can take over the poles and wires of the Toronto Electric Light Co., it will mean not only that the city has lost control of its streets to a company with unrestricted and perpetual powers, but that it has lost also its terminable rights under the agreement with the Toronto Electric Light Co. to purchase the assets of that company in 1919 and to prevent the amalgamation of that company with any other.

Foreign Notes.

Argentina.—During 1917 the Compania Italo-Argentina de Electricidad extended its mains to the southern zone (industrial districts) of the city of Buenos Aires.

The Company made a contract to supply current to the Cia. de Tramways Electricos del Sud for 15 years, for which purpose a second station (containing two Diesel generators of 500 kw. each) has been erected in Banfield. Two Diesel generators have also been put in at Moreno, and 1,000 kw. converters are being put in at the Tres Sargentos and "Montevideo" stations. When the units in course of erection are completed the Company will have in use 13 Diesel generator groups with a total capacity of 6,500 kw. and 20 converter groups, with an aggregate of 17,000 kw. In addition to special services and installations for third parties, the cables in use are 768 km. h.t. and 11,365 km. l.t. Static transformers installed amount to 3,040 k.v.a., and this total will be much increased during the current year. There are 1,900 private consumers, and the new consumers include the Cia. de Tramways Electricos del Sud (300,000 units d.c. per annum), the Gt. Southern Railway (about the same quantity of three-phase h.t.) and the Cia. Industrial de Electricidad (h.t. for electric steel foundry). The total connections are equal to 46,143 kw., and with orders in hand the total demand is 52,000 kw. Units generated were 31,345,363, converted into d.-c. or three-phase l.t. 22,306,766, and distributed 28,252,770. The year's gross profit was $698,623.

Chili.—The Ministry of the Interior has made provision for the postponement until one and two years respectively after the war of the periods fixed for the commencement and completion of the proposed electric railway between Vina de Mar and Concon, and the works necessary for the supply of electrical energy in the vicinity of the line.

Electric Traction in Switzerland.—The Swiss Federal Railways Board has submitted to the Council of Administration a scheme for the adoption of electric traction.

The projected programme will be carried out over a period of 30 years, in three sections, and at a total cost of three to four thousand million francs (about £120,000,000 to £160,000,000). The necessary electrical energy will be obtained mainly from hydro-electric plant.

Hydro-Electric Works in Japan.—According to "Engineering," the Kobé Municipal Council propose to erect hydro-electric works on a section of the Chigari on the upper reaches of the Muko river, about 20 miles away from Kobé.

Mr. Kobori, director of the Electric Bureau in the Kobé city office, says the site selected is a very suitable one, and application for permission to use the river will shortly be made to the proper authorities. It is proposed to obtain about 5,000 kw. on an average, with a maximum

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capacity of 10,000 kw., and it is estimated that the undertaking will cost about 3,500,000 yen. When the works are erected it will be possible to supply Kobé with about one-third of its present supply of current.

Italian Electrical Firms Combine.—A new company has been formed, with a capital of 64 million lire (to be increased to 80 million), to absorb Messrs. Franco Tosi, of Legnano, the Officine Insubri (ex Langen & Wolfi), and the Soc. Elettrotecnica Galileo Ferraris (ex Thomson Houston).

Swedish Telephone Firms' Amalgamation.—The "Journal" of the Swedish Chamber of Commerce also states that the amalgamation of the Aktiebolaget L.M. Ericsson and the Stockholm Allmanna Telefon A.B. was decided upon at meetings of the shareholders in June last.

Miscellaneous.

British Industries Fair.—This Fair, which will remain open until Aug. 31, was opened at the Kelvin Hall of Industries, Kelvingrove, Glasgow, on Monday, by Sir A. D. Steel Maitland, head of the Department of Overseas Trade.

Admission to the Fair is confiend to trade buyers. Invitations can be obtained from the General Manager, 38, Bath-street, Glasgow, or the Director, 10, Basinghall-street, London, E.C.

Chemical Trades' Industrial Council.—The first meeting of the National Industrial Council for the Chemical Industry was held on Friday last at Caxton Hall, Westminster.

Mr. Roscoe Brunner (chairman of Brunner, Mond & Co.) was elected president, Mr. Ernest Bevin (Dock, Wharf and Riverside Workers' Union) vice-president, Mr. Lloyd Roberts (Winnington, Cheshire) secretary, and Mr. J. O'Grady, M.P., treasurer. A provisional Executive Committee was appointed to report on the constitution of permanent committees.

A letter was read from Dr. Addison suggesting that technical and commercial questions in the chemical trade should be dealt with by an advisory committee of the Association of British Chemical Manufacturers, on which should be co-opted two labour leaders and two members of the Chemical Employers' Federation. The meeting accepted Dr. Addison's suggestion, and appointed Messrs. Roscoe Brunner and W. Stuart (for the employers), and Messrs. W. T. Kelly and Fleming Eccles (for the workpeople) as the co-opted members.

Non-Ferrous Metal Industries.—The Board of Trade wish to make it clear that applications for licences under the Non-Ferrous Metal Industry Act may be made at any time. The extension of time allowed for trading without licences applies only to those whose applications had been received by Aug. 5.

Educational.

University of Durham (Armstrong College).—In the department of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, &c., there are complete courses of instruction in preparation for degrees of the University of Durham The next session commences on Sept. 23, and particulars of the courses may be obtained from the secretary (Mr. F. H. Pruen, M.A.), Armstrong College, Newcastle-on-Tyne.

University of Edinburgh, Engineering Department.—The next session commences on Oct. 8, and the preliminary or entrance examination is held in September. The University provides complete courses in civil, mechanical and electrical engineering, qualifying for the degree of B.Sc. Eng. Particulars from the Matriculation Office, The University, Edinburgh.

Royal Technical College, Glasgow.—The session 1918-19 begins on Sept. 24.

The diploma of the college is granted in the departments of civil, mechanical and electrical engineering, mining, naval architecture, chemistry, metallurgy, building, &c. The college is affiliated to the University of Glasgow, and the degrees of the university in engineering and applied chemistry are open to its students. A full course of instruction in wireless telegraphy is also provided. Prospectuses (free) from the Director.

Finsbury Technical College.—The programme of this college for the session 1918-19 has been issued, and gives particulars of the day and evening courses in civil, mechanical and electrical engineering and applied chemistry. In engineering the courses of instruction extend over two and three years, with an optional third year. Prof. W. H. Eccles, D.Sc., M.I.E.E., is head of the electrical engineering department, and he is assisted by a competent staff of lecturers and demonstrators.

Heriott-Watt College, Edinburgh.—Complete three-years' courses of training in mechanical, electrical and mining engineering, leading up to diploma, are provided at this college, and arrangements are made for shortened apprenticeships with local mechanical and electrical engineering firms. There is a joint scheme with the University of Edinburgh for degrees in civil, mechanical and electrical engineering. Prospectus, &c., from the Principal.

University of Bristol, Faculty of Engineering.—Particulars of fees and a list of the professors in the faculty of engineering are given in our advertisement columns.

Tenders Accepted.

SHEFFIELD.—The Corporation has accepted the tender of Geo. Cooper for a steel chimney for Neepsend power station.

STOCKPORT.—The Guardians have accepted the tender of W. A. Shaw & Sons for fire alarms for their Shaw Heath Institution, at £115

Government Contracts.—The following tenders were accepted by the British Government Deaprtments during July :—

War Office.—Johnson & Sons, X-ray apparatus; Tilling Stevens (Ltd.), dynamos, &c., Belliss & Morcom, H. T. Boothroyd, Browett, Lindley & Co., Buffalo Forge Co., Equipment & Engineering Co., General Electric Co., H. Green & Co., R. A. Lister & Co. (Ltd.), and Siemens Bros. Dynamo Works, generating sets; Mawdsley's (Ltd.), motors, &c., Foster Engineering Co., transformers; Ferguson, Pailin & Co., h.t. switch panels, National Physical Laboratory; Siemens Bros. & Co., elec. supply cables, N.P.L.; Thos. Barton, steam generator set.

Post Office.—British L.M. Ericsson Mfg. Co., Siemens Bros. & Co., and Telegraph Construction & Maintenance Co., submarine cable; W. T. Henley's Telegraph Works Co., New Gutta Percha Co., Siemens Bros. & Co., Union Cable Co., and Western Electric Co., telegraph and telephone cables; British Insulated & Helsby Cables, London Electric Wire Co. & Smiths, Peel-Conner Telephone Works, and Phœnix Telephone & Electric Works, telephone cords; Siemens Bros. & Co., telephone earpieces; British Insulated & Helsby Cables, cable distribution plugs; British L.M. Ericsson Mfg. Co., telephone plugs; Peel-Conner Telephone Works, telephones; Brunner, Mond & Co., voltoids; T. Bolton & Sons, Shropshire Iron Co., F. Smith & Co. (inc. in London Electric Wire Co. & Smiths), bronze wire; Siemens Bros. & Co., insulator bronze wire; T. Bolton & Sons and British Insulated & Helsby Cables, copper wire; Johnson & Phillips, v.i.r. wire.

India Office.—Peel-Conner Telephone Works, telephone sets; Callender's Cable & Construction Co., Shropshire Iron Co., and R. Johnson & Nephew, wire.

Appointments Vacant and Filled.

An electrical engineer is wanted to take charge of the electrical installation at a large general hospital for the duration of the war. Particulars from the House Governor and Secretary, Royal Victoria Infirmary, Newcastle-upon-Tyne. *See advertisement.*

A teacher of electrical engineering for evening classes and a good practical electrician for instructing disabled soldiers and sailors in wiring are required at the Polytechnic, 309, Regent-street, London, W.1. Applications, with copies of testimonials, to the Director of Education. *See advertisement.*

A north of England firm require an assistant with knowledge of d.c. or a.c. machine design. *See advertisement.*

An assistant master for applied mechanics and physics is required for the Temple Junior Technical School, Bristol. Salary £180, rising to £220 per annum. Applications by Aug. 27. Forms from the Registrar for Education, Guildhall, Bristol.

Applications are invited for the posts of head of engineering department and assistant lecturer in engineering at Barrow-in-Furness Technical School. Maximum salary £300 and £250 respectively. Particulars from the Director of Education, Town Hall Barrow. Applications by noon Aug. 31.

A vice-principal and head of the chemistry and natural science department is required for the Portsmouth Municipal College. Salary £350 to £400. Forms of application from the Secretary, Offices for Higher Education, Municipal College, Portsmouth.

Middlesbrough Education Committee require a headmaster with B.Sc. in engineering (£275 to £300, with £26 war increment), and an assistant master for physics and chemistry (£180 to £240, with £26 war increment). Applications by Aug. 31. Forms from the Director and Secretary, Education Offices.

The City of Birmingham Education Committee require lecturers in electrical engineering and practical mathematics for the Handsworth Technical School. Forms of application, &c., from the Principal.

Mr. H. C. Waters has been appointed chief draughtsman and electrical engineer to the East Anglian Engineering Co. (Ltd.), Stowmarket. Mr. Waters has been engaged with Messrs. Crompton & Co. for some years.

Business Items.

Messrs. Fleming, Pirkby & Goodall's works and offices will be closed for the staff's annual holiday from Saturday, Aug. 31, to Saturday, Sept. 7, inclusive. Between those dates only urgent correspondence will be dealt with.

The works and offices of Messrs. E. Brook (Ltd.), Huddersfield, will be closed from Friday, Aug. 30, to Saturday, Sept. 7, inclusive, for holidays.

Lifting Magnets.—From the Société de L'Eclairage Electrique, 8, rue d'Agueseau, Paris, we have received a pamphlet giving particulars of the company's litfing magnets.

Drying Stoves.—The Davis Furnace Co., of Luton, has recently issued circular DO/18, which deals with drying stoves of different types, suitable for core drying, japanning, enamelling, armature drying, &c. Current prices, gross weights and measurements, &c., are given.

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Liquidations.

The Woods-Gilbert (British) Rail Grinding & Milling Co. (Ltd.) is being wound up voluntarily for reconstruction as the Woods-Gilbert Rail Re-modelling Co. (Ltd.). Mr. Jas. Cameron (Kelvin, Bridgefield-road, Sutton, Surrey) and Mr. A. G. Conway (170, Strand, London, W.C.) are liquidators.

The Asuncion Tramway, Light & Power Co. is being wound up voluntarily. Claims to the liquidator, Mr. B. H. Binder, 80, Bishopsgate, London, E.C., by Sept. 17.

Claims against the Devonport & District Tramways Co. (in vol. liq.) are to be sent to Mr. P. Newton Gray, 136, Aldersgate-street, London, E.C.1, by Aug. 27.

Municipal Accounts.

Belfast.—The capital expenditure on the electricity supply undertaking is £450,779 (increase £521). The sinking fund amounts to £139,318 and the renewals suspense account to £58,842.

Revenue was £152,737 (compared with £136,228), gross profit £45,696 (£35,550), and net profit £13,385. Total cost of production was 1·305d. (1·26d.) per unit, and interest and sinking fund required 0·414d. (0·4d.). Units generated were 22,083,990 (21,389,765) and sold 19,688,372 (19,180,541). Total maximum supply demanded was 11,686 kw. (11,289 kw.).

Glasgow.—The electricity department's accounts for the year ended May 31, 1918, show gross capital expenditure £3,072,387 (increase £297,834), of which £827,990 has been redeemed

Revenue was £789,001 (compared with £580,433 in previous year), gross expenditure £542,716 (£404,404), and gross profit £246,285 (£176,029). Interest required £101,649 (£91,306), instalments of loans £1,586 (£1,532), and sinking fund £75,768 (£66,250), leaving £7,145 to transfer to reserve. Last year £38,666 was taken from reserve. Kelvins generated were 182,481,170 (162,398,668) and sold 155,194,785 (141,193,627). Total maximum supply demanded was 132,316 (123,180) kw. Working cost per until sold was 0·7480d. (0·6024d.), and total cost, including capital charges, rates, taxes, depreciation, &c., 1·2091d. (1·0523d.), while gross receipts were 1·2201d. (0·9866d.). The report of the Electricity Committee states that motors supplied from the Corporation mains aggregate 12,904 (12,401) = 105,739 H.P. (97,733 H.P.).

At the Port Dundas station the third 8,000 H.P. turbo-alternator referred to in last year's report has been in commission since Dec. 25, 1917. A fourth 8,000 H.P. Dick, Kerr set has been purchased in a partially completed condition, and is expected to be on load by October next. The capacity of the station will then be 48,160 H.P. Two 1,000 kw. rotary converters manufactured by the British Thomson-Houston Co. have been installed in the sub-station, the capacity of which is now 4,000 kw. The erection of a 20,000-volt sub-station to form a connecting link between Port Dundas and the new Dalmarnock station is now being proceeded with. At the Pollokshaws-road station the 8,000 H.P. turbo-alternator supplied by Willans & Robinson is now in regular service, the capacity of this station being 33,120 H.P. Two 1,500 kw. rotary converters have been ordered from Bruce, Peebles & Co. A 20,000-volt sub-station is also being erected in this station. A 1,000 kw. rotary converter, made by the British Thomson-Houston Co., has been installed in Govan, and a similar set in Partick. The steam plant in Partick was only run during the winter months. Owing to the increased demand in both districts, two 1,000 kw. rotary converters have been ordered, one for each of these stations, and when these machines have been installed the capacities will be: Govan 3,750 and Partick 2,750 kw. of converting plant. At Yorkhill a 500 kw. Bruce Peebles rotary converter has been installed in place of a 250 kw. rotary converter set removed to another sub-station. Steady progress has been made with the buildings at the New Dalmarnock works. Orders have been placed for two additional 15,000 kw. turbo-alternators, making four in all.

Hampstead (London).—At March 31 the net capital expenditure of the electric supply department was £163,483.

Total income from sale of current for past year was £80,302 (against £76,142), and working expenses were £53,112 (against £48,273), leaving gross profit of £27,190. Interest absorbed £7,697 and repayment of principal £22,001, leaving a deficit of £2,507. Total works costs were 2·44d. per unit (against 2·23d.); maximum demand was 3,140 kw. (3,028 kw.), and there are 8,761 consumers (8,543). The units sold amounted to 5,217,247, including 4,597,921 supplied to private consumers.

Leeds.—The accounts of the tramways department for the year ended March 31 show capital expenditure £1,766,609 (increase £2,716). £502,190 has been applied in reduction of debt and £381,771 remains in the redemption fund.

Revenue was £586,631 (compared with £515,806 in previous year) and working expenses were £314,042 (£260,885), leaving gross profit £272,588 (£254,920). After providing for interest, income tax, rent of lines and war allowances (£12,053), the amount carried to appropriation account was £193,186, and after providing for redemption, revenue contribution to capital outlay (£2,742), permanent way and general renewals (£61,765), reserve, &c., the net surplus was £58,000 (£79,431). Total revenue per car-mile was 14·746d. (12·817d.), and working expenses, including power, were 8·731d. (7·098d.). Passengers carried were 124,519,119 (112,151,833) and car-miles run 9,547,670 (9,658,595). The railless trolley vehicles produced £1,485 net profit

Poplar (London).—At March 31 the capital expenditure of the electricity department was £567,336 (increase of £46,235 over 1917), of which £318,274 is outstanding.

Income was £107,710 (compared with £104,218), and total cost of production was £74,679 (£67,069), leaving gross profit £32,687 (£36,808). Net revenue charges were £25,389 (£24,994), and after adding income from property (£38) and profit from sales department (£218) the net surplus was £7,553 (£12,011). Total maximum demand was 8,150 k.w (9,400 kw.). Units generated and purchased were 25,101,075 (28,039,171) and sold 20,505,024 (23,476,842). Average income per unit sold was 1·257d. (1·062d.), and average cost of production per unit sold was 0·874d. (0·686d.). Load factor was 30·85 (30·11) per cent.

Mr. J. H. Bowden (engineer and manager) says in his report he recently submitted figures to the Coal Controller showing that two undertakings running interlinked during light load periods could save £2,130 per annum with coal at 25s. a ton and cost of fuel at 0·5d., and that he has, in conjunction with the engineers of Hackney, Shoreditch and Stepney, drafted a revised working agreement for linked-up working.

Companies' Meetings and Reports.

AMERICAN TELEPHONE & TELEGRAPH CO.—The report for the first half of 1918 shows total income $29,497,300 (compared with $26,812,100 in the first half of 1917). After payment of interest and dividends, the surplus carried forward was $4,130,000 ($3,751,100). The gross receipts of the Bell undertakings for the same period were $155,256,000 ($136,188,900), and the net revenue, after providing for interest and other charges, was $26,901,000 (decrease $1,640,100).

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—The report of the directors for 1917 states that total income was $6,203,698, and after providing for general and legal expenses, interest, and charges on loans, &c., the net revenue was $5,266,518, allocated as follows: General amortisation reserve $250,000, four dividends at 1¼ per cent. each on preference shares $600,000, and dividend of 1 per cent. on ordinary shares $1,064,136, surplus carried forward $3,352,382. The surplus revenue undistributed has been applied to liquidation of floating indebtedness and to providing for the necessary capital expenditures of the company and its subsidiaries. The net earnings of subsidiary companies in milreis were as follows: Rio de Janeiro Tramway, Light & Power Co., 33,553,764 (compared with 32,311,411 in 1916); Sao Paulo Tramway, Light & Power Co., 13,315,816 (13,326,782); Sao Paulo Electric Co., 1,002,389 (1,115,618).

COMPANIA DE ELECTRICIDAD DE LA PROVINCIA DE BUENOS AIRES.—The report for the year ended July 31, 1917, states that units sold were 6,283,972, against 6,295,842; customers were 14,451, against 13,583; and gross revenue was £206,072, against £189,883. Total expenses in the Argentine were £152,796, this increase of 20·32 per cent. being entirely attributed to the abnormally high prices of fuel and all materials. Net profit from operation was £54,902, against £62,728. The results do not permit the payment of a preference dividend. During the year £5,198 was expended on capital account. The loss for the year amounted to £2,110, less £630 discount on debentures.

HAVANA ELECTRIC RAILWAY, LIGHT & POWER CO.—The gross earnings for 1917 were $6,989,599, against $6,017,708, operating expenses and taxes $3,385,469, against $2,443,885, net income being $3,604,129, against $3,573,823. Miscellaneous income was $149,754, against $144,561, giving a total net income of $3,753,884, against $3,718,384. First charges were $1,138,623, against $1,297,093, net profit being $2,615,260, against $2,421,291. There has been set aside as reserve for depreciation and special charges $211,843, leaving $2,403,416; $2,024,501 was brought forward, making $4,427,918. This has been disposed of as follows: Dividends paid (6 per cent. on the preferred and common shares), $1,976,254; provision for sinking fund in respect to English bonds of the Compañia de Gas y Electricidad de la Habana, $12,566; provision for sinking fund in respect to the Consolidated Mortgage bonds of the Havana Electric Railway Co., $104,807; reserve for bad and doubtful debts, $64,000; carried forward, $2,270,290.

MANILA ELECTRIC RAILROAD & LIGHTING CORPN. (LTD.)—The gross earnings for 1917 were $1,795,746 (increase of $201,668 over previous year), operating expenses and taxes were $917,499 (increase $82,074), and net earnings $878,248 (increase of $119,593). Bond and interest charges were $265,008 and sinking fund requirements $67,650, leaving $545,590 (increase of $95,752). Total accumulated surplus is $1,816,116 (increase of $135,376). The reserve for replacements and renewals was increased from $80,000 per annum to $108,000 per annum.

SHAWINIGAN WATER & POWER CO.—The report for 1917 states that the demand for electric energy exceeded that of any previous year. The gross earnings were $2,902,210, compared with $2,325,872 for 1916, and the net revenue increased by $97,128. Two large enterprises (the construction of the La Loutre dam for the Provincial Government of Quebec, and the building of the plant for the Canadian Electro-Products Co.) involved a large expenditure, and there were also substantial expenditure involved in the increase of the capacity of the plant of the Carbide and the Electrode Companies, &c. In order to provide for the expenditures above referred to and to provide against future capital expenditure the directors authorised an issue of $4,500,000 two-year 6 per cent. convertible gold notes. The various electric companies controlled and operated by the company have shown a healthy growth, and all of them have had a successful year. A new works, constructed at Shawinigan Falls by the Canadian Aloxite Co., will require about

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12,000 H.P. and will employ a large number of hands. The works are substantially completed and the installation of equipment is going on. The Canada Carbide Co. enjoyed the best year in its existence. Its output is now at the highest point in the history of the company, and it is anticipated that in 1918 it will prove even more successful than in 1917. Closely allied with the Canada Carbide Co. is the Canadian Electrode Co., which manufactures carbon electrodes largely for use in the carbide furnaces. This plant has proved to be an important factor in the operations at Shawinigan, and has had a satisfactory result. The Canadian Electro Products Co. is also now operating on a satisfactory basis. Various accidents and delays occurred in attaining results, but a new contract with the Imperial Munitions Board extends the operation of the plant throughout 1918. In connection with the increased growth of the power business, not only has power been taken from the Laurentide Power Co. in accordance with the contract, but a considerable amount of excess power has also been purchased. Benefits to the power situation have resulted from the joint operation of the power developments at Grand Mère and Shawinigan Falls. The territory served by the company was probably the only section in the continent which had an ample supply of power during 1917, and the continuation of this satisfactory condition is guaranteed for 1918 by putting the La Loutre storage dam into operation. The new business exceeded that of the previous year, which was the record up to that time, and should increase the demand on the plants by 35,000 H.P. While a great amount of power is being used in the manufacture of chemicals, aluminium and other commodities now being used for war purposes, it should be noted that in almost every instance those works were in full operation previous to the war, and will doubtless be in full operation after the war as well. There has developed during the year a situation in the electric power business which has become especially favourable to all water-power enterprises. The coal situation in the United States has become uncertain: large industries are shut down for want of coal and public service enterprises driven by steam have been obliged to reduce their output on account of the scarcity of coal. The effect of this condition will be lasting, and manufacturers using electricity will, so far as possible, prefer to obtain it from reliable water-powers.

WESTINGHOUSE ELECTRIC & MFG. CO.—The report for the year ended March 31 shows gross earnings $95,735,407 (compared with $89,539,442 in the previous year). In addition to the regular quarterly dividends at the rate of 7 per cent. per annum on the preferred and common stock a special "Red Cross" dividend was paid, making the total paid in dividends $5,610,848. The net surplus was $26,404,694 (increase $8,299,396). The report states that the company's holdings of 4 per cent. debenture stock and preference and ordinary shares in the British company were sold to a syndicate formed in London (Electric Holdings, Ltd.), and payment therefor has been received in 5 per cent. prior lien debenture bonds maturing in 10 years.

WINNIPEG ELECTRIC RAILWAY CO. (LTD.)—The gross earnings for the past year were $3,339,009, and operating charges (exclusive of depreciation) $2,143,512, net operating revenue being $1,195,497. After adding miscellaneous income and deducting interest on debenture stock, bonds, &c., and other charges, the net income (excluding depreciation) was $353,629, a decrease of $151,621 compared with last year, notwithstanding that the gross revenues for the year increased by $27,840 over previous year.

New Companies, Mortgages and Charges, &c.

CHARLES WINN & CO. (LTD.)—(151,156)—Private company. Reg. Aug. 10, capital £50,000 in £1 shares, to take over business of manufacturers of and dealers in steam, gas and electric fittings, lamps, pumps, tools, &c., formerly carried on by the late C. Winn and P. Winn in Birmingham as Charles Winn & Co. P. Winn governing director.

DOMESTIC ELECTRIC CO. (LTD.) (151,091.)—Private company. Reg. Aug. 1, capital £100 in £1 shares, to sell, deal in and manufacture combustion engines and other machinery, &c. First directors are W. Paul and H. Orme.

EAST LONDON MICA CO. (LTD.) (151,149).—Private company. Reg. Aug. 8, capital £1,000 in £1 shares. Manufacturers of and dealers in mica and talc, &c. Permanent directors are C. G. Grout and P. H. Butler. Reg. office: 17A, Edinburgh-road, Walthamstow, E. 17.

HOWARD ELECTRICAL CO. (LTD.) (151,085)—Private company. Reg. July 31, capital £5,000 in £1 shares. Electrical engineers and contractors, carriers of passengers and goods, suppliers of electricity, &c.

PNEUMATIC & ELECTRIC SYND. (LTD.) (151,145).—Private company. Reg. Aug. 8, capital £500 in 2s. shares, to acquire the option to purchase patents for improvements in pneumatic and electrical appliances, &c.

SCRIVEN & CO. (LEEDS) (LTD.) (151,077)—Private company. Reg. July 30, capital £100 in £1 shares. Engineers, machine tool makers, founders, electrical engineers, &c. The first directors are J. W. Crosthwaite, J. Scriven, G. D. Crosthwaite and A. E. Imeson (all British).

Mortgages and Charges.

T. & J. JACKSON (LTD.)—Particulars of £1,600 debentures created July 8, 1918, have been filed, amount of present issue being £1,330 (being conversion of existing loans). Property charged: Company's property, present and future. No trustees.

LAING WHARTON (LTD.)—Memorandum of satisfaction in full on July 16, 1918, of mortgage debenture dated Jan. 4, 1918, securing £700. Also registered mortgage debenture dated July 26, 1918, securing £500, charged on all real and personal property, including uncalled capital. Holders: Ministry of Munitions.

MAXIM LAMP WORKS (LTD.)—Particulars of £4,000 debentures created April 8, 1918, the amount of the present issue being £3,000.

Receivership.

PORTABLE SEARCHLIGHT & SIGNALLING CO. (LTD.)—Notice of appointment of E. J. Allcard, 28, Throgmorton-street, E.C., as receiver by Order of the Court dated July 26, 1918, has been filed.

City Notes.

BROUGH (WESTMORELAND) ELECTRIC LIGHTING CO. (LTD.)—A dividend of 5s. per share for the past year has been declared.

CITY OF BUENOS AYRES TRAMWAYS CO. (1904) (LTD.)—A dividend of 1s. 3d. per share, or 5 per cent. per annum, less tax, has been declared for the three months to June 30.

COMPAGNIE FRANCAISE POUR L'EXPLOITATION DES PROCEDES THOMSON-HOUSTON (SOC. ANON.)—There was a net profit for the past year of £200,000, and a dividend of 8 per cent. has been declared on the ordinary shares.

EDISON SWAN ELECTRIC CO. (LIMITED & REDUCED).—An advertisement in another column announces the registration by the Registrar of Joint Stock Companies of the Order made by Mr. Justice Astbury, on Aug. 1, confirming the reduction of the capital of the company, and gives particulars of the nominal, the issued and the paid-up capital.

HONG KONG TRAMWAYS CO. (LTD.)—An interim dividend of 7d. per share has been declared.

WALTER SCOTT (LTD.)—The trading profit for the year to June 30 was £100,991 after providing for excess profits tax. A final dividend of 10 per cent., making 15 per cent. for the year, is proposed, £16,889 being carried forward.

The Round Table.

By "kVA."

ET BONUM QUO ANTIQUIUS, EO MELIUS.

"There's no new thing beneath the sun"
The weary preacher said
The things we strive to do to-day
Were done by those long dead.

When Davy, Jablockoff and such
Tamed the electric spark
And led it captive, naming it
With honest pride, the arc.

All men admired this novelty,
That put to flight the dark;
But they forgot, e'en as they gazed
'Twas Noah built the Ark.

And when we stroll through city streets,
And see the nimble trolley
Slide neatly through the switching frog
We're apt to say "By Golly"—

"Now ain't that smart: a cute idea!
A stunt both new and rare O:"
Yet they'd a perfect plague of frogs
Back in the days of Pharoah.

W. R. M. in "Glover's Almanac."

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, August 20, 1881.]

ELECTRIC LIGHT IN SYDNEY.—Caterers for the amusement of the public in the Antipodes appear to be following the example of their cousins here, and are adding the electric light to their other attractions. We hear that a circus in Sydney has been illuminated by the electric light.

ELECTRIC LIGHT IN SPAIN.—On the occasion of the recent journey of the King and Queen of Spain to Ferrol, the Marquis of Comillas entertained their Majesties at his country seat at Comillas. Amongst other attractions was a ball of peasants in Asturian costumes, the illumination of which was effected by 10 electric lights.

UNCEREMONIOUS BEHAVIOUR OF THE ELECTRIC LIGHT.—To show, we suppose, that it is no respecter of persons, the electric light employed in the Vorarlberg Tunnel, now being constructed in the Tyrol, suddenly went out whilst the Emperor of Austria and party were inspecting the works, leaving them in utter darkness. The Emperor is said to have been highly amused by the occurrence. We are glad to say his Majesty was soon rescued by workmen with lamps, and we believe came out of the Tunnel with whole shins.

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CONTENTS.

Notes ... 369
Some Applications of Electromagnetic Theory to Matter. By A. C. Crehore.—*Continued* ... 372
Oerlikon Three-Phase Low-Speed, Variable-Speed Motors with Large Flywheel Effect, for Direct Coupling to Mine Ram Pumps. Illustrated.—*Concluded* ... 374
The Capacity-Potential Curves of an Induction Coil. By E. Taylor Jones, D.Sc. Illustrated ... 376
The Application of Electric Welding to Ship Construction and Repair ... 379
What are the Lessons of the British Scientific Products Exhibition? ... 380
Reviews ... 380
National Physical Laboratory ... 381
British Scientific Products Exhibition. Illustrated.—*Continued* ... 382
Labour Notes. By Our Labour Correspondent ... 384
The I.M.E.A. and Coal Economy ... 384
Patent Record ... 384
Volunteer Notices ... 385
Commercial Topics ... 385
Electricity Supply ... 385
Educational ... 387
Tenders Invited and Accepted ... 387
Companies' Meetings and Reports ... 387

Notes.

Standardisation of Voltages.

The Tungsten Lamp Association has taken the important step of formally endorsing the standards advocated by the British Electrical and Allied Manufacturers' Association and the British Engineering Standards Association. These pressures are 100, 110, and 115 for low voltages and 200, 220 and 230 for high voltages. At the moment, the Association do not propose to go so far as these figures indicate, but to adopt a wider range, as follows: 25, 50 and 55 volts for under 100 volts; 100, 105, 110, 115, 120 and 125 volts for low voltages; and 200, 210, 220, 230, 240 and 250 volts for high voltages. It is felt that the change can be made more easily by a gradual transition, and therefore lamps of these voltages will be supplied at standard prices, but an extra charge will be made for all lamps of intermediate or higher or lower voltages. Eventually the standards of the B.E.A.M.A. and of the British Engineering Standards Association will be made applicable to lamps manufactured by members of the Association. We need scarcely emphasise the great advantages of this standardisation for the electrical manufacturer, while contractors, dealers and even consumers should also benefit. From the point of view of manufacturing, there is evidently a serious disadvantage in making a multiplicity of types, and from the point of view of the trader there is the disadvantage of having a proportionately larger variety of stocks of similar material. Thus the cost of living is increased all round. In Continental practice the number of voltages in regular demand is limited to one or two in both the high and low voltage ranges, while in the United States and Canada there has been an effective movement during the last four or five years to reduce the number of standard voltages to not more than three. It is realised generally in these days that there is a great advantage in standardisation, and it is undoubtedly well that the Tungsten Lamp Association should join in this desirable movement. We hope that the necessary restrictions which it will entail will be generally supported by all electrical interests, both on the power and lighting side of electrical work.

Coal Supply for Electric Power Stations.

The members of the Incorporated Municipal Electrical Association, like all other engineers connected with electricity supply, have been viewing the position of power stations in regard to the supply of coal with considerable misgivings, and therefore, on behalf of the Council, Mr. Faraday Proctor recently wrote a letter to the Controller of Coal Mines laying before him various matters for his consideration. The letter dealt in particular with the low heat value of much of the coal that is now used, its high ash content, the inefficiency of freight when a large percentage of ash is involved, the reduced output of boiler plant and sinilar difficulties with which we have become familiar. It was pointed out that the percentage of dirt in slack is higher than in larger grades of coal and that consequently electricity stations suffer more than other consumers in this respect. The suggestion is therefore made that all coal should be crushed to a standard size (say, 2 in.), instead of the large best coal being used for household purposes where a good quality is by no means important. Lastly, the suggestion is made that the miners' eight-hour day should be suspended and that a working day of 9½ hours should be substituted, thus leading to an increase of, say, 20 per cent. in the present output. The reply of Mr. D. Wilson, on behalf of the Coal Controller, does not take us very much further. Mr. Wilson points out that although the uniform crushing of coal is an interesting suggestion there would be great difficulty in installing the necessary plant for the purpose at the present time. We do not doubt that this for once is the case; we are glad to learn, however, that every effort is being made to ensure, in the very near future, a stock for at least three weeks for electric power stations. Also efforts are being made to improve the quality of the coal, and a special representative from the Production Department has been detailed to take up with the collieries, and also directly with the miners themselves, the question of effecting an improvement of this kind. With regard to the eight-hour day, Mr. Wilson states that this is a question of high policy in which a very large number of factors have to be taken into consideration. We very much fear that at present the miners are not working even an eight-hour day when this is considered throughout the week, and that they do not regard the matter of increased output as being so vital as is evident to all other sections of the community.

Pity the Poor Patentee.

In referring to the annual report of the Comptroller of the Patent Office, one of our contemporaries is "amazed to see that during 1917 a profit of £124,427 (more than 33⅓ per cent.) was made on the receipts from patent fees." and expresses the opinion that the fees are altogether too high. The opinion is one that will be endorsed by every patentee. Our contemporary asks the pertinent question, "Should the Patent Office be a department run at a profit, or in a position to render the greatest possible service to the country?" Our views on

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the Patent Laws are familiar to most of our readers, and reform on rational lines is long overdue. It is probable that if seats in Parliament depended on such trifling matters as Patent Laws, the latter would have been popularised long ago. The fact is that as matters stand at present seats depend upon a plentiful supply of cheap beer for the consumption of the majority, and upon such important subjects as Lottery Bills and the like. As long as this is so, the people of the country cannot expect Members of Parliament to waste their time, and incidentally lose their seats, by discussing matters which appear to have no interest to 99 per cent. of the electorate. At present, Ministers merely make plausible promises, and for four years the patentee has been paying fees for a protection which, in the majority of cases, is not of the slightest use to him till the end of the war. It is interesting to note that the number of complete specifications filed was 11,539, so that the profit amounts to nearly £11 per complete specification. In other words, if the authorities had permitted each patentee to have the first five years' protection for nothing there would still have been a surplus of receipts over expenditure. It is surely time that this foolish policy of excessive charges was abandoned.

The Effect of Dust in Fuel.

Some recent experiments by Mr. L. A. Stenger, described in the "Electrical World," suggest that the effect of the presence of much slack and dust in coal is much more prejudicial to efficiency of combustion than is commonly supposed. By "dust" is meant all particles of coal up to $\frac{1}{8}$ in. diameter. The immediate effect of such dust is to choke the passage of air, especially if the dust settles in layers and is not uniformly distributed; wetting the coal aggregates the dust in lumps or particles which attach themselves to the larger pieces of coal and thus no longer block the air. As an instance of the prejudicial effect of dry dust on combustion Mr. Stenger mentions that in one experiment dust-free coal of only 9,900 B.Th.U. gave much better results than a dusty coal of 12,000 B.Th.U. Thus in attempting to burn dust-bearing coal in any ordinary furnace there is sure to be some loss. The remedy suggested by Mr. Stenger is to crush the coal to a uniform, rather small size and then to screen out the dust, pulverise it, and feed it to boilers equipped with suitable combustion chambers for treating such material. The dust-free crushed coal would then be used in ordinary furnaces. In this way, it is suggested, all the coal burned, including the dust, will give the greatest efficiency. Whether or no this is the best method, it is an undoubted fact that uniformity in the size of fuel is important if the most efficient results are to be obtained.

Military Service Act, 1918.—The Council of the Institution of Electrical Engineers have been in communication with the Ministry of National Service with reference to the utilisation, with due regard to their skill, of members of the Institution called up for military service under the above Act. With a view to their being posted, as far as vacancies are available, to technical units, members of the new military age, on being called up for military service, are therefore invited to communicate with the secretary of the Institution, who will supply them with the Form and Certificate approved by the Ministry for this purpose.

A Government Division of Engineering in the United States.—In view of the attention being called to the need for better methods of utilising engineering talent for war service in the United States, it is interesting to observe that a Government Division of Engineering has been formed to deal with this matter. The Division will be under the direction of Mr. A. H. Krom, formerly secretary of the American Association of Engineers and recently engineer in charge to the State Public Utilities Commission in Illinois. It is estimated that organising professional mediums only reach about 20 per cent. of men with technical and engineering experience, and one of the tasks of the new department will no doubt be to reach and register all those who are not included in the great professional engineering bodies.

Damascene Steel.—In the middle ages Indian steel, famous under the name of damascene or Damascus steel, was a product of great importance. A note on the subject by Col. N. T. Belaiew, C.B., appears in the "Journal" of the Royal Society of Arts. The Hindoos, particularly, seem to have excelled in the manufacture of iron and steel and the famous wrought iron pillar at Delhi and other instances of their skill still exist. In some of these specimens high carbon crucible steels were undoubtedly used. Small cakes of the steel were examined by Réaumur and also by Faraday, whose investigations led to useful results. The fine watering of these Damascus blades shows the great amount of mechanical treatment to which they were subjected, the Oriental maker never exceeding a temperature of about 700 deg. From the point of view of after-the war trade this "damascene process" is of considerable interest.

An Electrically Operated Boat Hoist.—In the "Engineering News Record" an account was recently given of an electrically operated hoist used to convey boats and barges over the embankment 27 ft. high, which closes the channel connecting the Illinois River with Spring Lake (U.S.A.). Two motors of 75 h.p. and 18 h.p. respectively are needed for the equipment and receive current from the 13,000 volt transmission line. The incline on each side is about 300 ft. long, with a gradient of 1 in 10, a turntable being used between the inclines at the top. The boat is floated into the hoisting cradle and conveyed into a boat carriage on a pair of 8-wheeled trucks. By means of a $1\frac{1}{2}$ in. steel cable, led over a 5 ft. winding drum, the carriage is dragged up tracks on the inclines at a speed of 16 ft. per minute; the weight of the cradle is 55 tons empty and 400 tons with the largest boat.

Concrete versus Steel Ships.—According to "The Steamship" the first large concrete vessel ever produced in this country will very shortly pass into the service of the Government. She has a displacement of about 900 tons, and a deadweight carrying capacity of 400 to 500 tons. The chief advantage of concrete ships as compared with steel productions is that less steel is required, which in itself is of inestimable value at the present time. On a 5,000 tons ship, the saving in steel would probably not exceed about 20 per cent. On a small vessel over 50 per cent. might be saved. Other important advantages are cheaper and quicker construction, and the use of labour other than that of existing skilled shipwrights. Again the necessary shipyard plant is cheaper, simpler and more easily installed, whilst the materials for making the concrete are available in almost any locality. It is also possible that a claim for increased efficiency due to a reduction of skin-friction, could be substantiated. One of the main defects is the greater weight, which, type for type, approaches 100 per cent. increase. Where "bulky" articles have to be carried, the point is not so important, but any increase of net tonnage involves further expenditure for port and harbour dues. Bad weather has a greater delaying effect when concrete ships are being built than when steel is used, and in launching, as the increased weight adds to the dangers normally attendant on that operation. Thus the advantages in the ferro-concrete vessel are very valuable under present circumstances. Their utility as a war-time expedient is unquestionable, particularly the case in regard to the smaller vessels now being produced in this country. The development of the use of ships of large size and the question of the commercial future of concrete vessels may be left for the future to decide.

New Form of Cathode Tube.—Mr. W. D. Coolidge describes in the "General Electric Review" (U.S.A.) a new type of cathode X-ray tube for military use. The tube makes

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use of a target of large heat capacity and of such composition that electrons are only emitted at a certain range of temperature. The tube can thus be rendered self-rectifying and can be operated direct from a high-tension transformer. In the new form of tube the rectification occurs with greater completeness than in the older type. Formerly a temperature was apt to be reached at which the focal spot emitted electrons and accordingly an inverse current allowed to pass. This inverse cathode ray stream strikes the glass envelope and produces local heating with the result that the glass may crack. In the new form of tube special arrangements are made to keep the target cool, the anode consisting of a solid bar of copper ⅜ in. diameter, which is in connection with a radiator extraneous to the tube. On this copper anode a tungsten button ¾ in. diameter is cast and the heat capacity is approximately eight times that of the old type. The production of inverse currents is also hindered by the fact that a certain amount of oxygen is allowed to remain in the tube. This checks the emission of electrons. The author also describes a form of lead glass protective shield which can conveniently be used with this tube, the shield being made in two halves which are joined together, leaving only a small aperture through which the rays pass. The great difficulty in ordinary protective glass for X-ray work is to include enough lead; with the glasses ordinarily used the thickness must be 10 to 12 times that of metallic lead in order to give the same protection. Mr. Coolidge, however, has succeeded in making glass containing such a large quantum of lead that, for the same protective power as the metal, the glass need only be 1·4 times as thick. Such glass is very difficult to manufacture, but if, as a compromise, one adopts a glass whose thickness for equal protection need only be four times that of lead, such glass can be conveniently pressed into moulds of the required shape.

An Electrically Equipped Shipyard.—Lord Pirrie, who is on a tour of inspection through the shipbuilding areas of the North-East Coast, visited the Egis Yard, on Monday, Aug. 26. This yard, on which work was begun in November, is now nearly completed. It covers a site of nearly 16 acres on the banks of a North-East Coast river, and is interesting for the fact that it is entirely driven by electricity. It has four berths, each capable of building a ship of 430 ft. long by 56 ft. beam, and of about 10,000 tons deadweight. The principal buildings are erected on each side of the berths. On the south is a platers' shed, 532 ft. long by 100 ft. broad, which contains all the most up-to-date electrically-driven machinery for working the steel material. Direct gas-firing furnaces for frame and plates are installed. The means of erecting the material when worked on to the slips is provided by 20 steel derrick posts 98 ft. long with 35 ft. derricks, four on each side of each ship, with an independent electric winch capable of lifting three tons to each derrick. Six other portable electric winches are also provided for use where required. On the east side of the yard are the general stores, joiners' shop, mould loft, mast shed, with machines for making all masts, derricks, ventilators, &c., and a carpenters' shed. On the north-east side is a fitting-out quay 466 ft. long, where the vessels will be fitted out after launching. Along the quay is a 30-ton electrically-driven travelling crane capable of lifting 30 tons at a radius of 54 ft. and 10 tons at a radius of 90 ft., the height above crane wheels being 98 ft. On the west side are the beam shed, smiths' shops, finishing shops, plumbers' shops, &c., all equipped with the latest and most efficient machinery. Electric power, lighting, pneumatic piping, water pipes, &c., are taken down between each berth, and every facility is provided for utilising pneumatic power to the greatest possible extent. The shipyard is driven throughout by electricity supplied on the three-phase system.

Synthetic Rubber.—We observe in "Engineering" a summary of a communication, dealing with synthetic rubber, by Dr. Duisberg, one of the leading chemists of the Elberfeld Farbenfabriken, to the meeting of the Bunsen Gesellschaft, held at Berlin in April last. In the years 1910 to 1912 Fritz Hoffmann, of that firm, succeeded in preparing isoprene and dimethylbutadiene, hydrocarbons somewhat resembling benzene, which on long-continued boiling (for weeks or months, it is now admitted) turned into a substance resembling caoutchouc. This synthetic product seemed promising as a rubber substitute or as addition to rubber at that time but when the price went down to four marks the new process was abandoned. The war once more forced attention on such processes, but meanwhile, aluminium and acetone, essential reagents, had become equally rare and precious. As regards aluminium the manufacture of the metal was taken up in Germany, and there are now three works. With respect to acetone, Böttinger, with the aid of the bacillus macerans, was able to produce acetone from putrid potatoes, the fermentation yielding a mixture of about two parts of alcohol and one part of acetone. The process was not a success on a large scale, and calcium carbide was then utilised in order, as a result of a series of chemical processes, to obtain acetone. The rubber manufacture was then resumed. The rubber industry was not favourably disposed to the new material which at ordinary temperature resembled leather more than rubber, and became elastic only when warm. The addition of dimethylaniline and of toluidine cured these defects. In the improved condition the rubber is used for making the tyres for heavy motor vehicles and also for artificial teeth. The Leverkusen works can now supply 2,000 tons of rubber per year, which is about one-eighth of the amount of rubber required. Meanwhile other processes, still in the experimental stage, are regarded as promising. As to the outlook for these synthetic rubbers in normal times Dr. Duisberg was guarded.

Obituary.

PROF. B. HOPKINSON.—We regret to record the death of Col. Bertram Hopkinson, C.M.G., F.R.S., Professor of Mechanism and Applied Mechanics at the University of Cambridge, who was accidentally killed on the 26th inst., while flying in England.

Prof. Hopkinson, who was born on Jan. 11, 1874, was the elder son of the late Dr. John Hopkinson, F.R.S., and was educated at St. Paul's School and Trinity College, Cambridge. He was called to the Bar in 1897, and on the death of his father in 1898 he started in practice as a consulting engineer in partnership with Messrs. Charles Hopkinson and E. Talbot. With his partners he was jointly responsible for the design and construction of the electric tramways at Leeds and Newcastle-on-Tyne and other tramway and electric supply works. In 1903 he was appointed professor of mechanism and applied mechanics at Cambridge, and in 1904 he held a professorial fellowship at King's College. He edited the "Original Papers" of Dr. John Hopkinson, with a memoir, and he was the author of several scientific and technical Papers read before the Royal Society, the Institution of Civil Engineers and other scientific bodies. For the past two years he has held the position of deputy assistant director at the Air Ministry, and his death was due to a flying accident. Col. Hopkinson carried out a good deal of experimental work on the phenomena of explosion, &c. In 1903 he married Mariana, the eldest daughter of Mr. Alex. Siemens, and he leaves a widow and seven daughters. The funeral will be a military one, and will take place at Cambridge this (Friday) afternoon, at 2.30.

ALD. V. FOWLER.—The death of Ald. Valentine Fowler (deputy mayor and ex-mayor of Scarborough, and secretary of the Scarborough Tramways Co.), at the age of 69, occurred on the 20th inst.

ENG. REAR ADMIRAL F. H. LISTER, M.I.N.A., M.I.Mech.E.—Rear Admiral Francis Hy. Lister died suddenly at Kingstown on Aug. 20 at the age of 56.

He was instructor in engine design at the Royal Naval College, Greenwich, from 1896 to 1899, Inspector in the Dept. of the Engineer-in-Chief of the Fleet from 1905 to 1910, and Assistant Engineer-in-Chief of H.M Navy since 1911. He was Admiralty engineering representative on various sub-committees of the British Standards Committees, and also on the Steel Research Committee.

Personal.

Mr. John Henry Bunting (general manager, Messrs. Bruce Peebles & Co.) was married on Saturday last to Miss Janet (Nettie) Rintoul Mitchell at St. Serf's Parish Church, Edinburgh.

Mr. Robert N. Tweedy has received a commission (technical) in the R.A.F., A.G.S. branch, and he will be in charge, under the C.O., of the power and lighting installations at all the aerodromes in Ireland. Consequently, he has resigned his appointment as manager of the Dublin and south of Ireland branch of Messrs. Wm. Coates & Son (Ltd.), which he has held for nearly 12 years.

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Some Applications of Electromagnetic Theory to Matter.*

By A. C. CREHORE.

(*Continued from page* 351.)

V. First Application of Electromagnetic Theory.

It will be understood that electromagnetic theory is perfectly general in that it expresses the force at a single instant of time only, and does not prescribe at all how the two charges in question shall move relative to each other. We have been led to believe for many reasons that electrons revolve in approximately circular orbits in the atoms. The Bohr theory above referred to assumes this as the natural stable condition. Granting that this is true, it must be evident to you that the first step in the application of electromagnetic theory to atoms should be the solution of the problem of finding the force that one electron when revolving at a uniform rate in a circular orbit, exerts upon a second electron revolving in a different circular orbit These orbits must also be fixed in space in perfectly general positions, because the electrons in different atoms are, of course, situated in every possible manner.

It has been the speaker's contribution to this subject to solve this problem in its most general form, no terms of any kind having been omitted. It may not, at first, be apparent to you that any solution is required, or rather, perhaps, of what a solution consists, since the general theory gives the force of one of these electrons on the other. But you will see with some further consideration that the equation we want must contain several quantities the radii of the two orbits in question, the values of the constant velocities of the electrons in the orbits, the location of the position of the centre of the second orbit in space with respect to the first, that is, the x, y and z co-ordinates in ordinary geometry, and finally the relative positions of the planes of the two orbits, whether parallel or not. All of these quantites must find a place in the final solution, and, of course, none of them finds a place in the original general equation for the simple reason that it is general, not specifying any orbits or any positions for them. It requires three full pages to print this equation, but events have shown that it contains most important consequences when applied to electrons in atoms. It is some of these that I propose to discuss. The question probably occurs to you how could it have been claimed before that electromagnetic theory had been applied to electrons until the solution of this general equation had been obtained. This is a part of my contention in support of the view that these claims have not been very well founded, and that there remains much of value to be done

VI. Rings of Electrons

In giving an account of them I shall not follow the order in which the results were obtained, but prefer to review them, as it were, with hindsight instead of foresight. Naturally one of the first things to do with this equation is to apply it to the particular case where the two orbits in question exactly coincide, the two electrons then being in different places in the same orbit, for, in this way we may learn something of the properties of rings of electrons, of which the atoms are supposed to be composed.

A very great simplification is naturally made in the general equation when the two orbits coincide, because the co-ordinates of the centre of the second orbit referred to the first are all zero, and the speeds of the two electrons are the same. So the equation reduces to a very manageable form. The *total* force of the second electron on the first may then be conveniently resolved into two components, the one along the radius of the orbit, and the other along the tangent line perpendicular to the one. In general, neither of these components of the force is zero, and, as we make the velocity of motion less and less, the force reduces to the ordinary electrostatic force.

(*a*) *Two-Electron Atom.*—If there are only two electrons in the ring, it is evident that they must take positions at the extremities of the same diameter of the orbit on opposite sides of the nucleus of the atom, which may now be imagined at the centre. For a stable position, both the radial component of the force and the tangential component must vanish, otherwise there would result both a change in the radius of the orbit and an acceleration along the orbit, neither of which conditions represent a steady state. In such an atom, consisting of a nucleus and just two electrons, I have calculated the total radial force on one electron, including that due to the nucleus, that due to the other electron and that due to the centrifugal force of the electron itself. The equation for the radial force is

$$F_\rho = e^2\left(-\frac{7}{4a^2}+\frac{\beta^4}{2a^3}\right)+\frac{m_0v^2}{a}.$$

There are two radii at which the radial force vanishes, the one about 2×10^{-10} cm. and the other at $1{\cdot}85\times10^{-5}$ cm. In between these values the force is negative, signifying an attraction of the electron towards the nucleus, and, for all values greater or smaller than this, the force is positive, signifying repulsion. From this it is evident that the larger root corresponds to an unstable position, and the smaller root to the only stable position. This result entails some very radical consequences as regards atomic theory, some of which must be referred to here.

In the first place, it makes the order of magnitude of the radius of the orbit of the electrons 10^{-10} instead of the much larger order 10^{-8} cm. given by the Bohr theory.

In the second place, by omitting the forces due to the *motion* of the rings of electrons, the $e^2\beta^4/2a^3$ term in the equation, and by taking into account the electrostatic forces only, and balancing these against the centrifugal forces as Bohr does, the ordinary conditions for planetary motion as in a solar system obtain, except that there is repulsion instead of attraction between the planets. He has made use of the following theorem, which applies quite generally to all such systems: "In every system consisting of electrons and positive nuclei, in which the nuclei are at rest and the electrons move in circular orbits with a velocity small compared with the velocity of light, the kinetic energy will be numerically equal to half the potential energy."

It is the use of this theorem that has to be abandoned, because of the neglect of the forces due to the motion of the ring. By the help of this theorem Dr. Bohr was led to adopt the equal angular moment of momentum hypothesis for each and every electron in all atoms, which he stated as follows: "In any molecular system consisting of positive nuclei and electrons, in which the nuclei are at rest relative to each other and the electrons move in circular orbits, the angular momentum of every electron round the centre of its orbit will, in the permanent state of the atoms, be equal to $h/2\pi$, where h is Planck's constant." This theorem is derived directly from the preceding theorem, and fails when it fails.

The reason for obtaining such different results by a strict application of electromagnetic theory is apparent. The difficulty at the time Dr. Bohr first published this theory in July, 1913, was that there was no available expression for the forces due to the motion of the ring, but now the general equation referred to above has applied this. It appears that there is a term in the force $e^2\beta^4/2a^3$ due entirely to the motion of the ring, that coming from the magnetic component in the general equation, which varies inversely as the third power of the radius and directly as the fourth power of the velocity in terms of that of light. This term has not been pointed out before. It is a repulsive force, and very small at distances anything like 10^{-8} cm.; but, because it varies as the inverse cube of the distance, it is evident that it rapidly increases the smaller the radius, and must overtake in size any term that varies inversely as the square of the distance—namely, the electrostatic forces that Bohr used. It is where the balance between these two kinds of terms is effected that we obtain the stable position of the orbit.

For complete equilibrium, as was stated, the tangential force of one electron upon the other must also vanish. This subject has been discussed in that now classical work on "Electromagnetic Radiation," by G. A Schott He has derived an expression for the sum of the forces upon one electron in a ring due to all the others in the ring, but it is not given in a form that is easy to use, involving as it does the use of Bessel's functions and summations. However, our two results are based upon the same premises, although expressed in different form, and they should agree. They do agree in so far as a comparison has been possible, which gives some assurance that both are correct. Now, these tangential forces can never be zero, as Schott points out, unless we also take into account the force that the one electron exerts upon itself The other electrons in the ring exert forces on the one in such a direction as always to accelerate the motion of the one electron, thus doing work upon it. The one electron exerts an exactly equal and opposite force, and thus

* Lecture delivered before the American Institute of Electrical Engineers, slightly abbreviated.

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makes the total tangential force zero. In other words, it requires some energy to keep the ring in motion. Strangely enough, however, it requires much less the greater the number of electrons in the ring.

(*b*) *Regulation of Speeds of Rings in Electromagnetic Theory*.—In electromagnetic theory it is not possible to conceive of a single electron moving alone through the ether, sending out from itself a wave of energy in all directions and still keeping up an undiminishing velocity, unless the electron is itself changing in some way. There must be a source of this supply of energy to supply the energy radiated and lost to the electron. Schott has accounted in a beautiful manner for the regulation of the speed of electrons in rings. The regulator acts through the medium of these tangential forces, and Schott has shown that the peculiar nature of these forces is such that the velocity of the electrons in a ring will remain substantially a constant, or subject to very small variation for comparatively great changes in the radius of the orbit. This refers to the actual, not to the angular, velocity.

It is not easy in a talk of this kind to carry you along so that the reasons for certain conclusions have much force, partly because there are many related matters that have a direct bearing upon any given one. Suffice it to say here that there are strong reasons to believe that the regulation of the speeds of rings of electrons is accomplished in the manner indicated by electromagnetic theory as pointed out by Schott. The ground is taken here that this loss of energy by radiations is excessively small—too small to be detected by any means as yet at our disposal, and that no observations connected with the quantum theory are in the least affected by its existence.

(*c*) *Velocity of the Ring.*

(*d*) *Line Spectra and Rydberg's Constant.*

Let us next consider some of the consequences of the law of radial force which you have seen in the curve. It may now be stated that, in order to get this curve numerically the velocity of the electron in its orbit had to be known for the different radii, and, in accordance with the above statement, the velocity in the orbit has been taken as approximately constant for all radii between the two roots of the equation The velocity of an electron in any ring, according to these ideas, may always be taken equal to $p\frac{\pi^2 e^4}{h^2}$, where p is the number of electrons in the ring, e the charge of the electron, and h Planck's constant. The justification for the use of this value is that it leads to precisely the same equation for line-spectra of hydrogen and helium as Bohr gives, which agrees very closely with observed spectra. It may be remembered that the derivation of Rydberg's constant (the constant connected with light spectra) in terms of the charge on the electron and Planck's constant, has been one of the most cogent reasons for adhering to the Bohr theory. The expression for Rydberg's constant is

$$K = \frac{2\pi^2 m_0 e^4}{h^3},$$

The force of the argument is that, when the values of the constants on the right determined by physicists in a number of different ways are substituted in this expression, we obtain a number $3{\cdot}294 \times 10^{15}$. The Rydberg constant, obtained by entirely independent observations on light spectra, is found to be $3{\cdot}290 \times 10^{15}$ Unless this expression were based upon a truth, the chances are that no such agreement as this would be found. I will not be able to devote the time here to a demonstration of the following statements, but will merely state that the modifications above discussed lead to precisely the same expression for Rydberg's constant as the above, including also the equations for the line spectra of hydrogen and helium. The new ideas are thus not a step backwards, but when it is stated that I get in a similar manner to the above an expression in terms of the properties of the electrons for the Newtonian constant of gravitation that agrees just as closely with the value of this constant as determined by the astronomers, it will be seen that this, when added to the Rydberg constant, greatly strengthens our position, thus being a step forward.

(*e*) *Energy of Separation of Ring from Nucleus*.—We may easily calculate from the force curve the energy that is required to separate the ring of electrons from the nucleus from one radius to another, separating both electrons together. A minimum point of the energy curve occurs where the force is zero. From this point outwards we have to supply the energy to pull the electrons away from the nucleus and from each other; but beyond the larger root (not seen on the chart), where the force changes sign to a repulsion, the system will do work upon the electrons. Suppose, for example, that we supply from some outside source enough energy to separate the electrons from their normal orbit at 2×10^{-10} to $1{\cdot}85 \times 10^{8}$ cm. The electrons will arrive there with little or no velocity, all of this energy having been used up; but after that the repulsive force of the system begins to act, and it will accelerate the outward speed of the electrons until the fixed amount of energy which corresponds to the separation from $1{\cdot}85 \times 10^{-8}$ to an infinite distance has all been converted into kinetic energy.

VII.—Electrons Ejected from Atoms with High Velocity.

It is calculated in the particular case of the ring of two and a nucleus of two that the velocity thus acquired is nearly 1/20 of the velocity of light. With a ring of four and with a larger nucleus the velocity will be greater than this.

In radioactive substances it has been experimentally observed for some years that electrons are projected out from them with velocities that approach very close indeed to that of light—98 or 99 per cent. of it. In the atoms in their normal condition it has never been supposed that the electrons have velocities anything like as great as that of light, and this theory has now given a valid reason why there may be a great increase in the velocity when electrons are ejected from atoms.

VIII.—X-Ray Spectra.

In the Bohr theory, as has been stated above, there are supposed to be several steady states of the orbits which differ according to the values of an integer, τ. In his theory, the radii of these orbits increase with τ as the squares of the integer 1, 4, 9, 16, &c., and there is supposed to be a definite change in the kinetic energy of the electron from orbit to orbit All of these results came about due to the neglect of those forces due to the motion of the electrons. When these are taken into the account we have no change in kinetic energy from orbit to orbit; but the energy change is of the nature of potential energy, the work done in separating the electrons against the radial forces shown by the curve It may be stated that we now get a very different series of radii from those of the Bohr theory. The radius of the orbit for all values of τ from one to infinity never departs very far from the minimum point of the energy curve. We can find these radii corresponding to any value of τ by drawing a horizontal line across at a height just above the minimum point of the curve equal to the known value of the total energy to separate the electron to an infinite distance from the nucleus. Such a line is drawn in the second slide, which shows this same minimum point of the energy curve to an enlarged scale. Lines are drawn for $\tau = 2$, 3 and ∞, $\tau = 1$ corresponds to the minimum point itself. Each line cuts the curve in two points, and each point of intersection corresponds to the proper radius of the orbit for that value of τ Instead of a single value of the radius, as in the Bohr theory, there are two possible values.

I fully realise that it is not possible to make the reasoning on this matter appeal to you in the brief time at my disposal, but these results carry such important consequences that I could hardly avoid referring to them. They throw much light upon an experimental observation that has received no good explanation in terms of atomic theory. I refer to the charts of the X-ray spectra of the elements as observed by Moseley. These were shown here last year, I believe. Moseley shows a group of four lines close together which he has named the α, β, φ and γ lines in the L series, and in the K series the α and β lines. There has never been any clear understanding why there should be such a grouping of lines in the X-ray spectra. This theory gives a reason for it, and enables us to approximate to the positions of the lines. Bearing in mind that the orbital velocity is constant for varying radii, and that the velocity in a circular orbit is equal to $2\pi an$, it is evident that the orbital frequency is inversely proportional to the radius in this theory. So also is the X-ray frequency inversely as the wave-length λ. If, then, the X-ray frequency is connected with the orbital frequency in a proportional manner, which is very probable, then the X-ray wave-lengths should be proportional to the radii of the orbits. A comparison between the observed wave-lengths for the element curopium, which happens to be the heaviest element for which Moseley has shown all four lines in the L series, and the radii as estimated for values of $\tau = 1$, 2, 3 and ∞ is shown in the next slide. The general agreement is too close to be purely accidental.

In support of this view of the origin of this group of lines is the fact that they all run along in a parallel fashion without any cross-overs or intersections. You can see by the way the spacings are derived from the energy curve that any intersections of the lines in Moseley's chart would be fatal to this view of the matter. There is another interesting matter that this explanation involves. The radii for $\tau = 1$ are slightly larger than for $t = \infty$, so that the radii decrease slightly instead of increase for an increase in τ, but the amount of the total change is quite small. That is, we use the values on the left of the minimum point of the energy curve instead of those on the right In the Bohr theory the radii increase with τ, and as the squares of the integers, as 1, 4, 9, 16, &c.

(To be continued.)

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Oerlikon Three-Phase, Low-Speed, Variable-Speed Motors with Large Flywheel Effect, for Direct Coupling to Mine Ram Pumps.

(*Concluded from p. 354.*)

Fig. 9 illustrates curves of the no-load and short-circuit currents, as a function of the motor voltage for the different speed steps. From these values presented in this diagram one can calculate the stray factors X by dividing the no-load current by the short-circuit current of the same ordinate. The following table gives also the maximum power factors :—

24 poles	$X=0{\cdot}035$	power factor maximum	$=0{\cdot}93$.
36 ,,	$X=0{\cdot}088$	,, ,,	$=0{\cdot}86$.
48 ,,	$X=0{\cdot}110$	,, ,,	$=0{\cdot}82$.
72 ,,	$X=0{\cdot}240$	,, ,,	$=0{\cdot}68$.

Fig. 10 gives the kilowatt losses at different speed steps for the no-load and short-circuit trials as a function of the current and pressure respectively. The measurements were carried out by the two wattmeter method. Figs. 11 and 12 illustrate the efficiency, power-factor and current curves, and the input as a function of the output on the motor shaft, as also the efficiency, power-factor and motor output as a function of the speed.

It will be seen therefrom that the motor works even at the lowest speed step with an exceptionally high power factor and efficiency, and that the test figures are practically as good as those of a mono-speed motor, when the number of poles,

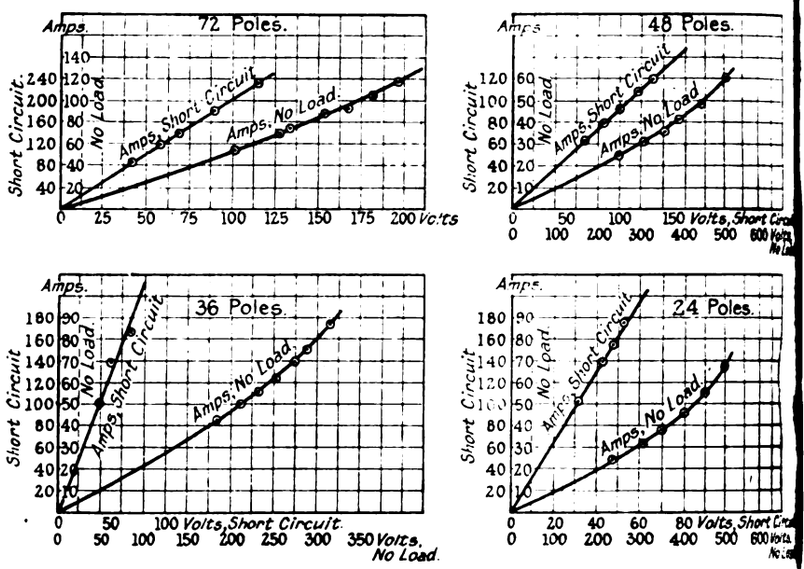

Fig. 9.—No-Load and Short-Circuit Curves.

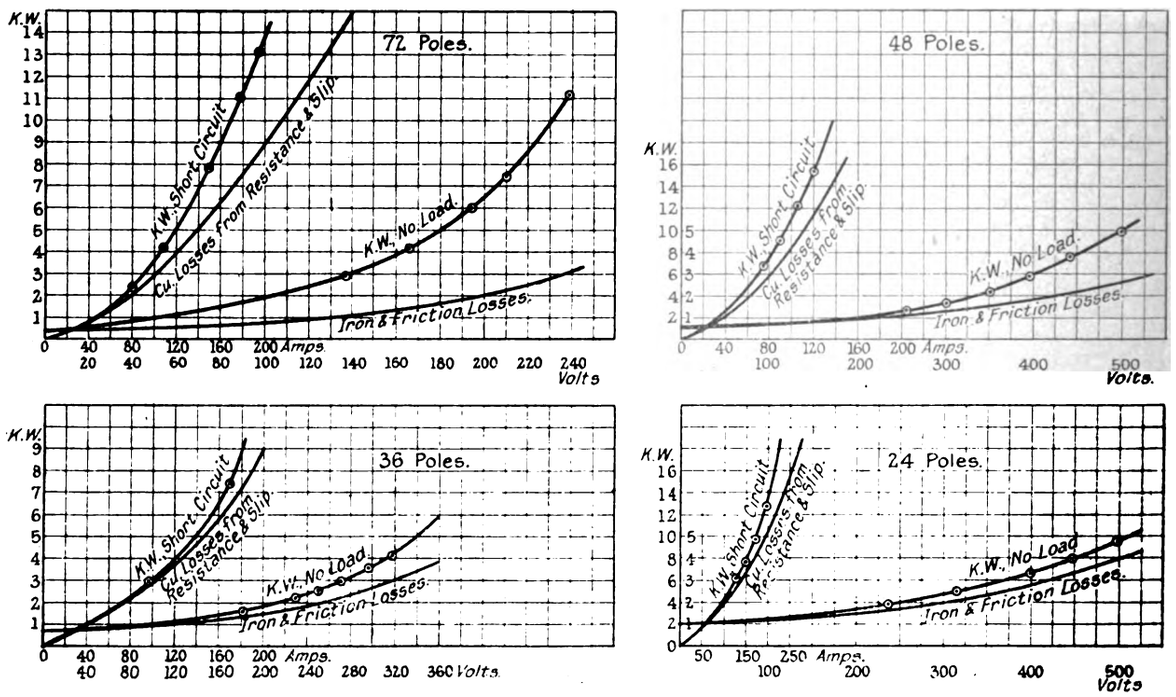

Fig. 10.—Curves of Losses at Different Speeds.

output and dimensions of the machine are taken into consideration

The starting performances of the motors are of special importance. It is interesting to note the small current fluctuations of the supply current when switching the motor over from one speed step to another, and this with a torque equivalent to the normal.

The accompanying table, giving results of test, speaks for itself.

In this table the values for the starting current, normal current and short-circuit current hold good for a line pressure of 3,000 volts It will be seen that the first speed step is not provided with a starting position with reduced voltage, but the motor receives immediately the normal working pressure. This is possible on the first speed step, as the short-circuit current at the normal voltage is not very much larger than the normal load current at the maximum speed.

Speed step.	No. of poles.	Pressure under (volts).	Momentary starting current. Amp.	Normal current, Amp.	Short-circuit current. Amp.
1	72	Normal working conditions (200 volts).	26·5	10	27
2A	48	Starting conditions (270volts)	20·5	—	48
2	48	Normal working conditions (400 volts)	—	12	—
3A	36	Starting conditions (200volts)	29·0	—	66
3	36	Normal working conditions (270 volts)	—	14	—
4A	24	Starting conditions (270volts)	50·0	—	115
4	24	Normal working conditions (400 volts)	—	20	—

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The three other speed steps are each provided with a starting position with reduced voltage. It was not necessary to provide separate contacts for these starting positions on the drums, for, as previously explained, the individual speed steps correspond to three different pressures. Robust and inexpensive bar windings could therefore be adopted.

The working pressure of the motors for the different speed steps is given below :—

With 72 poles	200 volts.
With 36 ,, ...	270 ,,
With 48 and 24 poles	400 ,,

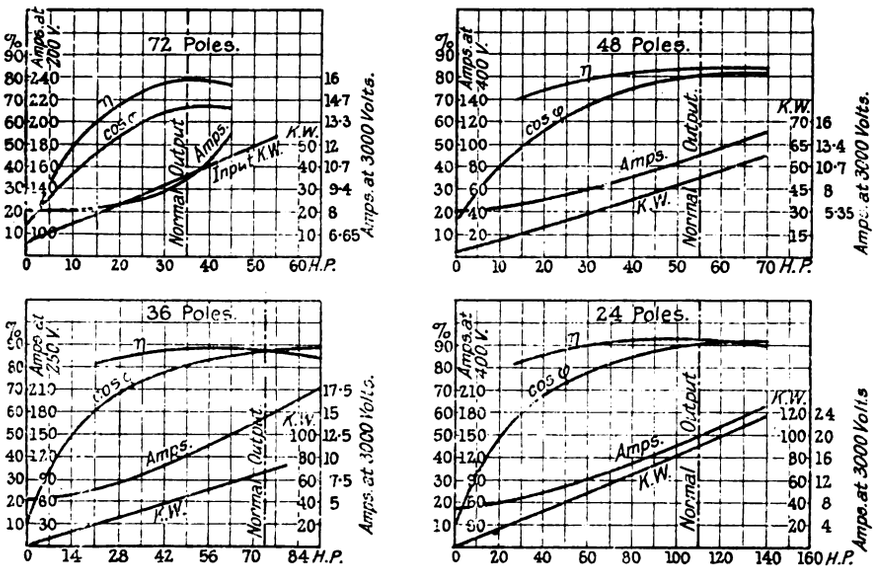

FIG. 11.—PERFORMANCE CURVES OF MOTORS.

By this means it has been made possible to use a tapping of 270 volts as starting speed-step for the 400-volt windings, whilst for the 270-volt windings a tapping of 200 volts is used for starting purposes. According to the table the starting current of 50 amperes on the last speed step is 2½ times the normal. If the motor, when at rest, were started dead on the fourth speed step, and also with the reduced pressure of 270 volts, then the starting current would be 115 amperes, or 5 8 times the normal.

These figures confirm the well-known fact that with an induction motor with squirrel-cage rotor, appreciably more favourable starting conditions are obtainable by gradually raising the speed by means of changing the numbers of poles.

The maximum torques are :—

On the first speed step...	50 p.c.	above normal.
On the second ,, ...	100 p.c.	,, ,,
On the third ,, ...	300 p.c.	,, ,,
On the fourth ,, ...	300 p.c.	,, ,,

The motors can be overloaded :—

On the second speed step ...	By 10 p.c.
On the third ,, ...	By 15 ,,
On the fourth ,, ...	By 20 ,,

without exceeding the specified temperature limits.

Figures for temperature rise are also very favourable, as the following readings show :—

At full load and 38 R.P.M.	max. temp....	50°C.
At ,, 60 R.P.M.	,, ...	42°C.
At ,, 82 R.P.M.	,, ...	36°C.
At ,, 118 R.P.M.	,, ...	25°C.

The weight of one motor with baseplate for the stator, but without bearings and without shaft, is 7·5 tons ; or the complete starting pole change-over device with load-transformer and switch 2 tons.

In addition to the above main ram pump variable-speed induction motors, the Oerlikon Co. supplied also two 10 B.H.P. 750 revs. per min. single-phase slip-ring induction motors for the driving of two compressors used in connection with the ram pumps. These motors are designed for a pressure of 110 volts 25 cycles, and receive their current from Oerlikon-built single-phase oil transformers, each of 16 k.v.a. output capacity, constructed for a pressure ratio of 3,000/110 volts. The complete switchboard has also been designed and constructed by the Oerlikon Works. It consists of two boards, one for each pump room, and it contains all the apparatus for the main motors and the auxiliary compressor motors, &c. The main switches are of the three-pole oil-break type, equipped with two maximum trip coils. Circuit links are provided to enable any section of the board to be removed for inspection and for overhauling. The whole switchboard equipment, as also the rest of the material, is built to comply with the Home Office Rules for Mining.

The general features of the board are seen in Fig. 13 which shows the principal view of the pump room and the motor.

The Oerlikon Works have proved, by the experience of these motors, that a new and large field of utility has been opened for three-phase induction motors. It is now possible to construct three-phase induction motors for the driving of slow-speed ram pumps and similar machinery, with a speed adjustable in the ratio 1 : 3, the motors being of extremely simple design, robust, efficient, with a high power factor, and with a relatively big flywheel effect, so as to secure a high degree of uniformity of speed.

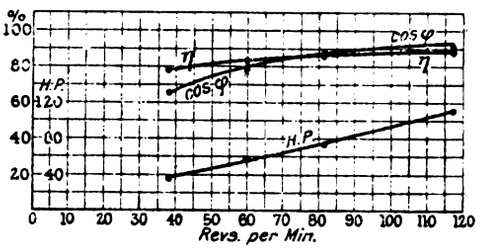

FIG. 12.—EFFICIENCY AND POWER FACTOR CURVES.

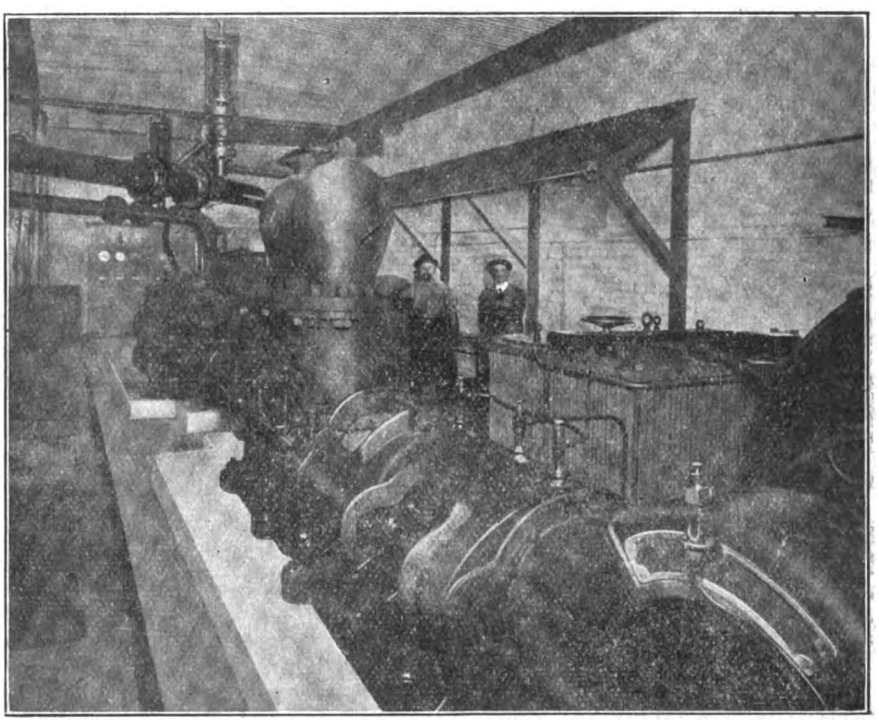

FIG. 13.—VIEW OF PUMP ROOM.

The consulting engineers for this work, Messrs. W. A. Scott & Partners, have expressed themselves as thoroughly satisfied with the working of the plant under severe temperature conditions, and they state that the arrangement of the speeds has proved most useful for regulating the load and obtaining a high load factor.

The Oerlikon Works are represented in this country by Mr. G. Wuthrick, M.I.E.E., of 34 and 35, Norfolk street, Strand, London, W C. 2.

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The Capacity-Potential Curves of an Induction Coil.

By E. TAYLOR JONES, D.Sc.

Summary.—An expression is given for the maximum secondary potential of an induction coil calculated on the theory that two oscillations are set up in each circuit at break. The relation between the primary capacity and the secondary potential, and that between the maximum efficiency of conversion and the coupling, are shown by means of calculated and experimental curves. The present results are compared with those found in previous experiments on the relation between capacity and spark-length. The uses of capacity-potential curves in the determination of the constants of induction coils are discussed, and examples are given of the calculation of optimum capacities. A repetition of Rayleigh's rifle-bullet experiment is described, the result further confirming the present theory.

According to the theory put forward by the writer the maximum potential at the secondary terminals of an induction coil is given (resistances being neglected) by the expression

$$V_{2m}=\frac{L_{21}i_0}{\sqrt{L_2C_2}}U\sin\varphi,$$

where L_{21} is the mutual inductance of the primary and secondary coils, $\sqrt{L_2C_2}$ is the oscillation constant of the secondary, and i_0 is the primary current at break. U is the function $1/\{1+u-2\sqrt{u(1-k^2)}\}^{\frac{1}{2}}$, in which k is the coefficient of coupling and u represents the ratio L_1C_1/L_2C_2. The angle φ is the phase at which the maximum V_{2m} occurs, its value, expressed in terms of the ratio of the two frequencies of oscillation of the circuits being :—

$2\pi/(1+n_2/n_1)$ if n_2/n_1 is between 1 and 5,
$4\pi/(1+n_2/n_1)$,, ,, 5 ,, 9,
$6\pi/(1+n_2/n_1)$,, ,, 9 ,, 13,

and so on.

The matter may be illustrated by means of curves, drawn for various values of k^2, showing how the secondary potential varies with the capacity of the primary condenser. In order to avoid the introduction of values relating only to some particular coil, or to coils of a particular design, it is convenient to take u as abscissa and $U\sin\varphi$ as ordinate. Since L_{21}, L_1, i_0 and L_2C_2 are constant the abscissa is proportional to the primary capacity, and the ordinate is proportional to the principal maximum secondary potential. The value of $U\sin\varphi$ for any values of u and k^2 is calculated as explained above, and the results apply, of course, only when the oscillations are treated as undamped.

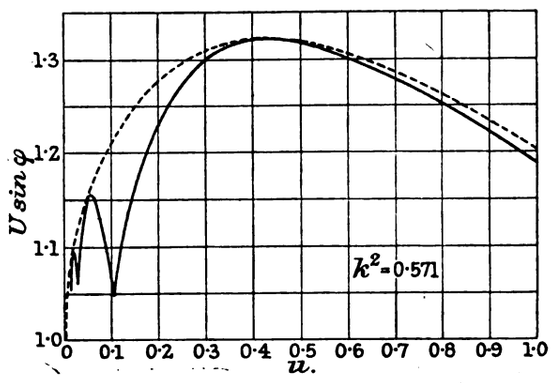

FIG. 1.

Five of these curves are shown in the following diagrams, in each of which the full-line curve represents $U\sin\varphi$, the broken-line curve U. The curves are drawn for the range $u=0$ to $u=1$; their continuations beyond this range are of no importance in the theory of the optimum primary capacity, but they are of interest in connection with that of the optimum *secondary* capacity, which will be discussed in a later section. In each case the U curve passes through the point (0, 1), since the value of U is unity when u is zero. The first diagram (Fig. 1) refers to the case in which k^2 has the value 0·571, the smallest of the values of the coupling giving unit conversion efficiency.

It will be seen that the $U\sin\varphi$ curve consists of a series of arches, all lying within and each touching the U curve. These may be called the 3/1, 7/1 and 11/1 arches, since their points of contact with the U curve occur at these values of the frequency-ratio. In other words, the points of contact of the two curves determine the *coincidences*, for which $\varphi=\pi/2$, and therefore $U\sin\varphi=U$. The maximum value of U occurs at $u=0{\cdot}429$ $(=1-k^2)$, and the 3/1 arch touches the U curve at its highest point. The maximum of U and the greatest maximum of $U\sin\varphi$, each of which has the value 1·323, occur at the same value of u, and this is the condition for maximum efficiency of conversion of primary magnetic into secondary electrostatic energy.

The points of intersection of the arches, *i.e.*, the minimum points in the $U\sin\varphi$ curve, correspond with the values 5, 9

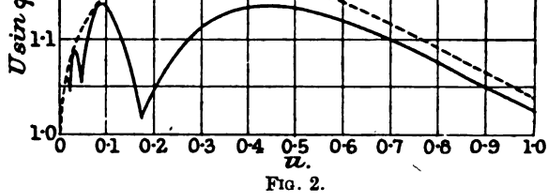

FIG. 2.

13, . . . of the frequency-ratio, the three shown in the diagram occurring at $u=0{\cdot}105$, 0·03 and 0·014. The corresponding values of the angle φ are $\pi/3$ (or $2\pi/3$), $2\pi/5$ (or $3\pi/5$), $3\pi/7$ (or $4\pi/7$). These points of intersection represent adjustments in which there are two equal principal maxima in the (V_2, t) curve ; at the first, the intersection of the 3/1 and 5/1 arches, the first and second maxima are equal ; at the second, the second and third maxima, and so on. The arches may be produced below the points of intersection, but these lower portions of the curves represent *secondary* maxima in the (V_2, t) curve.

If produced to the left, *i.e.*, towards the origin, the $U\sin\varphi$ curve would disclose an infinite series of diminishing arches, touching the U curve at points corresponding approximately with the frequency-ratios 15, 19, 23, . . . and meeting each other at the ratios 17, 21, 25, ... Since these arches all lie within (or below) the U curve it is clear that when $u=0$ (*i.e.* $C_1=0$) the value of $U\sin\varphi$ cannot be greater than unity. According to the present theory, therefore, the greatest maximum value of the secondary potential when $k^2=0{\cdot}571$, which occurs at $u=0{\cdot}429$, is 1·323 times the value attainable when $C_1=0$, even on the supposition that the interruption is perfectly sudden.

The curves for other degrees of coupling show the same general characteristics, but there are important differences in detail. Fig. 2 represents the case $k^2=0{\cdot}71$, which gives very approximately two equal greatest maxima of $U\sin\varphi$. In this case the 3/1 arch has no real point of contact with the U curve, since the greatest value of k^2 which allows the existence of the 3/1 ratio is 0·64. The summits of the 3/1 and 7/1 arches have practically equal ordinates, each being, however, well below the maximum of U. There are thus two " optimum " capacities, given by $u=0{\cdot}44$ and 0·09, but even with these capacities the conversion efficiency is only 0·918. It is clear, therefore, that the coupling $k^2=0{\cdot}71$ is disadvantageous from the point of view of efficiency of conversion.

The 5/1 minimum occurs at $u=0{\cdot}176$, the value of $U\sin\varphi$ being 1·017. In this adjustment the conversion efficiency would be as low as 0·734.

Fig. 3 shows the curves for $k^2=0{\cdot}768$, the coupling found by the writer for a certain coil by a well-known maker. In

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this case the greatest value of $U \sin \varphi$ (1·124) occurs in the 7/1 arch, near its contact with the U-curve. The optimum capacity is given by $u=0{\cdot}11$, the frequency-ratio being 6·801. The 5/1 minimum occurs at $u=0{\cdot}248$, and the 3/1 arch has a maximum of 1·038 at $u=0{\cdot}46$.

Figs. 4 and 5 represent the curves for $k^2=0{\cdot}835$ and $k^2=0{\cdot}9$, which are very approximately the second and third "unit-efficiency" values of the coupling. In each of these cases the U-curve is touched at its highest point by the $U \sin \varphi$ curve; in Fig. 4 by the summit of the 7/1 arch, in Fig. 5 by that of the 11/1 arch. The optimum values of u for these cases are 0·165 and 0·0965,* these being practically equal to the corresponding values of $1-k^2$. In Fig. 5 there is no trace of the 3/1 arch, the smallest value of the frequency-ratio (viz., $\sqrt{\{(1+k)/(1-k)\}}$ at $u=1$) being 6·163, which exceeds the 5/1 limit of this arch.

From these examples it will be seen that while the theoretical capacity-potential curves for different values of k^2 have the same general features, they differ from one another in certain important characteristics, such as the relative heights of the various arches, the ratio of the greatest maximum of $U \sin \varphi$ to the neighbouring minimum on the left side of it, the value of u at which the 5/1 minimum or the 7/1 maximum occurs, and so on. To each value of k^2 corresponds a certain form of capacity-potential curve, so that if the curves could be obtained by experiment, and if the characteristics of the curves are not too greatly modified by the resistances, some idea might be obtained from them as to the degree of coupling of the circuits. The curves given above refer, as already stated, to the case of an ideal induction coil in which the resistances

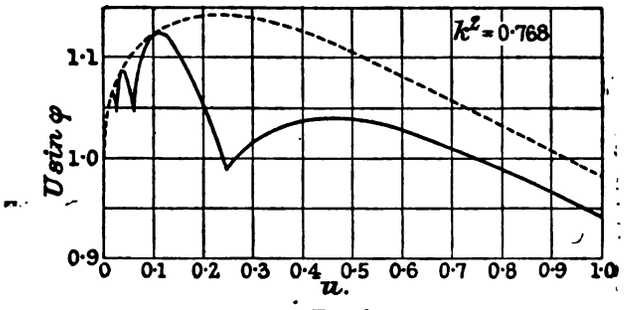

FIG. 3.

are negligible and in which the interruption of the primary current takes place with perfect suddenness. To what extent the form of the curves is modified in the working conditions of an actual coil will be described in the following sections.

EXPERIMENTAL ARRANGEMENTS.

The capacity-potential curves may be determined experimentally by measuring the greatest secondary spark-length for a given primary current with various capacities connected across the interrupter. A better plan, however, is to keep the distance between the spark terminals constant and determine for each value of the capacity the least primary current which will cause the spark to pass. This method is much more convenient than the other since it allows readings to be taken more quickly; and, further, since the secondary potential of an induction-coil is approximately proportional to the primary current just before interruption—so long as the current is not varied over wide limits—and since in this method the secondary potential is constant, the reciprocal of the minimum sparking current may (except in certain cases which will be referred to later) be taken as a measure of the maximum secondary potential developed at the interruption of a given primary current. It is thus unnecessary to know the relation between the spark-length and the sparking potential. This method of the constant secondary potential was therefore adopted in the following determinations, the results of which are represented as curves showing the relation between the primary capacity and the reciprocal of the minimum sparking current.

In order that the experiments should include a considerable number of values of $u(=L_1C_1/L_2C_2)$ between 0 and 1, it is desirable to connect the secondary terminals with a condenser. This increases L_2C_2 and therefore allows the smaller values of u to be attained without the employment of very small primary capacities which might fail to prevent sparking at the interrupter.

In the following experiments on an 18-in. coil the secondary terminals were connected with an oil condenser of about 0·001 mfd. capacity, and with an adjustable spark-gap having curved zinc electrodes 1·5 cm. in diameter. The total primary capacity available was 11 mfd., which could be reduced, by steps of 0·05 mfd., to 0·05 mfd. or to 0·0286 mfd. by connecting some of the condensers in cascade. The interrupter consisted of an amalgamated copper rod dipping into mercury under oil; this was worked by hand.

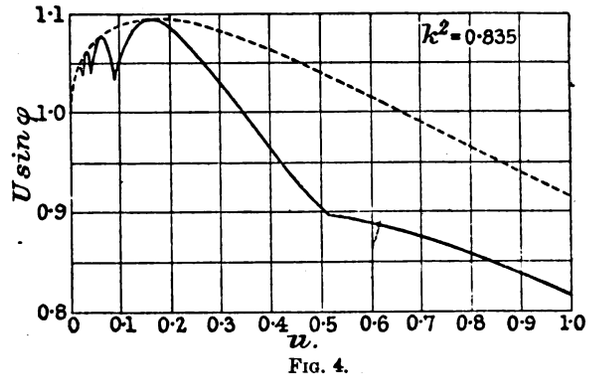

FIG. 4.

In the first experiments the spark-gap was maintained at 2·31 mm., the primary current required to spark across it being in the neighbourhood of 1 ampere. In determining the least sparking current it was found convenient to adjust the current until sparks passed at 50 per cent. of the interruptions. It was, in fact, generally found that the current could be so adjusted that the sparks passed for considerable intervals at alternate interruptions, a slight variation of the current one way or the other causing the sparks to fail altogether or to pass every time. The primary current measured (i_0) was that which caused the sparks to appear at one-half the number of interruptions.

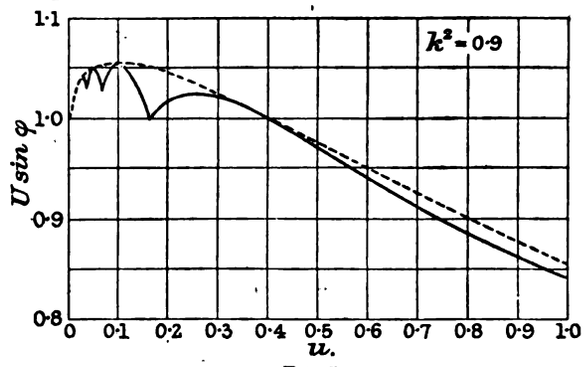

FIG. 5.

THE OPTIMUM CAPACITY AND EFFICIENCY OF CONVERSION AT DIFFERENT DEGREES OF COUPLING.

The first experiment consisted in varying the coupling by drawing out the primary coil, with the core, to various distances along the axis of the secondary, and determining the optimum primary capacity and the minimum sparking current for each position. In this experiment the initial electrokinetic energy is proportional to the square of the primary current, since the primary self-inductance is approximately constant. Also the maximum electrostatic energy in the secondary is constant, since the maximum secondary potential is constant, and the secondary capacity, which consists mainly of the capacity of the oil condenser, is not appreciably varied by changing the position of the primary coil.* Consequently the conversion efficiency is inversely proportional to the square of the primary current i_0.

* The exact value of the third "unit-efficiency" coupling is rather greater than 0·9, being more nearly equal to 0·9025.

* The capacity of the secondary coil was only about one-twentieth of that of the oil condenser.

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The coefficient of coupling of the coils was then determined for each position of the primary. This was done by measuring the period of oscillation of the secondary circuit first when the primary was open, then with the primary closed. The inverse ratio of the squares of these periods is $1-k^2$, if a small correction due to damping is neglected, so that the coefficient of coupling k can be thus determined. In these experiments the oscillations were started by sparking with an auxiliary coil to two electrodes connected with the terminals of the secondary condenser, care being taken that the discharge so passed to the condenser was just insufficient to cause a spark to appear at the 2·31 mm. gap. It may be assumed that the currents flowing in the induction-coil circuits, and therefore also the state of magnetisation of the core, were about the same when k^2 was determined as when the spark observations were made.

The oscillation frequencies were determined with the help of the electrostatic oscillograph, an instrument which will be described in a later section.

The results of these measurements are shown in Table I., in which the first column gives the position of the primary coil expressed as the distance in centimetres from a certain " zero " position chosen arbitrarily but near the symmetrical position as judged by external appearance, the second column gives the optimum primary capacity in microfarads, and the third column the minimum sparking current in amperes, with the barometer reading at the time when the observations were made. The fourth column gives the reciprocal of the square of the minimum sparking current, which is, as stated above, proportional to the conversion efficiency. The fifth column shows the values of k^2, the square of the coefficient of coupling.

Table I.

Distance of primary from zero position.	Optimum primary capacity.	Minimum sparking current, i_0. Bar. = 28·68 in.	$\frac{1}{i_0^2}$	k^2
0	2·20	0·906	1·218	0·815
2·3	2·25	0·905	1·221	0·832
10	2·40	0·906	1·218	0·843
20	1·50	0·911	1·205	0·767
25·5	1·025	0·932	1·151	0·699
	4·90	0·931	1·153	
30	4·50	0·910	1·208	0·654
35	3·50	0·895	1·248	0·580
40	2·75	0·905	1·221	0·504
45	2·10	0·942	1·127	0·378

It will be seen from the third column of Table I. that the primary current required to produce a secondary spark of given length is least when the primary is withdrawn to 35 cm., and greatest when it is at 25·5 cm. from the zero position.* At 25·5 cm. also—or very nearly in this position—there are two " optimum " primary capacities, *i.e.*, two values of the primary capacity which are more effective than all others. It is evidently a position giving equal greatest maxima in the capacity-potential curve. Several additional observations of i_0 were made in the neighbourhood of these two positions. It was found that the least sparking current was practically constant over the range 33 cm. to 37 cm. The middle point of this range, 35 cm. from zero, was taken as the most effective position of the primary coil, but the exact " optimum " position could not be determined with great accuracy. The position showing two optimum capacities—25·5 cm. from zero—was found to be much more sharply defined, a displacement of 4 mm. from this position sufficing to produce a decided inequality in the two greatest maxima of the capacity-potential curve. There was some evidence of a second minimum of sparking current at about 2·3 cm. from zero, though the variation over the range 0 cm. to 10 cm. was very small. The least sparking current in the 2·3 cm. position was, however, decidedly greater than that at 35 cm.

The results given in the fourth and fifth columns of Table I. are shown in the curve of Fig. 6, in which the abscissa represents k^2, the ordinate $1/i_0^2$. The ordinate is, therefore, proportional to the conversion efficiency, and the curve shows how the conversion efficiency varies with the coupling when the primary capacity is adjusted to its optimum value. The conversion efficiency is greatest when $k^2=0{\cdot}58$ (primary 35 cm. from zero), and least when $k^2=0{\cdot}699$, *i.e.*, in the position of equal greatest maxima (primary 25·5 cm. from zero). There is also another, though a smaller and less well-marked maximum at $k^2=0{\cdot}832$.

For comparison with these experimental results the theoretical value of the maximum conversion efficiency for various values of k^2 is shown in the curve of Fig. 7. In this curve the ordinate represents $k^2U^2\sin^2\varphi$, which is equal to the conversion efficiency in the ideal case of negligible damping.

The experimental value of the conversion efficiency is of course much smaller than that of the ideal coil,* but the curves of Figs. 6 and 7 show that the *variation* of efficiency over the range of the present experiments follows substantially the same course in the two cases. Though the positions of

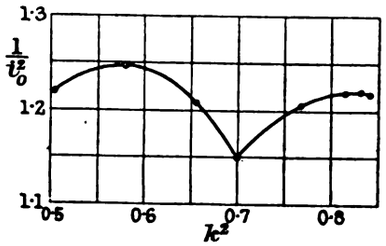

FIG. 6.

the primary coil corresponding to the maxima of conversion efficiency cannot be determined with great accuracy by experiment it is clear that the values of k^2 at the maxima are nearly the same in the two curves. At the minimum also there is no great difference in the values of k^2, though the value is distinctly less in Fig. 6 than in Fig. 7 (0·699 as against 0·71). In the ratio of the maximum to the minimum efficiency the two curves agree well, the values being 1·083 (Fig. 6) and 1·089 (Fig. 7).

The most marked difference between the two curves is that in the ideal case (Fig. 7), the conversion efficiency at $k^2=0{\cdot}835$ is equal to that at $k^2=0{\cdot}571$, whereas in the experiment it is decidedly less. In this respect the advantage is with the looser coupling, the reduction of efficiency due to the damping of the oscillations being apparently greater when the primary is placed symmetrically within the secondary than when it is withdrawn to a distance from the symmetrical position. This

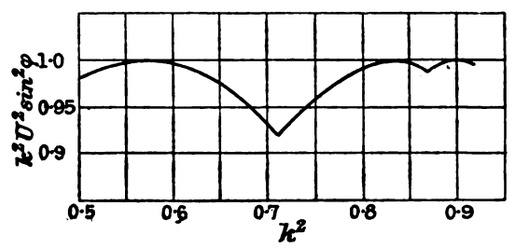

FIG. 7.

effect probably arises from a number of causes, which can only be discussed after an examination of the periods and damping factors of the component oscillations of the system in its various configurations.

The curves of Figs. 6 and 7, representing the conversion efficiency at different degrees of coupling, apply of course only to " optimum " adjustments, *i.e.*, those in which the primary capacity is the optimum for each value of k^2. Much smaller values of the conversion efficiency may be found, both theoretically and experimentally, if the primary capacity differs from the optimum value.

(To be continued.)

* The length of the primary *coil* was probably about 90 cm., that of the secondary, measured between the terminals, 51 cm.

* A rough estimate of the experimental conversion efficiency may be arrived at if we assume 9,000 volts as the sparking potential for the 2·31 mm. gap. Taking C_2 as 0·00105 mfd., L_1 as 0·162 henry, and i_0 as 0·895 ampere, the least value for the most efficient position of the primary (35 cm. from zero), we find for the conversion efficiency the value 0·65

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The Application of Electric Welding to Ship Construction and Repair.

The extent to which electric welding is applied to ship construction in this country is fully described in a report prepared by Mr. H. M. Hobart, under date of December 10, 1917, and such additional applications as have since been developed, are included in a report submitted to the U.S. Emergency Fleet Corporation on April 20, 1918, by Capt. James Caldwell, of the Admiralty. Also, a résumé of current British welding practice is to be found in a Paper entitled "Notes on Welding Systems," read before the Institute of Engineers and Shipbuilders of Scotland on January 22, 1918.

The systems of electric welding which are now being employed to a limited extent, with every prospect of considerable further application in the fabrication of ships are :—

1. Resistance welding, comprising (*a*) butt, (*b*) spot, and (*c*) line methods.

2. Arc welding employing either bare or flux covered metal electrodes.

These several methods of welding are briefly referred to hereunder :

Butt Welding.—This method is applicable to the welding of rods, bars, &c., transverse to the length of the pieces. It is suitable for the joining of bars which constitute the longitudinal members of a concrete ship, but the service applications in a shipyard are limited.

Spot Welding.—This method has been largely used to unite sheets or thin plate where a continuous weld or joint is not required. Work so welded is united by a line of small welds or spots, and may be compared to flush riveted work. Further developments of this method, which comprise the riveting of much thicker plates as required for the hull of a ship have been applied in America recently.

It would appear that spot welding is eminently suited to replace riveting and caulking to a very large extent in the future.

Line Welding.—This method is somewhat similar to spot welding; with a continuous line jointure which is obtained by passing the steel between roller electrodes.

Arc Welding.—It is of interest to note that, whereas arc welding with bare metal electrodes has until quite recently been almost exclusively used in America, the flux-covered metal electrode has had most extensive use in Great Britain.

(*a*) With the bare metal electrode system of arc welding an arc is struck between a rod of metal and the work. The heat then generated at this point melts a small pool on the parts to be welded, and additional metal is deposited from the electrode in a molten state, thereby forming a firm union between the new and the old metal, if certain precautions are adopted to ensure even application and the prevention of porous metal due to excess of current. To prevent oxidation the metal rod is sometimes coated with a sleeve of insulating material which decomposes with the heat and surrounds the molten metal with an inert gas.

(*b*) The flux-covered electrode system of arc welding most commonly used in this country provides for the metal electrodes being encased in a flux composition which becomes molten at the arc, so that the added metal is at no time exposed to oxidation. When properly applied, this flux forms a silicate slag of suitable viscosity which floats on the metal surface until removed when cold by tapping with a small hammer and using a wire hand brush. Arc welding, whether carried out with bare or flux-covered electrodes, has a wide application to ship construction and repair.

Relative Suitability of Each System of Electric Welding to Ship Work.

For carrying out spot welding alternating current is necessary. The supply voltage is immaterial, as a transformer forms part of each machine. With spot welding it was formerly understood that the metal adjoining the weld became very brittle when subjected to vibratory stresses, the line of jointure between plates containing a layer of oxide, which considerably weakened the weld, and difficulty was experienced in obtaining sufficient adhesion. However, with recently developed machines provided with gear to give sufficient pressure to close the plates and by the use of increased current, the latter difficulties have been overcome, whereas crystallisation does not occur to any appreciable extent with thick plate work.

A spot welding machine suitable for thick plates is a heavy tool weighing several tons, and is therefore most efficiently employed as a stationary plant It is therefore recommended that in the first instance spot welders be confined to the fabrication of internal ship parts. Spot welding work may be made more or less watertight by reducing the spacing of the spots even to the extent of making adjacent welds overlap. When spot-welding bulkhead plates and framing it is advisable for this reason to weld alternate spots in one operation, then transversing the work again to complete. Unfortunately, at the present time spot welding cannot be applied extensively in this country owing to the impossibility of obtaining the necessary machines and suitable electrical apparatus.

Arc Welding.—No sweeping decision can be made as to the relative merits of arc welding by means of bare metal and flux-covered metal rod electrodes. There are certain conditions that seem to preclude universal adoption of any one of these methods. In what follows a brief reference is made to circumstances that effect the choice.

Electricity Supply.—Direct Current.—Both bare and flux-covered metal electrodes are effective with direct current supply, provided the voltage and current at the arc is kept within the desired range. To obtain reduction in the line voltage a motor generator or rotary balancer must be employed.

Alternating Current.—Bare metal electrodes are not now suitable for use with alternating current, although there are certain developments afoot, such as the "Holstag" transformer, that would seem to make it possible to use bare electrodes from alternating-current supply. The results obtained with flux-covered electrodes are, however, quite satisfactory, and particularly good penetration is secured with certain types of electrodes. With the latter the supply may be taken direct to the arc through a "Holstag" transformer, or 110 volts may be obtained with a static transformer, the current regulation at the arc being maintained by a regulating resistance in series.

Relative Conditions.

As regards the respective merits of bare and flux-covered metal electrodes for arc welding, apart from electric supply conditions, these are considered below.

Tensile Strength.—There is no reason why a correct weld by either method should not be made to approach the strength of the original plate.

Ductility.—By virtue of the annealing properties of the slag and the absence of oxidation in added metal, the flux covered electrode is superior.

Quality of Metal.—The flux may be made the vehicle of constituents which will give desired characteristics to the added metal. Porosity or piping will also be reduced by the use of flux-covered electrodes.

Cost of Power and Equipment.—The bare metal electrode is the cheaper if connected direct to the general electric supply system. It is, however, more usual practice in America to provide an auxiliary machine with substitutional resistance or other regulating features to give the correct current at the arc, whereas with flux-covered electrodes no such refinement is necessary.

The power required and the cost of the equipment vary with the number of welders in use, the character of the work and the method employed. The larger the number of welders in simultaneous use the more closely the total power needed will approximate the sum of the averages, so that installations providing for many welders are relatively less costly in regard to power plant than small installations, with only few welders.

Welding versus Riveting.

By eliminating the routine of marking out, punching, rehammering and caulking, to say nothing of the planed butt straps and insertions at watertight joints, there is ample margin to cover the cost of similar construction by means of electric welding until the process is standardised, when costs would be further reduced.

The most important point in favour of extending the use of electric welding is the reduction in amount of labour as compared with the present charge under this head, which is :—

1. 25 per cent. for barge, tank and deck structure.
2. 50 per cent. for smith work.
3. 75 per cent. for selected details.

Furthermore, superfluous material in the form of overlapping riveted plates and of angles and brackets would be considerably reduced.

Wood-Lined Iron Tubes.—We observe that the shortage of essential metals in Germany has led to the introduction of the ingenious device of using iron tubes with a wood lining, instead of tubing of copper, brass, lead, vulcanite, &c. The wooden lining is said to act as an adequate protection against corrosion. Reference is also made to its value as an insulating medium in protecting against extreme heat or cold. Junctions are made by means of V-shaped projections which fit into corresponding notches.

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What are the Lessons of the British Scientific Products Exhibition?

During the last two or three weeks we have referred at some length to the British Scientific Products Exhibition, which is now open to the public at King's College. The avowed object of the Exhibition is educational—to stimulate public interest and confidence in the capacity of British science, combined with industrial enterprise—and with this object in view frequent lectures have been given. To be more explicit, it may be said that the lessons the promoters have in view are, firstly, that the Government of this country were mistaken in allowing us to become dependent upon other countries for essential products; secondly, the tacit acceptance of the idea that Germany was in many ways superior to this country is unjustified; and, thirdly, the idea that our scientific men (using this term in its widest sense) were not equal to those of Germany is unfounded. Now, in the short space of four years, all this has been changed; we are no longer dependent upon other countries for essential products, and our scientific men have come into their own.

This is the aspect of things that is most readily apparent, which is evident to the man in the street; but is this really all we have to learn? What will happen when the days of "piping peace" return, when the rigorous law of supply and demand holds sway once more, when the question of price once again becomes predominant, and when possibly there is no bias in our favour in the shape of protective legislation? It is only then that we shall know whether the experience of these troublous times has taught us its lessons, or whether old ideas still remain. The lessons which are by no means so apparent, but which nevertheless are to be seen by those who look beneath the surface are, firstly, that no industry can be strong unless making good profits; secondly, that industrial research is essential if proper progress is to be made in competition with other countries; and, thirdly, that co-operation and mutual support among British firms is far more beneficial than cut-throat competition. The first of these lessons is, of course, contrary to Socialistic ideas that dividends are a form of robbery, and it is even contrary to the views held by some comparatively responsible people in this country. Any such idea would, of course, be scouted by those who wish to put all means of production into the hands of the Government, for to them a substantial dividend is not an index of prosperity.

The placing of industrial research in its proper position is somewhat equivalent to giving the scientist a fair chance, but it also involves the education of the financial element in our industries, and this is what is really necessary. It is quite useless having scientific men, whether pure scientists or technologists or engineers, capable of the best work, unless those who direct the financial destinies of our manufacturing firms do not see the importance of industrial investigation. The idea that every investigation in the works must bring back its financial return within six months must disappear.

Perhaps the desirability of co-operation and mutual support among British firms is the lesson which it is most difficult to inculcate into the minds of those who are responsible for trade policy. Before the war we fear there were many who preferred to see a contract go to a foreign firm than to one of their own countrymen. Contracts accordingly went to foreign firms and British industry was the poorer. This seems to be one of the most difficult lessons to learn, for the simple reason that as a nation we prefer individualism to co-operation; but we hope nevertheless that this point will have been appreciated by the time the present world struggle comes to an end. To those who think otherwise we would commend a study of the ramifications of the A.E.G., and ask them to consider how individual effort can expect to compete against wholesale organisation.

Reviews.

Central Stations. By TERRELL CROFT. (London: Hill Publishing Co., Ltd.) Pp. x.+332. 10s. 6d. net.

The title of this book hardly gives a correct impression of its contents. We expect to find descriptions of the machinery, boilers, &c., which are actually in the station. Very little, however, appears on these subjects, most of the book being devoted to the distribution system.

The first section gives definitions of a large number of terms occurring in connection with the system, and the next five sections deal with the different factors necessary in calculating the various problems connected with the supply, which are defined in the Standardisation Rules of the American I.E.E. No fewer than six of these factors are explained very fully. The great feature of these sections is that after an explanation of the particular factor in words, one or more numerical examples are worked out in illustration. This greatly enhances the value of the explanations and makes them very simple.

The next three sections treat the general principles of circuit design, continuous current circuits and alternating-current circuits. Calculations of the voltage drop in transmission lines, the size of cable, &c., are given, and numerous examples again appear. Areas of wire are shown in circular mils, but it is simple to convert them to a measure more familiar in this country. The tables of reactance are worked out for 60 cycles, but it is, of course, not difficult to rewrite these for 25 or 50 cycles.

Section 10 deals with the transmission and distribution of electrical energy more from a descriptive standpoint. After discussing the choice of voltage, &c., sub-stations and the arrangement of the feeders are described.

Sections 11 and 12 describe very fully the types of lightning-protection apparatus and automatic voltage-regulators usually met with in practice.

Section 13 deals with switchboards and switchgear, but as it only occupies 30 pages, the information is not very full. Some of the diagrams could be made considerably larger with advantage. They are very difficult to follow in their present form.

The last five sections are devoted to prime-movers and boilers, and also include three pages on transformers. The whole of these sections occupy only 66 pages, so that the information is rather scrappy, especially as steam, gas, oil and water are all considered.

The first 12 sections, however, make the book of great value to all station-engineers. A good many American authors choose for their examples the biggest systems they can think of, so that engineers in this country are apt to put them on one side as not applying to the comparatively small plants in their charge; but in this book the examples are all of quite moderate plants and voltages, such as are usually met with in this country.

R. G. J.

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A Short Course in Elementary Mathematics and their Application to Wireless Telegraphy. By S. J. WILLIS. (London: Wireless Press, Ltd.) Pp. 182. 3s. 6d. net.

The title of this book is somewhat unfortunate. The contents are a mixture of elementary algebra, geometry and trigonometry in no particularly defined order, and the application to wireless telegraphy is not at all obvious. Certainly there are a few examples of an electrical nature, but not a great many, and they apply equally to any branch of electrical engineering. The principles of wireless telegraphy require for their complete understanding a knowledge of mathematics much more advanced than anything the author treats of here, and the student will not have a very great equipment for this purpose from his use of the book.

As far as the text itself is concerned, the book is very similar to many others at present on the market under the title of practical mathematics, and there does not seem much need for the introduction of another one of the same type. On the whole, the work is well done in an elementary way. The order is not all that could be desired. Geometry precedes algebra, whereas, we think, the opposite is preferable, it often being very convenient to make use of algebraic argument in geometrical problems.

The idea of a differential coefficient is introduced in the last chapter, though the method of its introduction is not a good one. There is no such thing as a "limit" mentioned, and to speak of the "ratio" dy/dx is very misleading. The average student would think of it as the ratio of two finite quantities dy and dx, particularly when he sees further a statement of this kind :—

$$\delta y/\delta x = 30x^4 = dy/dx.$$

If we are to have the calculus introduced at all, it is advisable that it should be done as soundly as possible within reasonable limits of difficulty. Apart from this one matter of the treatment of differentiation, the rest of the book is quite satisfactory, and should prove of use to students who are intending to become wireless operators, and for whom, we imagine, it is intended. H. C. K.

National Physical Laboratory.

The annual report of the Executive Committee of the National Physical Laboratory was submitted to the General Board at the annual meeting on June 25. The following are amongst the features of physical and electrical interest :—

On Nov. 23, 1917, His Majesty the King visited the Laboratory to inspect the numerous branches of work undertaken for the Ministry of Munitions, the Admiralty, the Air Ministry and other Government Departments. The King evinced the keenest interest in the various investigations and the testing work, and expressed high appreciation of the valuable part played by the Laboratory in connection with the war, as well as of its very successful development since the date of his previous visit in 1902.

An account is then given of the development of the Laboratory between the years 1902 and 1918.

The Committee record the loss by death during the past year of three prominent members of the General Board and of the Executive Committee—Sir John Wolfe Barry, Mr. Duddell and Mr. Tyrer.

The Committee express their appreciation of the services rendered to themselves and to the Laboratory by Sir Alfred Kempe, the Treasurer of the Royal Society, who has acted as Treasurer to the Laboratory since its inception and has been unsparing in his attention to its interests.

The recommendations made at the last meeting of the General Board, in June 1917, with regard to the future control and organisation of the Laboratory and its relations with the Committee of the Privy Council for Scientific and Industrial Research were accepted by the Research Committee, which has undertaken the responsibility for the finance of the Laboratory, leaving the control of its scientific work and researches, as heretofore, in the hands of the Royal Society. That control will be exercised, as in the past, through the General Board and the Executive Committee, and the representatives on the General Board of the great Technical Institutions will enable the Laboratory to maintain with them that close relationship which has proved so valuable and so essential to the success of the work. The terms of the modified scheme of organisation are printed as an Appendix. The new scheme requires the presentation to the Research Department in December of each year of an Annual Report and programme of future work. It will thus be necessary in future to hold a meeting of the General Board in December.

The Committee feel that it is of the highest importance that the interest of individuals and firms in the work of the Laboratory towards the advancement of science and technology should be fully maintained.

A plan accompanying the Report shows additions to the site of the Laboratory as well as proposed new buildings. Buildings under construction on the new ground are the new Aeronautics Building and the Gauge workshops. The third of the additional buildings at present under construction will provide accommodation for the testing of glass volumetric apparatus. Formerly such apparatus was largely procured from Germany. Its manufacture has now been taken up energetically in this country, and the Committee of the Research Department dealing with the matter is anxious that the standardisation of such glassware in large quantities should be undertaken by the Laboratory without delay. Space will also be available in this building for an optical workshop. This is needed in order that small mechanical alterations of telescopes, binoculars and other optical instruments may be made at the Laboratory to facilitate the rapid supply of these instruments, and save delay from the rejection of instruments owing to slight mechanical defects.

The foundry in the Metallurgical Department has been doubled in size to provide space for the increased work on light alloys, as well as for the optical glass research. It is hoped that the addition of a third storey to the Metallurgy Building will be proceeded with at an early date. An extension of the Engineering shops is required, and additional accommodation is necessary in the Heat Department and Tank Building. It is hoped that these matters may receive attention during the present year.

The Committee has recently been approached by the Board of Trade in connection with the work of the Electrical Standards Laboratory of the Board. The maintenance of dual systems of standards is uneconomical, and the new position of the Laboratory in relation to the Research Department renders it easier for the Laboratory to be recognised for this work by the Board of Trade. The issue of fresh Orders in Council relating to the place of custody of the standards and other matters is alone necessary. The officer in charge of the Board's Laboratory has recently retired, and in view of the proposed change the vacancy has not been filled. In cases in which the formal approval of the Board of Trade is required for action, the Director will report to the Board and the officers of the Board will act on this report.

A scheme of testing clinical thermometers has been arranged with the War Office, under which each individual thermometer is tested, rejected instruments being destroyed. The average number of rejections is now less than one-half per cent. It is understood that it will shortly be made compulsory that every clinical thermometer sold shall have passed the Laboratory test.

A number of researches are in progress for the Research Department. These include the optical glass research, investigations in the engineering department relative to the transmission of heat from hot surfaces to fluids in motion over them, and a research on oiliness for the Lubrication Committee. Experiments on the silvering of mirrors have been completed. A research on the properties of various building materials, in which the Laboratory would co-operate with the Local Government Board, is projected. For the Engineering Standards Committee experiments are being made on methods of notched bar impact testing, on the efficiency of electric heaters and hot plates, and on the heating of the sockets of Goliath lamp holders, with various investigations relating to screw threads. For the Institution of Mechanical Engineers, alloys research work is proceeding, together with a research on hardness. For the Institution of Electrical Engineers investigations are in progress into the heating of buried cables and the corrosion of lead covered conductors.

Considerable developments have occurred in the work undertaken for the Advisory Committee for Aeronautics, and the Committee has appointed three Sub-Committees which sit regularly, and other Sub-Committees have been constituted from time to time to deal with special matters.

The matter of the magnetic disturbances at the Laboratory which have occurred since the electrification of the London & South Western Railway was referred to arbitration, and the award of the Arbitrator, given in December last, is to the effect that the disturbances exceed in magnitude the limits laid down in the Act under which the electrification was carried out. The further steps that will be necessary to give effect to this award are receiving attention.

The Committee note with pleasure the awards of the O.B.E. to Mr. G. S. Baker, Dr. J. A. Harker, Mr. C. C. Paterson and Mr. F. E. Smith, and the M.B.E. to Mr. S. W. Attwell, Mr. B. P. Dudding and Mr. R. Wolfenden, all memebers of the staff, and they also cordially congratulate Mr. F. E. Smith on his election to the Fellowship of the Royal Society. The important work he has done in the redetermination of the fundamental electrical units is well known, and the high accuracy attained in this work was rendered possible only by a combination of wide knowledge of physics with exceptional experimental ability. Mr. F. E. Smith and Mr. Sears have been promoted to the rank of Superintendent and Mr. Selby has been nominated Secretary to the Laboratory, with equivalent rank. Until the end of the war Mr. Campbell will remain in charge of the Electrical Measurements Division, while Mr. Paterson retains full control of the Electrotechnics Building.

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The number of members of the staff now on military service is 49, of whom 12 hold commissions.

The Committee's Report then refers to the reports made to the Director by the Heads of Departments, of which abstracts will be given later, and statistics showing the numbers of tests made in the last three years are set out in tabular form.

Dealing with the Accounts, it is stated that the expenditure of the Laboratory includes salary of Director £1,500, scientific and technical staff £63,300, secretarial and clerical staff £7,700, equipment £3,350, materials, stores and miscellaneous £11,400, additional staff and expenses £2,500. Services rendered for other Government Departments are estimated as follows—Admiralty, £19,500; Air Ministry, £28,350; Ministry of Munitions, £10,000. Services to a large amount are rendered by the Office of Works, the Stationery Office, the Post Office, &c., and the cost of these appears in the estimates of the respective Departments, while the expenditure on the gauge work—a very considerable sum—will fall on the Vote of Credit. On the other side the fees received from private sources and certain payments from other Departments are estimated to produce £11,250.

The income for the year was £103,978. 18s. 5d., while that for 1916-17 was £70,896. 14s. 3d. By far the greater part of this increase is due to the work for the Ministry of Munitions—mainly the gauge testing. The receipts under this head have risen from £19,783. 14s. 9d. to £39,609. 13s. 10d. The ordinary test fees have increased from £23,657. 9s. 2d. to £27,381. 9s. 6d., while the grant in aid of Aeronautics Research including a balance carried over from 1916-17, has been £18,937. 6s. 10d., as against £14,068. 18s. 11d. Expenditure has grown from £67,094. 10s. 11d. to £100,784. 11s. 9d., and the credit balance is £3,194. 6s. 8d., compared with £3,802. 3s. 4d. last year. The staff has risen from 420 to 532, while the salaries have increased from £50,409. 9s. 2d. to £78,282. 1s. 8d.

The following subscriptions and donations have been received:—Institution of Mechanical Engineers (for alloys research), £200: Institution of Electrical Engineers (buried cables research), £250: British Aluminium Co., £500.

Lady Rücker has presented volumes from the library of the late Sir Arthur Rücker, F.R.S.

Grants for special researches made by the department of scientific and industrial research, either direct, or through the institutions named: optical glass research £1,250, transmission of heat from surfaces to fluids flowing over them £158. 6s. 3d., alloys research (for foundry extension and equipment) £604. 15s. 10d., lubrication research £115.

Through the Institution of Mechanical Engineers: alloys research £400, hardness research £66. 5s. 1d.

Through the Engineering Standards Committee: methods of notched bar impact testing £215. 19s. 1d.

(*To be continued.*)

British Scientific Products Exhibition.

(*Continued from page* 361.)

Electromagnetic Ore Separator.

For a number of years the manufacture of electromagnetic separators for feebly magnetic ores has been practically the monopoly of two German firms. The Rapid Magnetting Machine Co., of Birmingham, has now developed a separator which possesses features of considerable interest. Briefly, it consists of a travelling band which passes over two electromagnets, marked *N*, *S* in Fig. 5. As shown by the diagram, there are two horizontal revolving iron discs of larger diameter than the width of the belt, which are placed above the belt and over the electromagnets in the position shown. These become magnetised to an extent depending on their position and according to the distance above the belt. In the arrangement as shown in the diagram, the disc *AB* will be less highly magnetised than the disc *CD*. Consequently, only the more highly magnetic particles will be attracted by *AB*, and will be carried beyond the width of the belt; here, the overhanging part of the disc being no longer magnetised, it will cease to attract the particles, which therefore drop off. The disc *CD* will be more highly magnetised, and will therefore deal with the more feebly magnetic particles that still remain. The particles will be attracted at *A* and *B* and at *C* and *D*, so that four separations are thus obtained by two discs. It is, of course, possible to use more than one pair of electromagnets and more than one pair of discs, so as to obtain further separations. A view of a complete 3-disc machine is seen in Fig. 6.

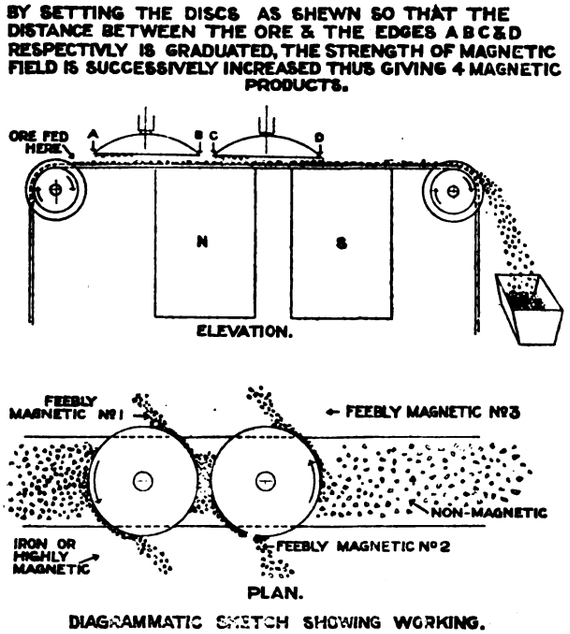
BY SETTING THE DISCS AS SHEWN SO THAT THE DISTANCE BETWEEN THE ORE & THE EDGES A B C & D RESPECTIVLY IS GRADUATED, THE STRENGTH OF MAGNETIC FIELD IS SUCCESSIVELY INCREASED THUS GIVING 4 MAGNETIC PRODUCTS.
ORE FED HERE
A
B
C
D
N
S
ELEVATION.
FEEBLY MAGNETIC Nº1
← FEEBLY MAGNETIC Nº3
NON-MAGNETIC
IRON OR HIGHLY MAGNETIC
FEEBLY MAGNETIC Nº2
PLAN.
DIAGRAMMATIC SKETCH SHOWING WORKING.

Fig. 5.—Diagram of Electromagnetic Ore Separator.

Automatic Controller for Electric Furnaces.

Watford Electric & Mfg. Co. have an exhibit which illustrates certain recent developments in the manufacture and use of automatic electric motor control gear. This class of labour saving appliance has naturally been in considerable demand during a period which has introduced in large numbers semi-skilled and unskilled employees who are required to operate control gear for electric motors. An ingenious type of automatic motor starter for direct-current supply forms part of the exhibit. These starters have one solenoid only, which when energised by a push button, float switch, pedal switch or pressure gauge closes a single pole circuit-breaker. This makes and breaks the motor circuit, and is provided with a magnetic blow-out and carbon break, and in turn operates a rheostat bar, which cuts out of the armature circuit the starting resistance in a large number of steps. The latter operation is retarded by an electrical device which ensures that the starting period is extended or shortened as the load on each occasion of starting is heavier or lighter. Further, with this construction, the de-energising of the operating coil ensures the return of the starter to the "all resistance" position, which is more difficult to secure when the rheostat is of the face plate contact type, in which a friction contact is necessary.

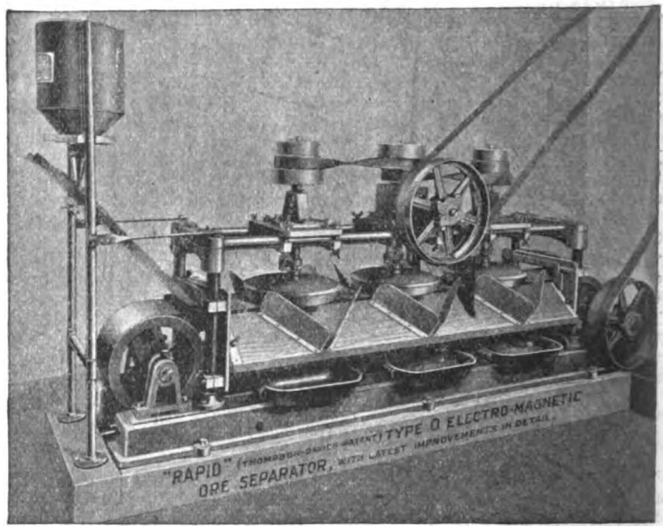

Fig. 6.—View of a 3-Disc Electromagnetic Ore Separator.

The main exhibit, however, relates to automatic control gear connected with the regulation of electric arc furnaces. This Company has supplied all the equipments on a large number of electric furnaces

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installed since the outbreak of war, the regulator being of the "Thury" type as exhibited.

Recently, however, an entirely new construction of regulator has been patented by the Company and its engineers, which is illustrated by a panel fully equipped for the control and regulation of one electrode of a furnace. The equipment provides for—

(1) Hand or automatic current control for the electrode.

(2) Superimposed control to prevent excessive overload cutting off the supply, and to prevent dipping of electrodes in the charge.

(3) Automatic adjustment of load from full load to one-fifth load by current regulation.

(4) Device to prevent excess pressure on and breaking of expensive electrodes.

The construction of the equipment to fulfil the above conditions shows considerable attention to detail which has resulted in the production of a very strong but sensitive regulating device and substantial motor control gear, such as is necessary for operating under steel works conditions.

There are also exhibited interesting photographs of electric furnaces, one illustrating a Héroult furnace as installed by Messrs. Campbell, Gifford & Waite, one an Electro-Metals furnace as supplied by Messrs. Electro-Metals (Ltd.), and a Greaves-Etchells furnace, as supplied by Messrs. T. W. Watson & Co. (Sheffield), Ltd., all of which use either the "Thury" or the "Watford Regulator" as described above.

ELECTRICAL INSTRUMENTS

Messrs. EVERETT, EDGCUMBE & CO. show a number of instruments, among which may be mentioned small size ammeters and voltmeters, which they term their "dwarf" pattern, since the diameter is about 2½ in. Instruments of this size used in this country have hitherto been largely, if not entirely, of foreign manufacture and mostly of the moving iron type; these were unreliable, and had an inaccuracy of anything between 10 per cent. and 50 per cent. Messrs. Everett, Edgcumbe have come to the conclusion that the moving iron type must be unsatisfactory, and they have, therefore, developed these small size instruments as moving-coil and hot-wire instruments, provided with front or back terminals, as desired. A new instrument of interest by the same makers is a frequency meter of the deflectional type. Resonance or vibrating reed type instruments are also made, and are very useful for laboratory work; but for switchboard use the deflectional type has some advantages. Such instruments, of a crude form, were made some years ago, but a fresh demand has led to a further study of the problem, and the present instrument is the result. Among its advantages may be mentioned independence of variation in voltage, which may vary to the extent of 40 per cent. on either side of the normal. Also the indications can be easily read at a distance, the scale being particularly open around the working point. These instruments are supplied for use both on the usual low frequencies and also for high frequencies, such as are employed in wireless telegraphy. A rotary synchroniser is shown of smaller size than used hitherto; it indicates how much the machine is out of step, as well as the exact moment of synchronism. This firm is also making a feature of reverse current relays as distinct from reverse power relays. It is pointed out that relays dependent on power often fail to act because when a reversal takes place there is always a large drop in power owing to the fall in pressure. At present there is a tendency to simplify matters and to use a simple relay actuated by current instead of power. It may interest our readers to know that Messrs. Everett, Edgcumbe have always manufactured their own springs, although practically every other maker of electrical instruments depended upon purchased springs, which were largely, if not wholly, of foreign manufacture before the war. It has been necessary to enlarge the department dealing with this part of the manufacture. These springs are of non-ferrous metals, and can be readily supplied of any strength and of any electrical resistance. Reference may also be made to the photometers by these makers, which are well known, the Trotter photometer being used largely by those interested in street illumination. Another illumination photometer, called the Luxometer, is useful for contractors who wish to obtain a definite illumination in rooms or halls for which they may have secured a lighting contract.

Messrs. EVERSHED & VIGNOLES show examples of their well-known testing and other instruments, among which may be mentioned the Dionic water tester. This has been found particularly useful in determining the contamination of water by measuring the conductivity, and appeals to those who employ sea water for condensing purposes. Knowing the normal conductivity of the condensed water, a variation in this figure gives immediate warning of contamination by sea water entering the condenser, and thus trouble from this cause may be stopped by minor repairs without waiting for further and more serious developments.

There is also an exhibit by Messrs. CROMPTON & CO. of their well-known potentiometers and other testing instruments.

Messrs. ISENTHAL & Co. have an exhibit of resistances for field regulation and laboratory purposes with which our readers are familiar. These are now manufactured in this country, and particular attention has been paid to the field type of resistance which is made mostly for mounting at the back of the switchboard with the operating spindle starting from the panel. In order to increase their output the makers now use many die castings, and the design is such that the various types can be built up from standardised units.

A convenient form of optical pyrometer known as the "Wedge" optical pyrometer is shown by the OPTICAL PYROMETER SYNDICATE. The heated body of which the temperature is to be determined is viewed from specially constructed prisms by means of a telescope. These prisms are moved by a mechanical device until a point is reached where the image disappears and all light rays are quenched. The temperature can then be read on scale. Each instrument is calibrated to cover a range of 400° C. or 800°C.

INSULATING MATERIALS.

Another direction in which this country was largely dependent upon Germany before the war was that of insulating materials. We notice among exhibits which fall in this category that Messrs. ABBOTT, ANDERSON & ABBOTT show several examples of their insulating cloths, which we described in THE ELECTRICIAN of November 23rd last. This firm is in a position to turn out 750,000 yds. of finished cloth per annum, and we understand that this material is being used largely by Government departments for work connected with aircraft, agriculture, traction, &c.

The DAMARD LACQUER COMPANY show a number of examples of moulded insulation made up with synthetic resins. This material is supplied in the form of powders, which are moulded under heat and pressure; the resulting material is strong, both mechanically and from the dielectric point of view, and is known under the name "Formite" Examples are also shown of rods obtained from the synthetic resin alone without he use of "fillers." Insulating varnish is also supplied.

Messrs. ERINOID, LTD., show samples of Erinoid which is now used as a substitute for the German product "Galalith" It is non-inflammable, easily worked, and may be used in place of ivory, ebony, celluloid, &c. The thinnest sheets are 2 mm in thickness and the smallest rods are 6 mm. in diameter.

Messrs. FLEMING, BIRKBY & GOODALL appear as new manufacturers in this class of work. The firm are already well known as makers of overhead line material for electric traction work, including all kinds of strain insulators, but their present development is connected more particularly with moulded insulation for general electrical work. We understand that keen and constant research work has been put in on Birkby's moulded insulation during the last four years with very gratifying results. Many difficulties have been successfully overcome, and an insulation produced having quite remarkable properties, of which the following may be mentioned:—

- Specific gravity, 1·33 to 2·0.
- Di-electric strength of base material, 500 volts per mil, or 20,000 volts per millimetre.
- Tensile strength, 4,000 lb. to 6,500 lb. per square inch.
- Unaffected by temperatures from 100°F. to 2,000°F.
- Has no softening point.
- Unaffected by water, weather, oils, acid fumes, alkalies, ordinary solvents, live steam, &c.
- Is not combustible.
- Not affected by surface condensation.
- Chemically inert.
- Not brittle.
- Extreme accuracy in moulding.
- Made in various colours.
- Contains nothing harmful or anything that will damage metal parts.
- Stated to be something entirely different and superior to shellac and similar gum compounds, hard rubber, ebonite, fibre, &c.

There is, of course, a wide field of use for an insulation of this character, and the firm point out that one or other of the different grades will be found suitable for practically all electrical requirements. We are asked to state that at present, due to large quantities of Government work, very little if any new business can be taken on for moulded insulation, but inquiries from interested firms will be welcomed.

Messrs. HIGH-TENSITE (LTD.) show some good examples of "High-tensite" mouldings with metal insets, which we described in these

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columns recently. The dielectric strength is stated to be over 20,000 volts per mm. The material is non-hygroscopic and non-inflammable; it does not carbonise under sparking and has a wearing surface equal to that of brass. It is, therefore, particularly applicable to magnetos.

An extensive exhibit is also shown by Micanite & Insulators Co., and comprises examples of micanite and built-up paper insulation which is sold under the trade name of "Paxolin." This is made up with phenol-formaldehyde varnish, and is shown both as sheets and cylinders. There are also examples of micanite commutator rings, micanite tape, &c.

The Improved Solidite Co. have an exhibit of "Solidite," which is a substitute for ebonite.

(To be concluded.)

Labour Notes.

(by our labour correspondent.)

The strike amongst the women employed on the London 'buses, which spread to some provincial towns, and the strike which immediately followed on it amongst the women and some of the men who work on the London tube railways, are in their origin precisely similar to the recent revolt of the women teachers in London. At the base of the trouble is the demand for "equal pay for equal work." This question is one which, owing to the gradual encroachment of women upon what had been regarded as men's work, has greatly exercised the minds of those in the trade union movement. In the recent strikes the matter was brought to an issue on the question of equal war bonuses for men and women. In the case of women conductors, it was understood from the first that they were to receive the same wages as the men they temporarily replaced. But in subsequent advances the arrangement has been broken, and in the wages awards which have been given the additional remuneration has been less for women than for men. The London women teachers objected to this process when applied to them, and it looked as though they would cease work to enforce their demand for equal treatment. The 'bus women actually did so, and the "tube" women, on the same issue, struck work also.

This question of women's work is not so simple from the worker's standpoint as it would appear to be. It raises difficulties which are by no means new; indeed, they are old-standing problems. Let us try to view the situation as the trade unionist conceives it. Women in industry have for the most part in the past been birds of passage, employed in the intervening years between leaving school and getting married, to which latter event the majority look forward. Earning a living is not as a rule so serious a proposition to a woman as it is to a man with family responsibilities; and in most industries women have not organised themselves. They have sold their labour at a cheaper rate, and thereby become a standing menace to the male worker's standard of life. Even when women were not employed on the same work as men they were regarded as potential competitors, and in any case the lower wages which female workers received were an impediment to any improvement in the economic position of the men. Now, though working-men are strongly conservative in many respects—and the general employment of women in industry is a matter on which they have been conservative—the root difficulty in their minds, and the reason for the opposition at times to the employment of female labour, has been the under-cutting of men's wages. Hence the view which the trade union movement has adopted of "equal pay for equal work."

Now let us look at it from the side of the women. The extension of the franchise has given several million women the vote, which is a symbol of the new importance of women. They are ceasing to regard themselves as an inferior kind of being for whom inferior treatment is natural. Moreover, it is to be remembered that the war has robbed the women of this country of husbands and potential husbands. A larger number of women than previously will need to support themselves, and perhaps dependents as well. This means that there will be fewer "pocket money" wage earners in the future. It is often argued that women are much more economical than men, and that they require less money to live upon. But if they perform the same work and get less wages for it than men obtain it merely means that the employer profits by the thrift, economy and more modest standards of women. If he is able to pay men a definite wage, and he pays women less for the same work, he is simply putting the difference into his own pocket. It may be that under an ideal industrial system those employed should be paid according to their needs; but at present the wage level is based on no such principle, and women are now arguing that the employer has no right to apply it to their case and to profit by it.

The principle of "equal pay for equal work" is well established in the cotton industry, where the women receive the same "piece rates" as the men. But the general application of the system clearly involves surmounting a good many practical difficulties. One thing is certain, however, women workers are becoming much more articulate and self-conscious, and the men, in defence of their own standards, will give greater and greater support to the women in their demand for "equal pay for equal work." The new movement amongst women, the growth of women's trade unionism, and the probable extension of Trade Boards in those industries where women are largely employed, will at least combine to end the sweating of female workers, which in the past has been an intensely black blot upon the industrial system.

The I.M.E.A. and Coal Economy.

The following are abstracts of a letter sent to the Coal Controller on Aug. 6 by the hon. secretary of the Incorporated Municipal Electrical Association (Mr. H. Faraday Proctor) and the reply on behalf of the Coal Controller, dated Aug. 8, 1918, in regard to the matter of coal supply.

In the letter to the Controller Mr. Faraday Proctor says the slack coals now being supplied contain a considerably larger percentage of ash, and also a larger percentage of fine dust, than used to be the case, a larger quantity is required to produce the same quantity of electrical energy, and the additional transport required to deal with the large increase of useless matter locks up thousands of railway wagons and barges. The output of existing boilers is considerably reduced, and much more boiler plant is required to be manufactured to deal with the power demands. The suggestion has been made that all coal should be crushed to a standard size, say, 2 in., which would result in the even distribution of the dirt amongst all users. A larger percentage of smalls or slack is made in the average household by the process of hand breaking than would prevail if the coal were broken by mechanical means. The Council view with alarm the recent great and rapid depletion of the stocks of coal held by electricity supply undertakings. Deliveries are being still further restricted, and failures of supply may occur at any time. Supplies of electrical energy should be maintained at all costs. It is suggested that in order to do this preference in coal deliveries should be given to electrical undertakings, so that a minimum of at least three weeks' supply may be kept in stock. The opinion is expressed by colliery managers that the present shortage could be practically met if the eight hours day is suspended, and the men allowed to work nine-and-a-half hours a day. This would probably increase the present output by 20 per cent.

In the reply on behalf of the Controller of Coal Mines, Mr. D. Wilson (technical adviser to the Controller) says: Owing to the large number of miners who have been withdrawn from the industry for military service, and increased demands for fuel for munition works and other purposes, all collieries are working under considerable pressure, and it is unavoidable that a larger percentage of ash and fine dust should be turned out than used to be the case. The difficulties referred to by the Association have been fully realised by this Department for a very considerable time, and every effort is being made to effect an improvement. For several months a representative from the Production Department has been detailed to take up with the collieries, and with the miners themselves, the question of effecting an improvement, particularly in slack fuels, and there have been numerous instances where, as a result of definite complaints, some improvement has been effected. One of the objects of the Department in endeavouring to obtain from electric power stations a monthly record of the average calorific value of the fuel they receive is to secure a valuable guide to assist them in dealing with this question of deterioration. It is inefficient to carry much of this low grade fuel over long distances, but at the present moment the shortage of coal of all descriptions is so pronounced that it is not possible to make arrangements for only the graded and better quality fuel to be supplied. Wherever this can reasonably be done, suitable arrangements will be made. There are practical difficulties in the way of installing crushers at the collieries just now, but that aspect of the case shall have consideration. The whole question of coal stocks at electric power stations is under review, and every effort is being made to ensure that in the very near future at least three weeks' stock shall be on hand. The requirements of the electricity supply industry will continue to receive special consideration.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 Specifications.

117,638 Dekker. Process for the electrolytic deposition of metals. (21/4/17.) (Patent of addition not granted.)
117,639 Lucas & Breeden. Dynamo-electric machines. (23/4/17.)
117,644 St. Helens Cable & Rubber Co. & White. Locking or securing devices for electric fittings. (18/6/17.)
117,647 B.T.-H. Co. (G.E. Co.) Braking systems for electrically-driven vehicles. (23/6/17.)
117,658 Platt Bros. & Co. & Colin. Apparatus for use in electroplating articles or pieces having holes. (23/7/17.)
117,676 Chivers & Marter. Insulating composition for magneto distributors and for other purposes. (26/7/17.)
117,682 Hobley. Methods of forming and treating electrical coils. (27/7/17.)
117,705 Gifford & Nalder Brcs. & Thompson. Indicating devices for electrical measuring instruments. (13/8/17.)
117,712 Hudd & Wion. Electrical point detectors for railways. (23/8/17.)
110,912 Comp. Phoebus. Electric pocket lamps. (28/10/16.)
117,758 Lucas & Eggington. Electric vehicle and other like lamps. (10/11/17.)
117,769 Dixton. Means for operating switches for tram roads in mines, quarries or the like. (13/12/17.)
113,616 McKenzie, Holland & Westinghouse Power Signal Co. Electric relays, particularly for railway traffic controlling apparatus. (20/2/17.)
117,784 Plaisant. Dynamo-electric machines. (22/6/17. Divided application on 18,387/16.)
117,786 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Electromagnetic lock-out switches for use in motor control systems. (6/3/18.)
114,834 McKenzie Holland & Westinghouse Power Signal Co. Manufacture of commutators. (16/3/17.)
117,441 Automatic Telephone Mfg. Co. Automatic telephone systems. (9/7/17.)

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APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

July 9, 1918.

11,216 HIGHFIELD. Water actuated electrical switch.
11,230 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Relays.
11,231 AYSCOUGH. Instrument for teaching Morse alphabet and transmitting messages automatically by Morse code.
11,232 HAY, RAVEN & WEATHERILL. Electric generator.
11,252 KNOWLES. Telegraphing apparatus.

July 10, 1918.

11,279 SIMON & WILLIAMS. Couplings for electrical conductors.
11,296 SOC. ANON. ITALIANA ANSELDO & CO. Electrical control of gun movements. (18/7/17, Italy.)
11,301 LONDON ELECTRIC FIRM, MORDEY & HUGHES. Electrical searchlight, &c., projectors.
11,304 FORRESTER. (Burgess.) Cone-heating elements for electric heating apparatus.
11,317 BLACKSTONE & CARTER. Operating magneto in reversible internal combustion engines.
11,336 LEACHMAN. Electric lamp flashers.

July 11, 1918.

11,340 GARRARDS, RAILING & WILSON. Electric motor starters.
11,370 NORRIS & OGILVIE. High-tension adjustable firing spark conductor.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain of the Week.—Capt. W. Darlet Bentley.
Next for Duty.—Capt. E. G. Fleming.
Sunday, September 1.—Commandant's Parade. Waterloo Station 8.45 a.m., opposite No. 9 platform, for work at Esher. Dress, drill order, without rifles. Midday and tea rations to be carried.
Monday, Sept. 2—Friday, Sept. 6—Drills as usual.
Special Notices.—All drills will take place at Headquarters unless otherwise stated. The M.O. will attend for the medical examination of recruits on Thursday evening at 6.30 p.m.

Commercial Topics.

The Swedish Export Trade.

At the present time the commercial community of Sweden is paying close attention to the organisation and development of the export trade of the country.

At a recent meeting of representatives of the most important industrial organisation in Sweden, a central Council of 22 was formed for the Swedish export industries. The Council is to serve the interests of Swedish export industries in a more thorough way than has hitherto been possible with existing organisations. The formation of the Council is stated to have been occasioned by measures taken by foreign countries for encouraging their exports after the war, particularly by Germany. The Council will "follow commercial political measures in foreign countries which may affect Swedish export, and consider what action should be taken to strengthen the position of Swedish exports in the near future. The object to be aimed at is, by means of collaboration, to obtain the most favourable export prices, &c., and in general to create an expert organisation which can be consulted when the question of drawing up new commercial treaties comes up."

In order to promote Russo-Swedish commercial relations, a company is being founded at Petrograd (with the support of the Russian Export Chamber) for carrying on both an export and an import trade, for organising a permanent exhibition of Swedish goods at Petrograd, &c.

Another company has been founded by leading Swedish banks for supplying credits to foreign countries. It has issued its first loan of 10,000,000 kronor in bonds, which are redeemable not later than April 15, 1921, and are to be sold at par. As a cover for this and future loans, the company is to obtain bonds, to the same amount as the loan, from foreign banks for credits granted to them. The banks are to be furnished with the security of foreign States or municipalities for at least 20 per cent. higher than the bonds. The guarantee fund furnished by the State, moreover, provides a collateral security for the bond loan.

* * * *

Organisation of Australian Industries.

A conference was recently held in Melbourne to consider Mr. Hughes' scheme for the organisation of Australian trade and industry.

There were 60 delegates, representing all the States, and most of the principal organisations in Australia concerned in trade or industrial questions. The conference approved unanimously of the broad principles of Mr. Hughes' proposals, viz., that trade and industry should be organised, and a committee was appointed to frame the details of a scheme. In Mr. Hughes' scheme industrial associations of industry will be the units of the scheme of organisation. The producers in each industry will form an association, whose objects will be economic, and confined within the limits of its particular industry. Its function is to advise upon all the circumstances of the industry, including production, distribution, sale and finance. Each association will have its council, which will be directly in touch with the General Council of Science and Industry and the Department of Commerce and Industry.

The Government proposes to place the science bureau upon a permanent basis, appoint first-class men of high qualifications in charge, and give it such financial backing as is necessary to ensure its success. Through it the technical schools and colleges and the universities and genera schools will be linked up. Pending the appointment of a temporary General Council decided on by the conference, a committee of seven has been appointed.

* * * *

Financial Assistance for Mining and Metallurgy.

The National Metal and Chemical Bank, which was formed a few months ago, has issued a circular giving particulars of the progress made, its policy and scope of operations.

It is stated that the bank has acquired extensive interests in undertakings producing iron ore, coal and the principal non-ferrous metals, and through its associated concerns is in a position to arrange for smelting and refining lead ore, zinc ore, hard zinc, &c., and to supply all descriptions of manufactured lead, zinc and alloys. The bank is also interested in chemical undertakings producing dyes, sulphuric acid, &c. The bank has a call upon the services of a large staff of engineers and chemists having wide practical experience of the various processes of metal and chemical production, and it is desirous of fostering metallurgical and chemical enterprises in any way inter-related with the base metal industry. The bank is prepared to advise on mining operations, metallurgical processes, the erection and organisation of works connected with any department of the base metal industry, &c. It will also be prepared to render financial assistance in connection with contracts secured by comparatively small concerns or by brokers.

* * * *

New Zealand's Industrial Development.

According to the report of the New Zealand Government on industrial conditions of the Dominion, there were 4,670 manufacturing and industrial establishments in New Zealand in 1916, compared with 4,402 in 1911.

There were 57,823 persons employed, compared with 56,234 in 1911. Power employed in industries is given at 146,041 H.P., which were provided by 6,041 separate power installations, of which 2,231 were operated by steam, 236 by water, 809 by gas, 239 by oil and 2,516 by electricity. The use of electricity has increased very rapidly from 1,084 installations in 1911 to 2,516 installations for 1916, and the outlook was stated to be very promising for a marked increase in the use of electric power in the Dominion.

Electricity Supply.

Extensions.

Colchester.—The Corporation has received sanction to a loan of £5,188 for additional plant for the electricity works.

Glasgow.—The equipment of the Corporation's Dalmarnock power station is nearing completion, and the Electricity Committee is visiting the works officially to-day (Friday).

Maidstone.—The Corporation has applied for permission to borrow £22,007 for extensions of the electricity undertaking.

Middleton.—The Corporation is applying for sanction to the borrowing of £7,500 for cable, plant, &c., in connection with the conversion of the electricity works into a transforming station for dealing with a bulk supply from Manchester.

Nottingham.—The Corporation has failed to obtain Government sanction to the purchase of the proposed new generating plant for its Trent Side station.

Whitstable.—Blean Rural Council has given permission to the Whitstable Electric Co. to erect overhead wires in the Council's area for supplying current to Whitstable-cum-Seasalter.

General.

Chesterfield.—The Corporation has decided to take a bulk supply of electricity from the Staveley Iron & Coal Co. and to stop generation at its own works.

Dublin.—The Dublin Industrial Development Association has decided to send a deputation to ask the Coal Controller to endeavour to modify his demand for the reduction of coal consumption, as the consequent reduction of output of electrical energy will render it difficult for manufacturers to carry on their business.

Electric Power in Rolling Mills.—At the meeting of the Sheffield Forge & Rolling Mills Co. on Thursday last the chairman (Mr. C. E. Siddall) made a statement as to the progress made with the adoption of the electric drive in the company's works.

The electric mills, which the company had been putting down for the last two years, were not yet running, as they had had great delays in getting the necessary permits. He hoped the first mill would be started within a week. Their adoption of electric driving had been very adversely criticised, chiefly by people who knew nothing about it, but who were the first to copy them immediately they got going. In adopting the electric drive they were adopting the right thing. There never was a better illustration of that than in the fact that that morning they were running their electric sheet mill, in spite of the coal strike. If they had

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had the two electric mills running it would not have mattered about the rest of the works—they would have been able to satisfy the wants of everybody. They had given the electric drive a fair trial, and it had proved successful. The sheet mills had paid for themselves during the three years that they had been running. Their running cost was less than that of steam. They intended gradually to electrify the whole of the works, and this would not mean any diminution of dividends, but rather the opposite.

When the time came for reorganisation and reconstruction, the Sheffield Forge would not be found in the background. When the time came customers need have no anxiety about the filling of their requirements. They would be well filled, and the Forge would be in a position to compete, and to help their customers to compete, with any concern in the country.

Greenock.—The salary of the burgh electrical engineer, Mr. F. H. Whysall, has been increased by £100 per annum.

Increased Charges for Electrical Energy.—The charges for current are being increased at the following places :—

Hereford charges are increased 5 per cent. The charges have increased by 50 per cent. during the war.

Wolverhampton Electricity Committee has increased its charges to ordinary consumers not under contract by 15 per cent.

Salford Council's charges from Sept. 1 will be increased from 20 to 30 per cent. over pre-war rates for lighting, 30 to 50 per cent. for power and heating, and 15 to 35 per cent. for traction.

Limavady (Ireland).—Work is proceeding in connection with the equipment of electricity supply works in Limavady. The Town Hall and streets are to be lighted electrically in the coming winter.

Nenagh (Ireland).—An electric supply undertaking for the town is proposed, and the local gas company is having estimates prepared for the work.

Provisional Order Applications.—The following applications are being made to the Board of Trade for electric lighting orders :—

Ellesmere Urban Council, Electrical Distribution of Yorkshire (for Luddenden Foot), Halifax Corporation (for Luddenden Foot and for Mytholmroyd).

Electric Traction.

Electric Refuse Wagons at Glasgow.—In the report of the Glasgow cleaning department for the year ended May 31 the following figures are given showing the cost of running electric and other refuse wagons.

Two Edison 2-ton electric vehicles were put into commission on Dec. 13, 1916, and May 1, 1917, respectively, and have proved efficient, dependable, economical and easily driven. Two more have been ordered. Cartage by the electric vehicles cost 3s. 5½d. per ton, compared with 4s. 6½d. for petrol and 4s. 1½d. for horse traction. The petrol vehicles compare unfavourably with the electric and horse vehicles as to cost on account of the numerous stoppages necessary. Extensive repairs to the petrol vehicles have been required, and the high running cost is due to some extent to their having been out of commission on several occasions.

Glasgow.—The Tramways Committee has decided not to increase the tramway fares.

Tramway Economies.—On the 1st prox. the penny fares on the Yorkshire (Woollen District) Tramways are to be raised to 1½d., and the number of cars run is to be reduced. It is thought desirable that long journey passengers should be given the preference in regard to accommodation on the cars.

On the Keighley tramways, about one-third of the stopping places have been abolished. Two or three of the railless trolley routes are not in use owing to the difficulty of getting the motors repaired.

Huddersfield Council has decided not to run tramcars on Sundays while the present restriction of coal continues.

Telegraphy and Telephony.

Argentine Wireless Station.—The following are extracts from a recent Presidential Decree regarding the installation of a high power wireless station in the vicinity of the City of Buenos Ayres :—

Having regard to the application by the Pan-American Wireless Telegraph & Telephone Co., of Delaware, asking for approval of plans and site of the high-power radiographic station for which that company holds the concession, the general plans presented by the company, and the site of the station, are approved conditionally. A further extension of time of 18 months is conceded within which to comply with the requirements of Article 1 of the Decree of June 20, 1916, the parts of the Decree of Sept. 14, 1915, which say " to establish direct radiographic communication with New York, United States of North America, employing the modified Poulsen system," should now read " to establish direct communications with New York or any other point beyond the South American continent, employing the modified Poulsen system, or the Alexanderson system, or the Marconi spark system, in order to produce continuous waves, or any other system which may be more efficacious for the object in view."

Brazilian Telegraphs.—The President of Brazil has authorised the opening of a credit of 600 contos (about $150,000 American currency) to the account of the Minister of Transportation and Public Works, in addition to the 1,000 contos (about $250,000) authorised by Decree of Nov. 8, 1917, to be expended in the improvement of the telegraph service in Brazil.

Montevideo Telephone Service.—A petition, extensively signed by subscribers of the Montevideo and National Co-operative Telephone Companies of Montevideo, has been presented to the President asking him not to delay longer the enforcement of the law of December, 1915, reorganising the postal, telegraph and telephone services, as regards the creation and financing of the national telephone, as the companies are unable to improve their services on account of the said law.

Imperial Notes.

Australasia.—The Australian Department of Commerce and Industry and the Science and Industry Bureau have appointed their principal executive officers.

The Director of Commerce and Industry will receive a salary of £1,500 per annum, and he will have the assistance of expert representatives of primary and secondary industries. Trade representatives are to be appointed overseas, and through them the aim of the department will be to open up new markets. The department will occupy itself generally with shaping a policy for expanding trade, improving methods and establishing new industries.

The Director of the Bureau of Science and Industry will receive a salary of £1,250, and this branch is being formed into a permanent institution, to take the place of the Advisory Council that recently concluded its labours. The object of the Government in creating this institution is to initiate an extensive scheme of scientific research in connection with, or for the promotion of, primary or secondary industries in the Commonwealth.

The Industries Committee of the New Zealand House of Representatives reports that it has had under consideration a proposal from Mr. Thomas Waddell, of Christchurch, to establish an electric plant for the melting of scrap steel. The Committee recommends the remission of Customs duty on the materials required for the erection of an electric furnace.

The Hydro-Electric Power & Metallurgical Co., Electrona (Tasmania), which utilises 3,500 E.H.P. from the State Hydro-Electric Dept. and manufactures 5,000 tons of carbide per annum, is expected to double that output before long.

Federated Malay States.—The annual report of the Mines department states that in 1917 there was a falling off in the machinery in use in the mines of the Federated Malay States, probably owing to the difficulty of obtaining machinery in England or Australia.

The only new plant of any magnitude installed during the year was the Tin Bentong Co.'s hydro-electric power plant and electrically-operated dredge. The following figures show the driving power in horse-power used in the mines, the 1916 figures being given in parentheses : Steam, 23,748 (24,810) ; steam-electric, 2,420 (4,255) ; hydraulic, 18,524 (17,911) ; hydro-electric, 4,395 (3,549) ; suction gas, 1,794 (2,203) ; oil engines, 2,692 (3,851) ; oil-electric, 2,003 (1,495) ; total, 55,576, (158,074).

Foreign Notes.

Argentina.—A company is to be formed for the purpose of erecting an electric power house for the supply of current for public and private purposes at San Javier, Province of Santa Fé.

Electrical Undertakings in Japan.—A statistical report showing the condition of existing electrical undertakings in Japan (except in Formosa, Corea, Saghalin and Kwantung) at the end of 1916 has been issued by the Direction General of Electric Exploitations, Tokyo.

There are 2,617 undertakings, including electric supply 472, electric traction 26, electric traction and supply 48, isolated plants 1,946 and official plants 125. The primary power is water in the case of 1,195, steam 854 and gas 568. Those using e.h.p. transmission (over 3,500 volts) number 159. There are 172 undertakings with plant capacity over 1,000 kw., of which 25 are over 10,000 kw. Only 26 are owned by municipalities. The total kilowatt capacity is 703,175, and the total length of lines used is 115,363 miles. The traction undertakings have 1,368 miles of (equivalent) single track, and use 4,077 motor and 415 trailer cars. Lamps connected amount to 107,907,757 c.p., and motors and other electric appliances in use equal 544,518 kw.

Norway.—What is stated to be the first Norwegian cable and rubber goods factory has recently been erected at Christiania.

The new factory will specialise in the manufacture of wire and cable, as well as in the production (later) of rubber goods, the imports of which in 1913 amounted to 6,000,000 kroner (or about £187,500).

Uruguay.—The concessionaire of the electric lighting and power station at Paysandú has transferred the undertaking of the Uruguayan Government.

Water-power in Venezuela.—According to the " Engineer," an ambitious project is being organised in Venezuela for the utilisation

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of water-power provided by the falls near the capital of the Republic, which are estimated to produce 30,250 H.P. daily.

These Naiguata waterfalls have been partially used, developing about 8,750 H.P. every 24 hours. One of the cataracts is said to be the largest but one in the Western Hemisphere, having an available fall of 3,346 ft. This is situated about 10 miles from Caracas. The flow of water during the maximum of the dry season is approximately 136 gallons per second, estimated to be sufficient to generate 8,000 H.P. per diem. A syndicate with a capital of $1,000,000 (£200,000), to erect the necessary plant, is now being formed, and it is stated that the money will be forthcoming without difficulty.

Miscellaneous.

Fire.—A fire, which caused damage amounting to between £20,000 and £25,000, occurred on the premises of W. Canning & Co., electrical engineers, Birmingham.

National War Loan.—The Federation of British Industries has invested a further £50,000 in National War Loan.

Scrap Disposal.—The Ministry of Munitions issued an order on 20 ult. that every person owning iron or steel scrap shall sell and transfer the same whenever required by the Controller of Salvage and Stores. Owners must make such returns as are required.

Sports for the Benefit of the Blind.—For the third year in succession the Bowling Club connected with Messrs. Callender's Cable & Construction Co.'s "Anchor" Works, Leigh (Lancs), have played a match (on the 17th inst.) with a selected team representing the other Bowling Clubs in the Leigh district, the whole of the proceeds being remitted to St. Dunstan's Hostel for Blinded Soldiers and Sailors. Thirty games were played, and the "Anchor" team won by 12 points. St. Dunstan's Hostel benefited by over £60.

Educational.

The University of Durham (Armstrong College).—In the department of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, &c., there are complete courses of instruction in preparation for degrees of the University of Durham The next session commences on Sept. 23, and particulars of the courses may be obtained from the secretary (Mr. F. H. Pruen, M.A.), Armstrong College, Newcastle-on-Tyne.

University of Edinburgh.—The next session commences on Oct. 8, and the preliminary or entrance examination is held in September. The University provides complete courses in civil, mechanical and electrical engineering, qualifying for the degree of B.Sc. Eng.

University of Birmingham.—The session 1918-19 commences on Oct. 1. Courses are provided in mechanical, civil and electrical engineering. The full courses extend over four years, and students who enter after matriculation and pass successfully the examinations at the end of each year will be entitled to the degree of bachelor of science in engineering. Syllabus and particulars of fees, scholarships, &c., from the Secretary.

Northampton Polytechnic Institute.—The full day courses in civil, mechanical and electrical engineering will commence on Sept. 30.

The courses in civil and mechanical engineering give a thorough grounding in engineering work, and, in the third and fourth years, include specialisation in various directions, such as automobile and aeronautical engineering. In electrical engineering, with similar grounding, the specialisation is in the direction either of heavy electrical engineering or of telegraphy and telephony, including radio telegraphy. The entrance examinations will be held on Sept. 24 and 25, at which three entrance scholarships will be offered. There are full and part time courses in technical optics, and an Aitchison scholarship (value £38) will be offered in this department at the entrance examination.

Tenders Invited and Accepted.

Electric Tipping Wagon.

MANCHESTER Electricity Committee require tenders by 10 a.m. Sept. 13 for the supply of a 3½-ton electric tipping wagon. Specification and form of tender from Mr. F. E. Hughes, Town Hall, Manchester.

Cables and Wires.

The SOUTH AFRICAN RAILWAYS AND HARBOURS ADMINISTRATION, Johannesburg, require tenders by noon Sept. 16 for the supply of electric cables and wires and bare copper wire (tender No. 165) during 1919. Specification, &c., Tender Board, Johannesburg.

Electrical Stores.

Tenders are required by first post Sept. 6 for six months' supply of electrical goods to the Cheshire County Asylum, Parkside, MACCLESFIELD. Forms of tender from the Clerk.

CARNARVON.—The Corporation has accepted the tender of the Electric Construction Co. for converting Diesel engine at the electricity works to use tar oil, £107.

SALFORD.—The Electricity Committee has accepted the tender of Stewarts & Lloyds for 16 elbow pipes for boilers at the electricity works at £195.

SOUTH SHIELDS.—The tender of British Insulated & Helsby Cables for cable amounting to £1,661. 14s. 7d. (plus £125 for contingencies) has been accepted by the Electricity Committee.

SWANSEA.—The Harbour Trustees have accepted the tenders of W. Rickard for 2½ miles of overhead cable at £147 and Richd. Johnson, Clapham & Morris for gal. steel wire at 46s. per cwt.

Appointments Vacant and Filled.

A lecturer in mechanical engineering and a lecturer in electrical engineering are required for the Plymouth and Devonport Technical Schools. Salary scale £200 to £370. Forms of application, &c., from the Education Secretary, Plymouth Education Authority, Applications by Sept. 11. *See advertisement.*

A controlled electrical firm in the Midlands advertises for a man with sound technical education to carry out candle power and other electrical and physical tests.

A charge engineer is wanted for certified undertaking. Turbines and water tube boilers. Salary £3. 7s. 6d. per week. Applications to the Borough Electrical Engineer, Electricity Works, Bedford.

A north of England firm require an assistant with knowledge of d.c. or a.c. machine design. *See advertisement.*

Mr. C. W. Gooden, of Grays, has been appointed chief electrical assistant to Horsham Council.

Business Items.

We learn from Mr. Herbert H. Berry that he has purchased from Messrs. Ferranti Limited the whole of the patents, stock and tools in connection with their electric heating and cooking business. Mr. Berry has transferred the whole of this heating and cooking business to the Jackson Electric Stove Co. (Ltd), of 38, Blandford-street, London, W. Mr. Berry has acquired an interest in and has been appointed a director of the Jackson Electric Stove Co.

General Electric-Fraser & Chalmers Amalgamation.—It is now announced that as the retention of the mining machinery business by Messrs. Fraser & Chalmers (Ltd.) would present so many difficulties in definition, it has been agreed that the General Electric Co. (Ltd.) will purchase the whole of Messrs. Fraser & Chalmers' Erith works, with all the manufactures, goodwill, &c. The scope of Messrs. Fraser & Chalmers will therefore only consist in future of merchant trading.

Liquidation.

The British Telegraph Instrument Co. (Ltd.), 179, Clapham-road, London, S.W. 9, is being wound up voluntarily, and Mr. J. H. Webb, 4, Ruskin-walk, Herne Hill, London, S.E., has been appointed liquidator.

Companies' Meetings and Reports.

Benn Brothers (Ltd.)

The 22nd annual meeting of Benn Brothers (Ltd.) was held at the offices of the company, 8, Bouverie-street, London, E.C., on Friday last. Mr. ERNEST J. P. BENN, C.B.E., presided, in the absence of the chairman, Sir John Benn, Bart.

The CHAIRMAN, in moving the adoption of the report, congratulated the shareholders on the very strong position of the company, and referred to the success which had attended the arrangements made at the end of 1916 whereby three other publishing houses had been amalgamated with Benn Brothers (Ltd.). The resultant economies in management, together with the satisfactory increase in the volume of business recorded, had enabled the company to successfully overcome the difficulties associated with the tremendous increases in the price of printing, and particularly of paper. The trade and technical press generally had done more than its share of war work, and the papers of the company had the honour of leading in several movements of tremendous importance to the nation. In the early days the "Hardware Trade Journal" probably had done more than any single newspaper in the interests of recruiting, and the Hardware Roll of Honour was a proud possession, testifying to the success of the movement. "The Electrician" newspaper had led the way towards the solution of one of the most pressing of our war needs in connection with the transport of materials, and the tremendous increase in production due to improved facilities in the handling of heavy goods in engineering works, thus enabling women to take the place of men, was largely due to the efforts of that paper. Little need be said in connection with "Aeronautics," which continued to hold its place as the technical paper of the aircraft industry, and was undoubtedly the mainspring of progressive thought and progress in that important department. The

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"Fruit-Grower" had been honoured with a message of congratulation from Lord Rhondda in connection with its special food production numbers, and the increasing ability of the nation to feed itself was due in no small measure to the assistance which the "Fruit-Grower" had been able to render to the farmer, the market gardener and the allotment holder alike. Perhaps the most important, although the least evident of the work done by their papers, was achieved by the "Export World," which, thanks to the support of far-seeing manufacturers, continued to spread the fame of British industries to the farthest corners of the earth, although for the time being so little export business was possible. Referring to the future of the trade and technical press, Mr. Benn said that, as the war drew nearer to its close the nation was beginning to realise that it must look to our trade and our industries for its future salvation. Upon them would rest the responsibility for repairing all the wastage, making up the arrears and providing for the progress of the future. The redemption of war debt, the provision of pensions, the maintenance of the standard of living between them constituted a huge task, which could only be performed by those responsible for our industrial activities. Trade and industry would have a new significance in the future, due to the great national needs, and it would enjoy a backing of public opinion which had been sadly lacking for generations past. Everything pointed to the prospect that the glamour of the professions would fade, and society would save its smiles for the producer, because it would be recognised that he was the only person who could satisfy the enormous needs of the future. We had recently heard a good deal about National Service, and that slogan would be adopted in the future; but would be applied not to the work of destruction, but to the work of civilisation and construction. The most pressing problem of the immediate future was that which concerned the relations between employers and employed. When the war came to an end not only would the status of industry itself be changed, but the status of the parties to it would have undergone a transformation. The workers must be recognised as sharing to the full the responsibilities for the progress of our industries. In this respect the great movement which was spreading through the land in connection with what is known as the Whitley Report deserved the earnest attention of all citizens. Two at least of the newspapers of the company were in the forefront in this matter. The gas industry, represented by the "Gas World," had for long had its own way of dealing with the relations between employers and employed in connection with co-partnership; while the furniture trade, represented by the "Cabinet Maker," had the honour of being one of the first of our industries to establish a Joint Standing Industrial Council. These new problems, as well as all the standing problems of industry, science, education and the improvement of machinery, and so on, opened out a vista of usefulness to the trade and technical press, and the directors were now engaged in making arrangements which should ensure that the papers published by Benn Brothers (Ltd.) would do their full share in promoting the spirit of progress and prosperity upon which the well-being of the future completely depended.

Mr. E. P. HASLAM seconded the motion for the adoption of the report and accounts, which was carried unanimously.

ABERDEEN SUBURBAN TRAMWAYS CO. (LTD.)—The report for the half-year ended July 31 shows profit £2,309, the balance at credit of profit and loss being £3,923. £1,200 is to be added to renewal and depreciation account (making £19,100), and a dividend at the rate of 5 per cent. paid, and £1,061 carried forward.

ELECTRIC LIGHT & POWER SUPPLY CORPN. (SYDNEY) (LTD.)—The report of the directors for the half-year ended April 30, 1918, states that the revenue was £31,511, and exceeded that of any previous half-year. Consumers connected are 5,299 (increase 413). Owing to the difficulty of obtaining copper wire, a number of applications for current have had to be deferred. The trading profit was £17,919. Interest on debentures absorbed £1,644, income tax £1,000, reserve funds £6,354 and dividend for the half-year at the rate of 8 per cent. per annum £8,920.

LISBON ELECTRIC TRAMWAYS (LTD.)—The directors' report for 1917 states that, after deducting interest and amortisation due on debentures of the Companhia Carris de Ferro de Lisboa, interest on and redemption of the debentures of this company, London expenses, &c., there wasanet profit of £16,678. 8s. This, added to £9,223. 13s. 7d. brought forward from last year, gave a balance of £25,902. 1s. 7d. After placing £10,000 to depreciation reserve, and paying preference dividend for the six months to June 30, 1917, amounting to £12,766. 11s. 10d., the balance, £3,135. 9s. 9d., has been carried forward to next year. Passengers carried were 79,434,362, compared with 76,620,194 in 1916. There has been an unprecedented rise in the prices of coal and other supplies, and further increases of wages have had to be granted, the rate of exchange has fallen, and owing to strikes and political disturbances the system was closed down on several occasions. The directors regret that the serious reduction of the profits prevented the payment of the preference dividend for the second six months of the year under review. In June of last year a law was passed in Portugal prohibiting any increase in the price of season tickets for the duration of the war and six months after, unless authorised by the Government, the General Council of the District or the Municipality. This law was a direct violation of the terms of the company's concession. Shortly after the new Government came into power an arrangement was arrived at with the Municipality, whereby the comapny was enabled to raise the rates of the season tickets by 40 per cent. as from Jan. 1 last. The whole of this increase was required to meet the demands of the men for higher wages. Since the end of the year tariff increases have been made which will help to compensate for the ever rising working expenditure.

New Companies, &c.

A. M. T. SYNDICATE (LTD.) (151,149.)—Private company. Reg. Aug. 9, capital £5,000 in 4,500 10% preferred shares of £1 each and 10,000 deferred shares of 1s. each. To acquire patent rights in instrument for automatically teaching Morse Code, &c.

BROWN BAYLEY'S STEEL WORKS (LTD.)—Reg. Aug. 1, capital £800,000 in £5 shares (100,000 preference), to take over the business of Brown Bayley's Steel Works (Ltd.), and to carry on the business of manufacturers of iron and steel, gas and coke, electric light and heat, chemical manufacturers, engineers, &c. First directors are R. Armitage, M.P., W. Armitage, Lord E. Hamilton, H. Brearley and M. R. Mainprice.

CLIFFORDS (LTD.) (150,828.)—Private company. Reg. June 27, capital £2,000 in £1 shares, merchants and factors of aircraft, wireless installations, materials, tools, engines and accessories, motor cars, electrical generators, switchboards, &c. Permanent managing director, Clifford W. Edwards, Peterborough.

FAR EASTERN DEVELOPMENT CO. (LTD) (150,817.)—Private company. Reg. June 26, capital £100,000 in £1 shares, to acquire any interest in or option over minerals, shipbuilding and water-power sites, rights for developing electric or other power, in any part of the world. &c.

R. F. HAMILTON & CO. (LTD.) (150,900.)—Private company. Reg. July 4, capital £3,000 in £1 shares, to take over the business of a seicntific instrument maker and gear cutter carried on by R. F Hamilton as "R. F. Hamilton & Co"; also manufacturers of and dealers in electrical and other instruments for laboratory and works use, &c. First directors are R. F. Hamilton, F. Atkinson and H. Chitty.

METALLURGICAL RESEARCH CO. (LTD.) (150,914.)—Private company. Reg. July 8, capital £3,000 in £1 shares, iron, brass, aluminium and metal founders, chemists, metallurgists, electro-metallurgists, manufacturers of and dealers in electrical and automobile supplies, &c.

J. MULCASTER & CO. (LTD.) (151,143).—Private company. Reg. Aug. 8, capital £41,000 in £1 shares, to take over the business of a manufacturer's agent and merchant for mechanical and electrical engineering supplies carried on by J. Mulcaster. J. Mulcaster is first director. Reg. office: 4, Commercial-buildings, Middlesbrough.

Receivership.

FARINGDON ELECTRIC LIGHT & POWER CO. (LTD.)—Notice of appointment of W. A. Henderson, 29, Gracechurch-street, E.C.3, as receiver on Aug. 9, 1918, has been filed.

City Notes.

CANADIAN GENERAL ELECTRIC CO.—A quarterly dividend of 2 per cent. for the three months ending Sept. 30 has been declared.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—An interim dividend at the rate of 5 per cent. per annum, less tax (the same rate as last year) has been declared on the ordinary shares for the half-year ended June 30.

FELLOWS MAGNETO CO. (LTD.)—The issue of £40,000 of fresh capital in the form of 8 per cent. cumulative participating preferred shares has been authorised by the Treasury, and the shares are being offered to the shareholders at par.

PARA ELECTRIC RAILWAYS & LIGHTING CO.—An interim dividend at the rate of 6 per cent. per annum has been declared on the ordinary shares for the past half-year.

RIO DE JANEIRO TRAMWAY, LIGHT & POWER CO. (LTD.)—A quarterly dividend of 1¼ per cent. has been declared.

SAO PAULO TRAMWAY, LIGHT & POWER CO. (LTD.)—A quarterly dividend of 2½ per cent. has been declared on the common stock.

SOUTH AMERICAN LIGHT & POWER CO. (LTD.)—A dividend of 5 per cent. (1s. per share), less tax, has been declared for the past year after paying £4,000 off discount on debenture issue. £2,608 is carried forward.

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, August 27, 1881.]

THE NEW ATLANTIC CABLE.—On Monday evening last the telegraph steamer "Faraday" picked up the shore end of the new Atlantic cable, and, having made the necessary splice, proceeded on her outward voyage, laying the mid-ocean section.

ELECTRIC LIGHT FOR TRAINS.—A novel departure has been initiated by the Great Northern Railway on which they are to be congratulated. Messrs. R. E. Crompton & Co. have contracted with the company to fit up a train with the Swan incandescent lamps. The result of this experiment will be looked forward to with great interest

A PECULIAR TASTE.—The Carmarthen County Justices have just committed an Irishman named Hurley to one month's hard labour for snatching up from a table in an inn, chewing and swallowing a telegraph message, with a shilling wrapped up in it, that was intended for elsewhere than down his, apparently, capacious maw. One month's hard labour will no doubt do much towards aiding digestion of the toothsome morsel.

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CONTENTS.

NOTES 389
Some Applications of Electromagnetic Theory to Matter. By A. C. Crehore.—*Continued* 392
National Physical Laboratory.—*Concluded* 394
The Capacity-Potential Curves of an Induction Coil. By E. Taylor Jones, D.Sc. Illustrated.—*Continued* 396
British Scientific Products Exhibition. Illustrated.—*Concluded* ... 398
THE COMMITTEE FOR SCIENTIFIC AND INDUSTRIAL RESEARCH 400
The Reluctance of an Air Gap Having Slots in Both Opposing Surfaces. By F. W. Carter, M.A. Illustrated 400
CORRESPONDENCE 402
Scientific and Industrial Research 402
The Dick, Kerr Ventilated Tramway Motor. Illustrated 403
Coal Conservation Committee 404
Patent Record 404
Volunteer Notices 404
Commercial Topics 405
Electricity Supply 405
Educational 407
Tenders Invited 407
Companies' Meetings and Reports 408

Notes.

Equal Payments for Equal Work.

As the result of the recent strike of women conductors of the London omnibuses, the Government has appointed a committee to consider the whole question of equality of payment as between men and women. It has been generally agreed that there should be equality of payment under present conditions; but in certain awards that have been made this has not been taken into account. The question really becomes more important, however, in connection with post-war requirements rather than under conditions as they exist at the moment. We think it may be said that there is no clear logical reason against equality of payment, provided the work obtained in every case is the same. It is quite clear that to the employer the main thing is to get the work done. Theoretically it matters not whether work is carried out by white labour or by black labour, or by man or woman, provided that the final result is the same. Actually, however, equality is rarely found, even between one man and another. It is a difficult matter to define equality of work in practice, and undoubtedly very considerable variations exist even where the same wages are paid. The simplest case is that of piece-work; and even here, although the same rate may be given to two workers, the fact remains that the worker who does the larger number of pieces per hour is worth more to the employer than the one who does the smaller. There are really two cases to be considered. The first is that in which women are normally employed, and the second is where women have replaced men. The success of women in the latter case has been due to repetition work, which has increased enormously during the war. After the war, however, this class of work will necessarily fall off, and it is obvious that a woman with a short training cannot maintain her efficiency if her work is continually varied. Leaving this point on one side, however, the fact remains that if women are paid a smaller wage than men there might be a tendency to retain women, to the disadvantage of the men who return from the war. This would lead to a fatal state of things, and probably most engineers will agree that equality of payment is the best basis. If this is adopted, it follows that men or women, as the case may be, will be employed according to the merits which they can display, and not because of any difference in wage rates. It must be remembered, however, that on this basis there are many points to be taken into account. For example, preference would certainly be given to men working six days a week as against women working four days a week, assuming the daily rate of pay to be the same.

Trade and Reconstruction in Germany.

IN the last issue of the Board of Trade "Journal" some account is given of the preparations now being made in Germany to meet the special conditions which will obtain on the cessation of hostilities. It is interesting to note that Economic Boards are to be established which are somewhat akin to the Whitley Councils. It is not intended to exclude private trade, but to set up these boards and to give the industries a form of self-government. It is proposed more particularly that these boards should exercise control over the distribution of the foreign exchange and of tonnage. With regard to the latter, the Tonnage Distribution Office of the German shipping industry will decide questions of a technical nature, and the preference that is to be given to the various goods in shipping. Owing to the probability of the scarcity of tonnage, the German Government has arranged for a subsidy to be paid to the shipping industry in compensation for their war losses, and there are to be stringent regulations so that shipping is retained and is used, firstly, for the transport of absolutely necessary imports, such as food and raw materials; and, secondly, for requirements that are purely German and not foreign. The Economic Board for the textile trades will regulate the distribution of certain kinds of wool and fibres to the cotton spinners as substitutes for cotton. In this connection it may be noted that, out of 1,700 spinning and weaving factories in Germany, only 70 large ones are now working; in the silk trade, out of 45,000 looms, only 2,500 are at work; in the oil industry only 15 out of 720 firms are still active; while in the boot and shoe trade half the firms have closed down. The most important point to note, however, is that the German Government is quite alive to the problems that will have to be faced in reconstruction, and in this country we shall do well to see to it that our plans are fully prepared and that the Germans do not make use of our methods before we put them into execution ourselves.

Latent Inventive Capacity in the Workshop.

FEW things are more conducive to harmonious relations between the management and the employees in a factory than a knowledge on the part of the latter that valuable suggestions will be welcomed and rewarded. In the past, speaking generally, there has not been much done to invite such suggestions, and when steps have been taken in this direction the results have not invariably been encouraging. But the quickening influence of the war has made workers more ready to offer suggestions, and the development of technical education will, in course of time, increase their merit. The problem is discussed in a recent issue of "Engineering." Three chief difficulties are mentioned: (*a*) The workers' fear that increased

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efficiency and greater production may lead to unemployment; (*b*) the suspicion that such ideas, while welcomed by the management, will be resented by the man's immediate superior; and (*c*) dissatisfaction with the monetary reward for the suggestion made. The solution of these difficulties is obviously a matter for the tact and judgment of the management. Such suspicions are human, and will disappear once the confidence of the worker is gained. A further question is the selection of ideas and the avoidance of irrelevant suggestions. This requires patience. It is not enough merely to put up a "suggestion box" and leave the rest to chance. The manager should explain to workers the kind of suggestions he desires, and illustrate this by reference to any valuable ideas submitted.

Results Obtained.

THE figures submitted by "Engineering" as typical of past experience seem hopeful. The number of suggestions may be expected to reach from 6 to 25 per annum per 100 workers. Of these, awards may be paid on 35–40 per cent., and it will be well for the management to err, if anything, on the side of generosity in this respect. Of suggestions received, it is probable that 70 per cent. will relate to improvements in plant, tools, &c; 22 per cent. to organisation and method; 5 per cent. to improvement in design of products, and 1 per cent. to inventions. The number of irrelevant ideas is estimated at the low figure of 2 per cent. If these figures can be regarded as typical, they appear anything but discouraging. It is naturally to be expected that the percentage of genuine inventions would be low, but the proportion still indicates that workers are influenced rather by sheer practical experience and environment rather than by imaginative and creative effort. The latter form of suggestion will be fostered by technical education and the inculcation of the spirit of research, and we believe that a certain amount of such training is desirable, not only for the management, but for the rank and file of industry. One of the greatest difficulties is the judging of suitable rewards. It is seldom that an idea of serious value can be made practical without investigation and the expenditure of a considerable sum of money. The average inventor is inclined to think that this part of the development is a small matter in comparison with his own work, and therefore he is often discontented with any reward that is given to him. It is, of course, impossible to satisfy cranks; but there is much to be gained by generous treatment and a proper recognition of resulting benefits.

Industrial Reconstruction Council.—A conference on Works Committees will be held under the auspices of the Industrial Reconstruction Council on Tuesday, September 10th, at 6 p.m., in the Hall of the Institute of Journalists, 2 and 4, Tudor-street, E.C. 4. The subject will be introduced by Mr. Robert Wilson, of the Ministry of Labour, after which the discussion will be open. No tickets are necessary.

Reconstruction Problems.—We have received from the Ministry of Reconstruction a small pamphlet compiled from the speeches made by the Minister of Reconstruction. Its object is to outline in general terms the main problems of reconstruction and the way in which they are being approached by the Ministry. Such subjects as shipping, raw materials, allocation of materials, transport, demobolisation, industrial organisation, joint industrial councils, working conditions and problems of finance are discussed briefly. The price of the pamphlet is 2d., and it is obtainable from H.M. Stationery Office, or through any bookseller.

The National Electrical Code (U.S.A.)—The Executive Committee of the National Fire Protection Association has decided, upon the recommendation of its Electrical Committee, to suspend indefinitely the enforcenent of Rule 26A of the 1918 edition of the "National Electrical Code," in so far as the rule requires the marking of wires and cables by manufacturers to facilitate identification of the polarity of conductors.

N.P.L. Volumetric Tests of Scientific Glassware.—We recently referred to the series of tests of scientific glassware being instituted at the National Physical Laboratory. Some fuller particulars of the "Class A" tests are now available in a booklet issued by the Metrology Department. The tests refer to (1) vessels of ordinary type as used in volumetric analysis and in the chemical and physical laboratory, (2) measuring vessels for gas analysis, (3) measuring vessels for milk analysis and the conditions to be complied with are set out in great detail. A scale of verification fees is appended.

The Value of the Engineer in Russia.—It appears that food cards are now to be introduced in Moscow and that there are four categories. Whereas those persons who are fortunate enough to be in the first category will receive 200 units of a given food, those in the fourth category will receive only 50 units. The first category consists of manual workers employed under specially hard conditions, and it is interesting to note that in the fourth category is to be found the engineer. He is in excellent company, however, for this class also includes heads of firms, merchants, clergymen, managers of businesses, contractors, lawyers, artists, authors, journalists and physicians as well as all those who live on the interest on capital, or who have no occupation. Evidently in Russia brain power is a drug on the market.

The Search for Metals in Germany.—Recent German technical papers contain frequent references to the constant search for metals which have become scarce, notably copper and now also aluminium. The mineral resources of Serbia are already being studied, and in Bosnia waste-heaps of old copper workings are being diligently explored. Reference is made to the mineral possibilities of Bulgaria, and companies have been recently formed to develop the coal beds in the regions adjacent to Sofia. German producers of aluminium have also been compelled to consider the exploitation of bauxite for aluminium in Austrian territory, which the cost of transport previously made impracticable. Both Herzegovina and Dalmatia are said to be especially rich in this commodity.

Portable Cinematograph Outfits for Salesmen.—In the United States the small cinematograph outfit for the use of salesmen seems to be gaining in popularity. The device has distinct advantages in displaying moving machinery or processes, and may possibly be more used in this country in the future. One type described in a recent issue of "Popular Mechanics" appears to be very compact, occupying in its case approximately 7 in. by 16 in. by 18 in., and weighing about 19 lb. The illumination is derived from a 250-watt gas-filled incandescent lamp, which can be applied to the local electrical supply, and it is said that quite satisfactory pictures can be obtained at distances of 6 ft. to 60 ft. It is thus adapted either to small or relatively large rooms. A feature is the use of three special condensing lenses, by the use of which a large angle of luminous flux can presumably be included. The apparatus accommodates a standard film up to 1,000 ft. in length.

Opportunities for Electrical Development in China.—In the American press instances are frequently given of the great field for electrical development in China, and a correspondent of "Popular Mechanics" comments upon the fact that, in the province of Chili, Peking and Tientsin were, up to two years ago, the only towns supplied with electricity, although there is a widespread demand. This province has a population of about 23,000,000, mainly a thrifty and prosperous class. In Tientsin there are several small plants in operation under franchises granted to various foreign settlements, and a French-Chinese concern has a monopoly for the native city. In Peking, where there is likewise a monopoly in the hands of a single company, the profits appear to be very large, notwithstanding the fact that the plant is far from efficient. There is every reason to believe that in many Chinese cities an up-to-date plant would prove a great commercial success.

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The Electrical Purification of Gases.—In the "Revue Générale de l'Electricité," Mr. J. Saget recently contributed an interesting summary of various processes for removing suspended particles from gases by electrical means. A method recently developed in France by Messrs. Lâiller and Gallot involves the use of a series of tubes, the increased potential gradient at the end of which is counteracted by varying the diameter. The efficiency of precipitation is stated to be directly proportional to the length of the cylinder and inversely proportional to the speed of the flow of gas. Fine particles are more difficult to precipitate than larger ones, owing to the fact that their capacity is less. In the apparatus illustrated two different methods are shown. In one case a vertical tube with a fine wire down its axis is used, in the other case the dust-laden gas is introduced into a horizontal tube with a negatively charged wire stretched down its centre. This has the advantage that the deposited material falls into hoppers in the lower wall of the tube, and does not accumulate round either of the electrodes or the insulators to which the wire is attached, and which are located outside the tube. It is stated that the process is being developed by a company, the Société de Purification Industrielle des Gaz, and that the materials precipitated include arsenic, antimony, sulphuric acid and various metals, sulphates, phosphates and oxides.

Large Refuse Disposal Works in New York.—In the "Engineering News Record" an interesting account was recently given of the very large refuse reduction plant installed in New York, whereby millions of tons of food-waste material are converted into grease and fertilisers. The waste is fed by a series of conveyers into 199 reducers in which it is cooked, washed and steamed for about 15 hours. Hand labour is practically eliminated and the chemical process is such that no offensive odours are given off. About 15,000 tons of refuse are treated each day, solvent and coal for boilers up to 3,000 H.P. being necessary. The tankage also discharges on to a belt conveyor, after which it passes through vessels with screens of progressively finer mesh. A narrow gauge railway connects the various sections of the plant; the handling of the coal is automatic throughout, and a magnetic separator is employed to remove objects of iron. The grease is ultimately packed into barrels, the pure and lighter varieties being separated from the heavier grease and used for making glycerine, soap, candles, &c. The plant is stated to be the largest of its kind in the world.

Photometer for Measuring Photographic Densities.—An application of photometry which has received some attention of late is its use for the determination of the density of photographic negatives. A useful apparatus for this purpose was described not long ago before the Royal Photographic Society by Messrs. D. E. Benson, W. B. Ferguson and F. F. Renwick. The design of the apparatus itself has nothing very striking in it from the photometric standpoint, though it appears well adapted for the purpose in view. A Lummer Brodhun cube is used to facilitate the comparison of two identical opal surfaces, one of which, illuminated by the source at a relatively short distance, receives the film to be tested in front of it, while the brightness of the other can be adjusted within wide limits. This adjustment is conveniently made by altering the distance of a double inclined mirror, the ray of light striking the mirror, undergoing double reflection and returning on its path. The device has the advantage of doubling the photometric distance corresponding with a given movement on the scale. The source of light requires careful selection. It must be of considerable brightness, concentrated within a small area. A special filament for the purpose has been used and it is suggested that for the darker films, such as those met with in X-ray work, the Ediswan "Pointolite" lamp would prove particularly satisfactory. It is presumably not necessary to maintain the voltage of the lamp absolutely constant as measurements are essentially relative. The authors attach much importance to the use of definite numerical data, obtained photometrically, as a supplement to impressions of density obtained through visual inspection.

"Direct Reading" Photometers.—Until recently photometric measurements have been almost invariably made on the zero principle, *i.e.*, the apparatus is manipulated until a balance is obtained and the corresponding illumination then observed on a scale. The ideal apparatus for quick observations would doubtless be one in which a reading on a dial was automatically registered by merely pointing the apparatus towards a light-source. This would apparently involve the use of so-called physical methods of light-measurement, such as the selenium cell, which at present can hardly be said to be practicable for everyday use, and involves various fundamental difficulties. But we seem to be moving appreciably nearer toward a self-registering apparatus. This is illustrated by two special photometers, exhibited by the Illuminating Engineering Society at the British Scientific Products Exhibition. The apparatus is shown by permission of the Ministry of Munitions and is described as suitable for the measurement of fluctuating lights of high intensity. Photometers of this type may, for example, be readily used to measure the candle-power of flares, rockets and similar transient but brilliant illuminations. In such cases it is impracticable to manipulate the instrument on the zero principle in the interval of time available. Accordingly, recourse is had to the method of providing a series of slots or stencilled letters of graded brightness, which are illuminated with progressively greater brightness, according to their distance from the small lamp in the instrument. An observation is then made, without any manipulation, by merely observing which letter or slot vanishes. A similar device seems to have been independently developed in the United States, and in a recent number of the "Transactions" of the American Illuminating Engineering Society a very compact form of instrument, utilising a series of dots of varying brightness, is described. The order of accuracy is probably less than that attainable under favourable conditions with a good illumination-photometer of the ordinary type, but for many purposes it has undoubted advantages. We believe that one of the first instances of the application of this principle is to be found in Mr. Trotter's "grid photometer," suggested by him many years ago, and illustrated in his well-known book on illumination.

Obituary.

ALD. F. LARARD.—The death is announced of Ald. Frederick Larard, who was for some years Chairman of the Hull Tramways Committee, and had been twice Mayor of the City. The deceased was 71 years of age.

LIEUT. L. G. BYNG, M.C.—We regret to record the death from wounds of Lieut. Leonard G. Byng, M.C. (Grenadier Guards) on Aug. 24.

Lieut Byng was 30 years of age and was the second son of the late Mr. G. Byng. He was a director of the General Electric Co., Anglo-Argentine General Electric Co., British General Electric (Australia) and British General Electric (South Africa).

Arrangements for the Week.

TUESDAY, Sept. 10th.

JUNIOR INSTITUTION OF ENGINEERS, NORTH-EASTERN SECTION.

7.15 p.m. At the Mining Institute, Neville-street, Newcastle-on-Tyne. Paper to be read on "Electric Furnaces," by Mr. C. H. Blenkinsop.

INSTITUTE OF METALS.

7.45 p.m. In the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W. 1. Two Papers will be read.

WEDNESDAY, Sept. 11th.

INSTITUTE OF METALS.

4 p.m. and *8 p.m.* In the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W. 1. Several Papers will be read.

THURSDAY, Sept. 12th.

IRON AND STEEL INSTITUTE.

10.30 a.m. and *2.45 p.m.* At the Institution of Civil Engineers, Gt. George-street Westmimster, London, S.W. 1. Several Papers will be discussed.

FRIDAY, Sept. 13th.

IRON AND STEEL INSTITUTE.

10 a.m. and *2.45 p.m.* At the Institution of Civil Engineers, Gt. George-street, Westminster, London, S.W. 1. Several Papers will be discussed.

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Some Applications of Electromagnetic Theory to Matter.*

By A. C. CREHORE.

(*Continued from page* 373.)

IX.—Ionising Voltages.

Without attempting here to give any derivation of it, I will merely state that the theory gives a formula of a very simple kind for the voltages that are required to ionise a gas and to start radiation. This is limited as yet to gases having atoms with single rings of electrons, like hydrogen and helium. A considerable amount of experimental work has been done recently on hydrogen on account of the interest in it from the standpoint of the Bohr theory. The voltages required the tear electrons off from the nucleus and to drive them entirely away from the atom, thus leaving the atom charged and making what is called an ion of it, can be measured experimentally. The theoretical formula is

$$V = 3{\cdot}3844 \times \frac{p^2}{\tau},$$

where p is the number of electrons in the ring and τ an integer. This subject alone is large enough to occupy the whole evening if it were gone into in detail, so we must content ourselves with saying that the theory gives all of the values approximately for hydrogen that have been observed, including a very recent value between 15 and 16 volts, which the Bohr theory gives no account of It also gives values for helium much nearer to the observed values than the Bohr theory It seems, however, that helium has not been so exhaustively investigated experimentally as hyrdogen in this respect.

X.—Theory of Crystal Structure.

Let us now pass to some results of a very different kind that have been derived from the general equation. I refer to the theory of crystal structure. By means of the X-rays you are aware that it has been possible to find the exact location of the centres of the atoms of which a crystal is composed. This method was discovered by Prof. Laue, and first published in a Paper by Laue, Friederick and Knipping. I shall confine these remarks to a few of the simplest forms of crystals belonging to the cubic or isometric system. In all of these the general arrangement of the atoms is in equilateral triangles in a plane. The whole crystal is built up by many separate planes of atoms all similarly arranged in each plane. I have brought here a number of models to help give you an idea of the space lattice arrangement in four of the important classes of crystals belonging to the cubic system. Without models it is not very easy to make much progress in understanding crystal structure. In each one of them you will observe that the fundamental arrangement is the equilateral triangle. The several planes of such triangles are related in several possible ways, which makes the characteristic differences in the resultant space lattice.

(*a*) *Directions of Axes of Atoms in a Crystal.*—According to our ideas of atoms, each has an individual axis of revolution, being determined by the common plane of the orbits of the electrons revolving around the nucleus If we fix the attention upon just two atoms whose axes point in different directions, the equations of electromagnetic force show that there is a tendency of the one atom to turn the plane of that of the other until they become parallel to each other before complete equilibrium is established. Now the angle between the directions of the axes of the two orbits is one of the quantities that is contained in the general equation, and unless we know the directions of the axes we cannot calculate the force by means of that equation.

Fortunately, it has been possible to find the directions of all the axes of the atoms because of the symmetry of the crystals coupled with the knowledge that each atom in the whole structure tends to turn the direction of the axis of rotation of every other atom. Any one atom feels the turning effect of all the others, and it is only the resultant of them all that determines the position of any given axis. Now, without knowing how much the tendency to turn the axis is, it is evident that if three atoms, which are just alike, are placed at equal distances from the given atom having their axes properly directed, they may annul one another and have no turning effect upon the given atom. Without going into the history of all the troubles that presented themselves before a solution of this question was found, I have a model which shows you an arrangement of the axes of the atoms in one of the equilateral triangular planes, and can prove to your satisfaction that this particular arrangement makes the total turning moment hold each axis in the crystal in just the position indicated by this model. In this model there are only four directions of the axes. One quarter of them all is parallel to one given direction, a second quarter to another, and so for the whole. These four directions are the directions of the medial lines of a regular tetrahedron, or, which is the same thing, the four diagonals of a cube. I have placed coloured strings in the models, one string passing through each atom to indicate the direction of its axis in exact accord with the plane model. You will find upon studying the models that each of the parallel planes has atoms with their axes arranged exactly like the plane model. Taking all these planes together you see that every atom has the direction of its axis fixed. But, again, you will observe that each model can be turned in any one of four different positions, so that a different set of planes each time makes up the whole crystal. And no matter in which of these four ways you turn the model the relative directions of the axes is precisely the same as in the plane model. In doing this we have really counted each atom four times, and every time the direction of its axis is right. Had some different arrangement of the axes been adopted for the plane model it would not have turned out that you could turn these models in any one of four directions and then found that the individual planes were the same as in the original model. In other words the possible number of arrangements of the axes in any plane is very limited, and it is my belief that this is the only possible arrangement that will satisfy the condition that the turning moments shall be zero.

(*b*) *Order of Magnitude of the Radii of the Orbits.*—Having found the directions of the axes, but not before, it is possible to apply the general equation to determine the total force on an atom due to all the rest in the crystal. When the expression for the force thus obtained is equated to zero for the stable equilibrium condition, the only two unknown quantities that remain are properties of the atoms themselves, viz., the sum of the squares of the radii of the orbits of the electrons in the atom in question on the one hand, and the sum of the products of the radius by the velocity for each.

In other words, starting from the known dimensions of the space-lattice forms in certain crystals, and knowing the kind of atoms there are at each point of the lattice, we may, by an application of electromagnetic theory, arrive at some knowledge of the sizes of the orbits of the electrons themselves within the atoms.

Without giving you the process in detail, the results may be briefly stated. The sum of the squares af the radii found in this way show a gradual increase with heavier and heavier atoms according to a definite curve, but the order of magnitude of the radii lies between 10^{-10} and 10^{-9} cm. This agrees well with the value found in an entirely different way for hydrogen.

(*c*) *Some Kinds of Atoms Show Two Possible Values of Their Radii.*—This theory has been applied to 20 different crystals, minerals, containing in all as many separate elements in different combinations. The same element, say chlorine or sulphur, occurs in several of these crystals. It may be regarded as a confirmation of the theory that the same values are obtained for the same kind of atom no matter in which crystal it occurs. This brings out a point of very great interest, because the above statement is not universally true. For example, the element sulphur occurs in four of the crystals, zincblende, ZnS, iron pyrites, FeS_2, manganblende, MnS, and galena, PbS. We get the same value for the radii for the sulphur atom from three of these crystals, but a different value in galena, PbS. The numerical relation between the sums of the squares of the radii in the two cases is $2^{4/3}$, the sulphur in galena being of smaller radius than the others. In a similar manner several other crystals give different values for the same element, and they always differ by precisely this same factor $2^{4/3}$ The result is very suggestive as indicating that the same atom may have at least two different states, differing in the size of the radii of the orbits, but without affecting the weight. It is possible to see by looking back at the equation for the radial force for the single ring of two electrons, where there were two roots at each of which the radial force is zero, that the more complex equation for atoms with several concentric rings might give more than two roots, and of these there might be more than one stable position for the radii.

* Lecture delivered before the American Institute of Electrical Engineers, slightly abbreviated.

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This is a thing that we might expect from our knowledge of atoms in chemistry. There are different kinds of sulphur atoms, having different valencies, and so with some other atoms. It is most important to observe though that the weights of these atoms are the same. Electromagnetic theory throws much light upon this matter, as we shall presently show.

(*d*) *Rigidity and Bulk—Modulus.*—We will conclude the remarks on crystals with the statement that the forces which have been obtained give a very good reason for the rigidity of crystals, and the resistance they offer both to change of shape and change of volume. The estimated value of the bulk modulus is of the same order of magnitude as the experimental values.

XI. Atoms at a Great Distance.

There is another matter to which the general equation has been applied, which I have left until the last, although it would have been most natural to place it first, as being perhaps the simplest application of the equation. The question is what effect will two atoms have upon each other according to the equation when the distance between them is very large, say one centimetre or more It may be shown that all of the electrostatic forces between two neutral atoms at a great distance exactly cancel out until we come to terms involving the inverse sixth power of the distance. Each atom has in effect a zero charge at these great distances, and the only part of the forces that we have to calculate arises from the *motion* of the electrons in their orbits. In the final analysis, therefore, to get the whole mechanical force between the atoms, we have to find the average mechanical force that one single electron in the second atom exerts upon another in the first atom. The total force is evidently merely the sum of a number of such expressions, the number depending upon how many different pairs of electrons there happen to be in the two atoms considered. If it happens, as it does, that the force due to any one pair of electrons gives us a quantity that is *not* cancelled out by that due to another pair, we obviously get a real resultant force between the two atoms. We know that such a force exists in fact, the gravitational force, and we should be interested to compare the force given by the equations with the actual known force.

(*a*) *Problem of Two Electrons. Average Force.*—In order to solve this problem for two electrons only it was necessary to obtain the average force between the two electrons taken over a very long time, a large number of revolutions. The only way as yet found to do this is to develop the equation into an infinite series of powers of the distance between the centres of the two atoms, and then average the separate terms. The result is that the series contains all powers of the inverse distance between centres, beginning with the first power, and so on. Moreover, the force is not in the direction of the line joining the centres of the two atoms. This is easily understood when it is remembered that the force between the two electrons in the original equation is not in this direction.

(*b*) *Force Resolved Along the Line Joining the Centres of the Orbits.*—We are interested, however, in the component of the total force that is in this direction, and hence the total force has been resolved in the direction of the centres. The part at right angles to it does not interest us because it will all be cancelled out by the action of the electrons in other atoms turned in every possible direction.

Now it results in the process of resolving the force along the centre line, that the first term of the series, the inverse first power term, cancels out leaving it to begin with the inverse square, and higher powers. Moreover, because the distance between the atoms is assumed to be great, all of the inverse higher powers are evidently negligible, so that the total force varies inversely as the square of the distance between the atoms. The resulting force-equation is of sufficient interest to give in full.

$$F=\tfrac{1}{2}e_1e_2\beta_2{}^2\{1-(-X\sin\alpha+Z\cos\alpha)^2\}r^{-2}. \qquad (1)$$

Here e is the charge on the electron; β_2 the ratio of the velocity of the second electron, the force of which we are getting, to that of light; X and Z are direction cosines determined by the position of the centre of the second orbit; α the angle between the directions of the two axes of rotation, and r the distance between the centres of the orbits.

(*c*) *Simplification of Result in Case of Two Masses of Matter.*—Let us apply this equation to two electrons, one in each of two atoms of any gas, liquid or solid, crystals excepted. At any given moment the axes of the two orbits may be turned in any possible directions relative to each other, so that the theory of probabilities must be applied, because it is the force on the average that we require. When this is done, it is shown that the quantity within the brace becomes 2/3, and hence the average force on the first electron due to the second becomes the very simple expression,

$$F=\tfrac{1}{3}e_1e_2\beta_2{}^2r^{-2}. \qquad (2)$$

This expression is in the form of the law of gravitation in two respects. First, it always gives an attraction, and second, it varies inversely as the square of the distance. Before inquiring into the magnitude of the force, let us apply the equation to the only kind of matter not included above, namely, crystals.

(*d*) *Attraction Independent of the Orientation of the Axes of a Crystal.*—We have seen that there are but four different directions for all the axes of the atoms in a crystal so far as the theory of crystals has been developed. Would we obtain the same result as before using these four directions only? If not, the theoretical attraction between two crystals would show some differences at the same distance when they are turned about in different directions. The experimental evidence is that the gravitational attraction shows no difference in any direction, and, consequently, if the force is to be identified with that of gravitation, it is necessary that the terms involving the directions of the axes in this parenthesis should give the same result as above even in the case of a crystal. It has been possible to show that they do, and this circumstance is due to the fact that the axes in the crystal are all parallel to the four medial lines of a regular tetrahedron.

(*e*) *A New Geometrical Theorem Obtained from Physical Considerations.*—There is an interesting incident in this connection. The equation showed that the following geometrical proposition must be true if the force is to be independent of the orientation of the crystal. "If through any point in space four lines be drawn making equal angles each with any other (that is parallel with the four medial lines of a regular tetrahedron), and, if from a second point in space, at a distance r from the first point, the four perpendiculars be drawn, one to each of the said four lines, then the sum of the squares of these perpendiculars is constant for all points at the same distance from the first point." The quantity within the brace of equation (1) is equal to the square of one of these said perpendicular lines.

The truth or falsity of this proposition was unknown at the time of arriving at the conclusion that it must be true if this is the proper form for the gravitational force. It has since been proved to be true,* and this has added a new geometrical theorem to the list, as it was unknown to the mathematicians to whom it has been submitted. This incident of a mathematical theorem deduced in this physical way helps to show that we may be on the right track in understanding the cause of the force of gravitation.

We see, therefore, that the force tallies in every way with the gravitational force except in the matter of magnitude, which will next be considered.

(*f*) *Magnitude of the Force.*—As you have seen above in considering hydrogen, we have a knowledge of the probable speed o the electrons, and there is nothing else in doubt that we need for calculating the force, since the charge on the electron is known. Using these known speeds, the force calculated from this equation comes out about 10^{31} times greater than the actual value of the gravitational force. This is an enormous error, and cannot be accounted for by assuming any mistake in the velocity of the electron used. The result is very significant at the same time, because the calculation indicates a force 10^{31} times greater, *not less*, than the actual existing attraction. It is a more fortunate result than it would have been had the calculated force come out the smaller of the two, because then gravitation might easily be attributed to something else, but, as it stands, we are forced to question the truth of the hypotheses that have entered into the case. What are they? They are really but two. First, that the atoms are structures consisting in part of electrons revolving in circular orbits, or approximately circular orbits as you please. Second, that the modern Lorentz form of electromagnetic equations applies to the case.

We are not yet ready on the strength of any electromagnetic theory to abandon the idea that electrons describe approximately circular orbits within the atoms. It is easier to believe that some modification in the present form of electromagnetic theory is required. Let us look at the expression for the average force upon one electron in a circular orbit due to another a little more attentively. We have already seen that the expression gives a good account of itself in many ways. It represents always an attraction and not a repulsion, and obeys the inverse square law. It also shows that, when such forces are summed up for two crystals, the result is independent of the orientation of the crystals. In fact, it has the right look in so many ways that I have been led by natural steps to suppose that some very important factor has been omitted somehow from the Lorentz theory.

(*To be concluded.*)

* The proof is due to Prof. F. W. Owens, of Cornell University.

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National Physical Laboratory.

(*Concluded from p.* 382.)

The following are abstracts of the Report of the Director, Sir R. T. Glazebrook, giving details of the work of the various departments :—

PHYSICS DEPARTMENT.

I. ELECTRICITY.

A. Fundamental Units.

The time of the division has been almost entirely occupied with work of a confidential nature, of which part was connected with wireless telegraphy.

Electrical Standards.—The standards of resistance are in a satisfactory state. A few Weston normal cells have been constructed, and the laboratory standards of E.M.F. have been compared with the standards of Japan through the intermediary of some cells brought to Teddington by Dr. Yokoyama. The results are given below :—

No. of cell.	Date of construction.	Amalgam.	Hg_2SO_4.	N.P.L. standard minus E.M.F. of cell in microvolts.
111	28·3.1916	10 p.c.	Electrolytic.	+7
113	,,	,,	,,	+2
114	,,	,,	,,	+4
Sh. 3	Nov. 1910	12·5 p.c.	Chemical N.P.L.	+17
10	,,	,,	,,	+12
14	,,	,,	,,	+19
16	,,	,,	,,	+10

Cells Nos. 111, 113 and 114 were brought by Dr. Yokoyama to Teddington on January 10, 1918. Cells Nos. 3, 10, 14 and 16 were made to the N.P.L. instructions by Dr. Shimidzu in November, 1910. They have remained at Teddington since that date.

The mean difference of 4 parts in one million between the N.P.L. Weston cells and those brought by Dr. Yokoyama is very gratifying.

Magnetograph Records.—Additional 24 hour records have been taken and coincidences found between the running of electric trains on the L.S.W.R. system and magnetic disturbances at the laboratory.

B. General Electrical Measurements.

Standard Inductometer.—The construction of a standard mutual inductometer for a maximum of 1 millihenry was continued. It is of similar design to the large one of range to 10 millihenries, which is in such constant use in the department, the lower range of the new instrument being particularly wanted for tests of wavemeter coils. To ensure permanence the coils are being mounted on a white marble support. On the lowest range the whole scale will be equal to 1 microhenry, extended to a hundred times this amount by the dial coils.

Uniformity of Magnetic Fields due to Solenoids.—As two accurately wound search coils were submitted for test (to our highest accuracy), an investigation was made of the possibilities of error in such determinations. The usual test on a search coil is to determine the turns × area, N_2s. In general for this purpose the coil is placed inside a solenoid or near some other primary coil of such a kind that the magnetic field produced at the search coil by a known current in the primary coil shall be easily calculable. It is also desirable (especially for search coils whose axial length is not relatively small) that the magnetic field should be as uniform as possible throughout all the space occupied by the search coil. A long, uniformly wound solenoid is commonly used as the primary coil, but sometimes it is more convenient to use the central region of a large (short) circular coil or of a pair of coils as in a Helmholtz galvanometer. The N_2s of the search coil is found by testing the mutual inductance of the combination against a standard, this part of the procedure being capable of high accuracy unless the inductance is too small. When a solenoid is used, a somewhat unexpected difficulty arises, namely, that of obtaining sufficiently uniform winding. This difficulty was investigated some years ago by Gehrcke and v. Wogau ("Verh. Deutscher Physikalischer Gesellschaft," Vol. XI., p. 664, 1909, and Vol. XIII., p. 448, 1911), and our experiments corroborate their results. By moving a small search coil to various positions along the axis inside a solenoid the uniformity of the field can be accurately tested. With a solenoid wound very carefully on a long tube of smooth surface, it is not unusual to find variations of 1 to 2 per cent. from the mean, after allowing for the finite length of the solenoid. (To attain the best result, a carefully cut screw-thread would be wanted, but, for use with alternating current, it is difficult to find a good material for the tube). The best solenoid was calibrated as described above and used to test a standard search coil. The latter was a single-layer coil of enamelled wire, very carefully wound on a marble cylinder of 3 cm. diameter. From the dimensions, which were very accurately determined, the value of the turns × area was calculated. The result agreed with that determined by the solenoid method to within about one part in 1,000. To obtain higher accuracy than this would require much greater elaboration in the design of the solenoid.

Alternating Current at 10 ∿ *per Second.*—Sensitive vibration galvanometers for frequencies of the order of 10∿ per second have been reconstructed. One of these shows a sensitivity of about 400 mm. at 1 metre for 1 microampere, with an effective resistance of 1,000 ohms.

A simple arrangement has been set up as a small source of steady alternating current at 10∿ per second. It consists of an electrically maintained tuning fork, one limb of which wags a coil between the poles of a permanent magnet.

Effective Resistance at Radio Frequencies.—Preparations have been partly made for a research on effective resistance at radio frequencies. Suitable vessels have been obtained for the calorimetric work, and well stranded coils to go into these have been constructed. A new 400-volt secondary battery (for use with large valves to generate the high frequency current) is at present being installed.

II. ELECTROTECHNICS.

A. General Work, including Photometry.

Insulating Materials.—Investigations have been made into various insulating materials. Magneto distributor material has been tested for mechanical and electrical properties, including the tendency to carbonise in the presence of sparking. Mica used for magneto condensers has been experimented with to test the effect of the presence of traces of air. Special insulating compositions have also been tried for their electrical properties, in addition to a large number of routine tests on ebonite.

Heating of Goliath Lamp Sockets.—Large gas-filled lamps cause considerable heating of the lamp sockets used with them, owing to conduction of heat from the bulbs. At the request of the Engineering Standards Committee measurements were made of the temperature rise of ventilated and unventilated sockets and of the leading in cables when used in lanterns of the open and enclosed types. It was found that the cables were liable to a total temperature of about 140°C., and that little improvement resulted from the use of existing arrangements for socket ventilation.

Measurement of Average Candle Power.—A certain amount of work has been necessary to develop satisfactory methods for the photometry of gas-filled lamps. The old step by step methods of determining average candle power are slow, particularly when the lamp cannot be rotated, and for many purposes—such as for life tests—a knowledge of the average candle power is all that is wanted. A cubical integrating photometer has been adapted for this work, employed with the necessary precautions as regards the similarity of the distribution of light of the standard used in the calibration. Unfortunately, existing conditions have not permitted the installation of a spherical integrating photometer for the purpose. The work is generally carried out by using a suitable light filter in conjunction with a standard vacuum lamp running at normal temperature. Much remains to be done in perfecting methods of this character when normal conditions return.

B. Continuous Current and Resistance Measurements.

Buried Cables Research.—This research has made good progress during the year, and an interim report has been presented to the committee, dealing with the work carried out during the past year together with suggestions for the coming year.

The report gives a description of the methods used in the tests, in particular that in which the rise of temperature in the cable is determined by measuring the increase of resistance of the conductors by means of a Kelvin double bridge. Alternating current was used to heat the cables and, for the purpose of measurements, a small continuous current was superimposed on the alternating current. The accumulators are put in series with the secondary winding of the transformer and with the cable by means of a double-pole change-over switch. The method requires that while the observations are being made, the whole of the alternating current is flowing through the accumulators, and the double bridge and galvanometers are carrying a comparatively large alternating current in addition to the continuous current to which they respond.

The electrical constants of the materials of all the cables under test have been determined. In all, some 230 samples of the copper were tested for resistivity, the mean value obtained being 0·1541 ohms per meter gramme at 20°C., while the average temperature coefficient of 47 samples was 0·00390 at 20°C.

The lead sheathing was used to determine the rise of temperature by measurement of the resistance of the outer portion of the cables, and a large number of samples of the sheath were examined in order to have reliable figures for computing the temperature rise. The mean value of 31 samples was 2·443 ohms per meter gramme, and the average temperature coefficient was 0·00385 at 20°C., the extreme values obtained being 0·00404 and 0·00373.

Results are given in the report for the cables when laid out on the floor of the room and when laid in the ground under different conditions, together with a comparison of the results now obtained and those given by various other observers. In general, the rise of temperature of a cable drawn into a stoneware duct was twice that of a similar cable armoured and laid direct in the ground, while the cables laid solid in bitumen occupied an intermediate position.

A large number of other points, such as the length of time required by the cables to attain to their maximum temperature, the effect of the ends, and the temperature gradient in the duct and in the cable, are dealt with in the report.

The design of the special motor-generator set, which will be used to supply the continuous current for the cable, and which will also be used for the heavy test work in the laboratory, has occupied a considerable time. All details have now been settled and the machine is under construction.

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III. HEAT.

A. High Temperature and General Work.

The use of tungsten arc lamps as a comparison source for calibrating optical pyrometers has been extended, the Edison Swan Co. having constructed for the division special lamps which cover a range of apparent temperatures from 900°C. to 2,400°C. This has greatly facilitated the test work.

Improved graphical methods have been devised for computing the results of observations with optical and total radiation pyrometers, which enable the coefficients to be obtained with a minimum of trouble from linear relationships.

High Temperature Scale.—The work on the high temperature scale has been continued as opportunity allowed, and a thorough investigation made to determine the best conditions for the calibration of thermo-elements at the freezing point of nickel and of the nickel graphite eutectic. Additional thermocouples of platinum, platinum-rhodium alloy have been purchased and calibrated so as to serve as working standards.

Special types of furnace have been designed, one of which is to be employed for the direct calibration of optical pyrometers against the melting points of palladium and platinum.

(*a*) *Total Radiation Pyrometers.*—Diaphragms of various aperture have been fitted to three of the standard total radiation pyrometers so as to obtain a series of overlapping scales, and the work on high temperature standardisation of the instruments has been pushed forward during the year.

In the course of the work, it was found possible to standardise directly against the melting points of gold and palladium. The method employed was to sight upon a diaphragm in a furnace (giving black body radiation) across the face of which a gold or palladium wire is stretched. The temperature of the furnace was gradually raised and the pyrometer reading taken when the circuit through the wire was interrupted. The instrument had been previously calibrated against a platinum, platinum-rhodium thermo-element and gave the value for the gold melting point of 1,062°C., the accepted value for which is 1,063°C., while the palladium value agreed closely with that obtained by extrapolation. It thus appears that, if due precautions are taken, the wire method is very reliable.

It is proposed to continue the work and calibrate, if possible, against the platinum point in a similar manner, and also to investigate several factors which limit the accuracy attainable with this type of instrument.

(*b*) *Thermocouples.*—For accurate work with platinum thermocouples at high temperatures, it is of the utmost importance to detect the presence of contamination. An apparatus has been constructed for this purpose which has given satisfactory results.

Some further experiments have been made during the year on the freezing point of nickel in contact with carbon. Observations with a new platinum-rhodium couple confirmed the existence of a definite freezing point, apparently of a nickel-graphite eutectic, at 1,330°C.

Tests of Electric Hot Plates and Cooking Stoves.—The Division collaborated with the Heating and Cooking Panel of the Engineering Standards Committee in the development of efficiency tests for electrical plates and cooking stoves, and a considerable amount of experimental work has been carried out in connection with this subject.

Tests of Pyrometer Tubes.—Amongst the miscellaneous tests carried out during the year, was the examination of a number of pyrometer sheaths of British manufacture. The following procedure was adopted in testing the tubes for their softening point and porosity at high temperature.

(*a*) *Softening Point.*—The softening was determined by fixing the tube horizontally with the end projecting as a cantilever into a furnace, the experiments being conducted under precisely the same conditions as would obtain if the sheath were a pyrometer employed for the temperature determination of the furnace. The furnace was raised to a series of increasing temperatures, which were maintained steady for some hours, and the temperature obtained when the tube bent under its own weight.

(*b*) *Porosity at High Temperatures.*—The closed end of the tube was inserted into a furnace, and the interior exhausted to a pressure of a few millimetres of mercury. The pump was then shut off and the rise in pressure, if any, observed.

Some of the samples of porcelain supplied, although unglazed, withstood the porosity test remarkably well; in fact, the walls collapsed under the external pressure before any leakages occurred. On the other hand, tubes of fireclay and of shrunk alumina will often show a return to atmospheric pressure in about 10 seconds.

Thermal Conductivity.—A large series of aluminium alloys have been investigated for thermal conductivity on behalf of the Light Alloys Sub-committee of the Advisory Committee on Aeronautics.

The advantages of aluminium alloys for the construction of cylinders and pistons of aero engines on account of their high thermal conductivity, have been appreciated for some time, and it was thought desirable to make a systematic investigation into this physical property in alloys of various compositions.

It was evident at the outset that thermal conductivity measurement at room temperature would not be sufficient, since the temperatures encountered in actual practice ranged up to 300°C. Hence it became necessary to find an expeditious method for the determination of thermal conductivity and its variation with temperature. An absolute method was devised and has been in constant use throughout the year. A number of aluminium samples of high purity have been investigated in this connection, as well as other pure metals.

The influence of heat treatment on the conductivities of the alloys afforded data of considerable interest.

A summary of the results obtained has been published and circulated by the Air Ministry to the manufacturing firms concerned.

B. Thermometer Testing.

A considerable development of the work of this division has taken place during the past 12 months, largely owing to arrangements made with the Glassware Supply Department of the Ministry of Munitions for the testing of clinical thermometers for Government use.

The number of "Precision" thermometers tested was 701, compared with 451 in the previous year.

Many commercial undertakings are now realising the importance of having such instruments tested, particularly under the conditions in which they will eventually be employed.

A detailed description of the equipment and methods of test for all classes of thermometers is now being prepared for distribution to those interested. It is hoped that the publication of this may be completed within a month or two.

IV. METROLOGY.

The past year has again been distinguished mainly by the further development of the gauge testing work. During the whole of the period under review there has been a steady increase in the number of screw gauges tested, but during the first three months of 1918 there has been a considerable reduction in gauges of the more simple types, so that the total quantities being handled are now appreciably reduced, and it has been possible to reduce the staff again slightly.

The work of the gauge rectifying shop during the year has been extremely valuable, but it has been found much too small to meet the demands upon it. New and valuable types of measuring apparatus—in particular a vertical form of projection apparatus for screw thread inspection and measurement—have been evolved and miscellaneous demands from the testing rooms have been supplied. Great difficulty has been experienced in securing check gauges of the more difficult kinds, such as screw and position gauges, for use in the test rooms. Additional facilities are needed for assisting gauge makers who wish at times that their mechanics should be allowed to work at the laboratory to correct difficult gauges under the direct control of the inspection department. To meet with these requirements and to extend the utility of the gauge rectifying shop generally, the Ministry has sanctioned the erection of a new workshop of about 10,000 sq. ft. area, to be devoted to this work. A site has been secured adjacent to the laboratory, and the building has been commenced.

The revision of the pamphlet, "Notes on Screw Gauges," occupied a considerable amount of time; the revised edition was published in November, 1917. The demand for copies shows that it is much appreciated by gauge makers and others.

With the beginning of the new financial year, the Metrology Division is to be reconstructed as an independent department.

V. OPTICS.

Telescopes and Binoculars.—In the report for the year 1916-17, attention was called to the heavy demands made upon the observer staff of the division as a direct result of the war. The number of instruments submitted for test had remained at a fairly constant level for some years before 1914, but since the outbreak of war the demands for tests on instruments, particularly gun-sighting telescopes, look-out telescopes and binoculars, have grown very considerably.

Optical Glass Testing.—The number of specimens of glass examined for refractive properties has risen largely above last year's total, which again was much greater than any previous figure. The auxiliary apparatus used in connection with these tests which was mentioned in the last report and was shown at the Optical Society's Exhibition held in January, 1917, has continued to give the greatest satisfaction. The tests are made on a Pulfrich refractometer, and our experience shows that a properly constructed instrument of this type used under suitable conditions gives results realiable to an accuracy only attainable by most other methods with the expenditure of much more time and trouble. During the past year investigations of a comprehensive character, both theoretical and experimental, have been made on various aspects of refractometry and on the types of instrument suitable for high accuracy in such measurements. As a result proposals for a new form of instrument have been made, but this unfortunately cannot be obtained during the war. A second refractometer of the type at present available has been purchased on account of the volume of test work which now has to be carried out.

VI. RADIUM AND X-RAY WORK.

No changes have to be recorded in connection with the work of this division. The number of samples tested has shown an appreciable increase, due to the increase in the use of radium luminous compound in connection with instruments employed on aircraft. The number of samples of radium of high content tested during the year is 51, of a total approximate value of £12,000. The number of samples of radium luminous compound tested for radium content is 30 more than double the number recorded for the last year.

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The Capacity-Potential Curves of an Induction Coil.

By E. TAYLOR JONES, D.Sc.

(*Continued from p,* 378.)

Summary.—An expression is given for the maximum secondary potential of an induction coil calculated on the theory that two oscillations are set up in each circuit at break. The relation between the primary capacity and the secondary potential, and that between the maximum efficiency of conversion and the coupling, are shown by means of calculated and experimental curves. The present results are compared with those found in previous experiments on the relation between capacity and spark-length. The uses of capacity-potential curves in the determination of the constants of induction coils are discussed, and examples are given of the calculation of optimum capacities. A repetition of Rayleigh's rifle-bullet experiment is described, the result further confirming the present theory.

The Experimental Capacity-Potential Curves.

Turning now to the capacity-potential curves the first of these is shown in Fig. 8. It was taken with the primary coil in its most effective position, 35 cm. from zero, in which the coupling was found to be $k^2=0{\cdot}580$. The abscissa represents the primary capacity C_1 in microfarads, the ordinate the reciprocal of the minimum sparking current in amperes. The abscissa is thus proportional to $u(=L_1C_1/L_2C_2)$, some of the experimental values of which ratio—determined by methods to be described in a later section—are indicated above the diagram.

The curve of Fig. 8 should be compared with the full-line curve of Fig. 1, the theoretical curve for an ideal coil in which the coupling is $k^2=0{\cdot}571$, the first of the values which allow of unit efficiency of conversion. It will be seen that the two curves bear a strong resemblance to each other

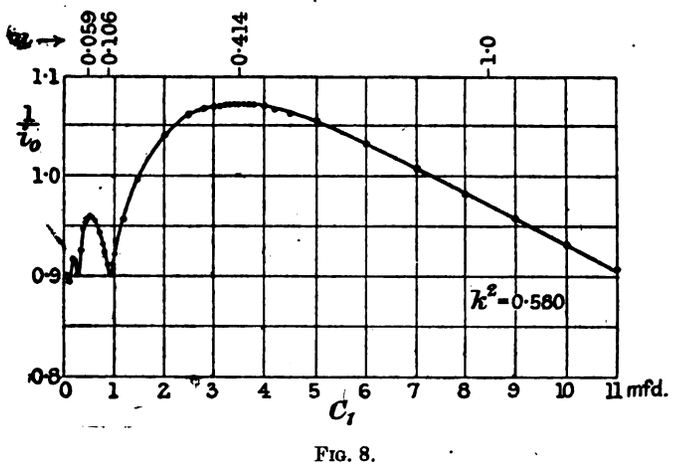

FIG. 8.

in general form, each consisting of a series of arches diminishing in height with diminishing u. The relative proportions of the successive arches are substantially similar in the two curves, though there are certain differences in detail. For example, the ratio of the greatest maximum to the nearest minimum is, in Fig. 1, 1·26 as against 1·19 in the experimental curve of Fig. 8. It should, however, be remarked in this connection that it is not easy to determine the experimental minima very exactly. Near their points of intersection the arched curves are very steep, so that unless one can proceed by very small steps in the variation of C_1 one may easily pass over the exact minimum point, and the true minimum may be appreciably less than the minimum actually observed. There is also another reason why the ordinates at the minimum points are rather too great, both in Fig. 8 and in the other curves about to be described. It will be shown later that in the adjustments giving these minimum points the curve of secondary potential (V_2, t) is of the double-peaked variety corresponding to the frequency-ratios 5, 9, . . . of the system. In these cases it is found that the spark passes more easily in the second peak than in the first, even though the potential is rather lower in the second than in the first. In other words, if the two peaks are nearly equal, the least sparking current generally causes the spark to pass at the *second* peak. The least sparking current may, therefore, fail in such cases to be a reliable indication of the *maximum* secondary potential. This matter will be referred to again in connection with certain other phenomena.

On the other hand, the maxima in the experimental capacity potential curves can be determined with greater accuracy, and closer agreement is found in the ratios of successive maxima between the curves of Figs. 1 and 8. Taking the ratio of the

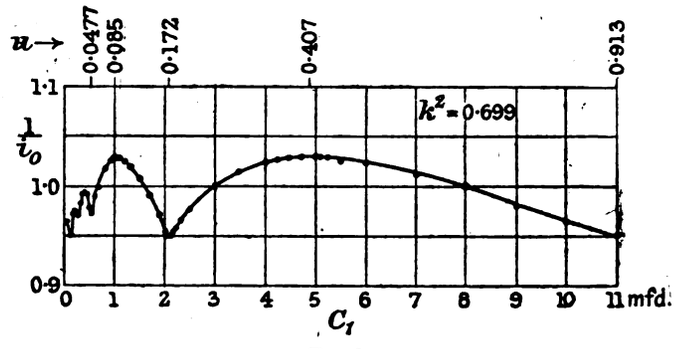

FIG. 9.

greatest to the second maximum in Fig. 1 we find the value 1·146; in the experimental curve of Fig. 8 the ratio is 1·116. The ratio of the second to the third maximum is 1·056 in Fig. 1, and 1·048 in Fig. 8.

The two curves also show fairly good agreement in regard to the values of u at which the maxima and minima occur. The greatest maximum occurs at $u=0{\cdot}429$ in the ideal curve (Fig. 1), at 0·414 in the experimental curve; the first minimum at $u=0{\cdot}105$ in the ideal curve, the experimental value being 0·106.

In Figs. 9, 10, 11 are shown the experimental curves obtained in three other positions of the primary coil, viz., 25·5, 20 and 2·3 cm. from zero, the values of the coupling in these positions being respectively 0·699, 0·767 and 0·832. These curves

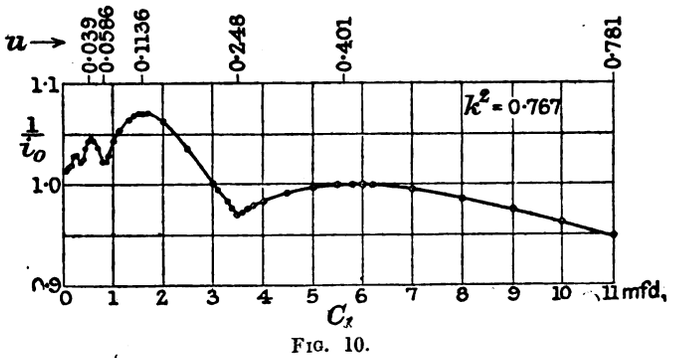

FIG. 10.

should be compared with the theoretical curves of Figs. 2, 3 and 4, which are calculated for an ideal coil having nearly the same degrees of coupling. It will be found on making the comparison that there is in these cases, as in the case just described, general agreement in form between the ideal and experimental curves, with similar points of difference. The most marked general difference between the two sets of curves is that the percentage drop from the greatest maximum to the neighbouring minima is somewhat less in the experimental than in the ideal curves. The reasons for this have been

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already explained. The percentage drop from the greatest maximum to the next maximum (on the left) is also rather greater in the ideal than in the experimental curves, and this difference increases with the coupling. It appears therefore that the effect of the resistances in reducing the secondary potential is greater the greater the primary capacity, and especially so when the coils are closely coupled. One consequence of this is that the position of the primary coil which gives equal greatest maxima (25·5 cm. from zero) is such that the coupling is rather less than 0·71, the value for the ideal coil. If in the experiment the primary coil had been placed

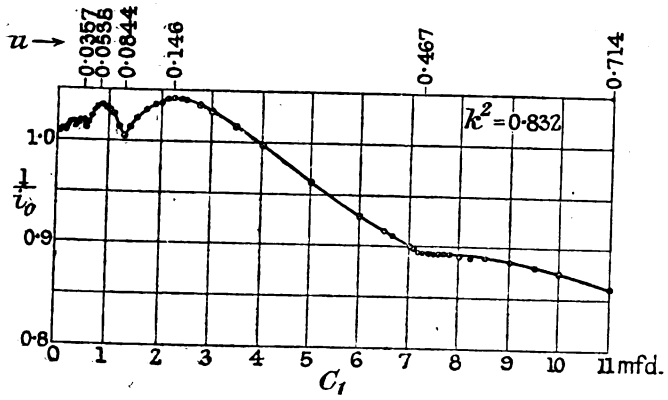

Fig. 11.

rather further inside inside the secondary, so that k^2 was raised to 0·71—a displacement of about 5 mm. would have sufficed—the second maximum would have been distinctly greater than the first.

Except in the case of Figs. 4 and 11 the values of u at which the chief maxima, and the points of intersection of the arches occur, agree well in the ideal and experimental curves. In Fig. 11, however, (k^2=0·832), these values of u are all less than the corresponding values in Fig. 4 (k^2=0·835). Thus the greatest maximum occurs at u=0·146 in Fig. 11, at 0·165 in Fig. 4, the neighbouring minimum at 0·0844 in Fig. 11, at 0·0862 in Fig. 4. These differences cannot be attributed to a constant error in L_1 or in L_2C_2, but more probably arise

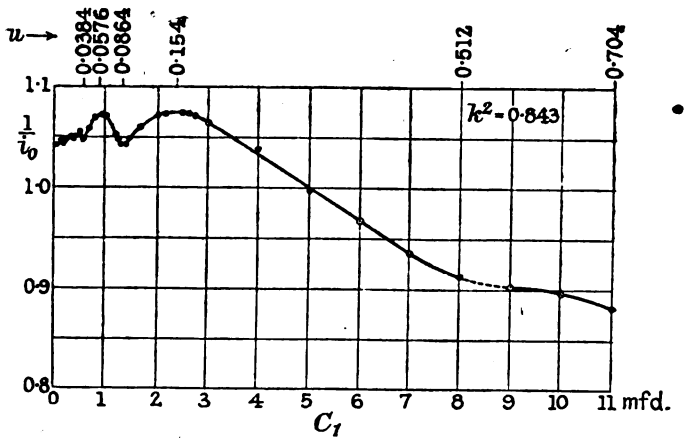

Fig. 12.

from the general distortion—greater at the higher degrees of coupling—of the capacity-potential curves due to the resistances. Another instance of the more deleterious effect of the resistances at closer coupling is the fact, already noticed, that the conversion efficiency is less at k^2=0·835 than at k^2=0·571 (*see* Figs. 6 and 7).*

* It may be noticed that the values of the greatest maxima shown in Figs. 8, 9, 10 and 11 are all considerably less than the values indicated in Table III. for the same adjustments. These differences are doubtless to be associated with variations in the atmospheric pressure, which, as is well known, affect the sparking potential. The barometer readings on the occasions when the four curves were obtained were (in inches) 30·19, 30·21, 29·05 and 30·58 respectively, all being higher than that of Table III.

Two more experimental curves, determined by Mr. J. H. Jones, B.Sc., with the same coil, are given in Figs. 12 and 13. Fig. 12 is the curve for the coupling k^2=0·843. In this case the two greatest maxima are again approaching equality. In the ideal coil they become equal at k^2=0·87 but in practice this equality would probably occur at a rather looser coupling. In the curve there is still some trace left of the first arch (on the right). According to the theory this does not entirely disappear until the least possible value of the frequency-ratio is 5, and this occurs when the coefficient of coupling is given by $(1+k)/(1-k)=5^2$, or k^2=0·852.

The other curve, Fig. 13, refers to a much smaller coupling, viz., k^2=0·504. This curve extends the series at the other end, and further illustrates the growth of the first arch in relative importance with diminishing closeness of coupling. The optimum capacity is 2·8 mfd., corresponding to u=0·418. Calculated from the theoretical expression given above the optimum value of u for the coupling k^2=0·5 is 0·41, so that the agreement between the ideal and experimental cases is fairly close.

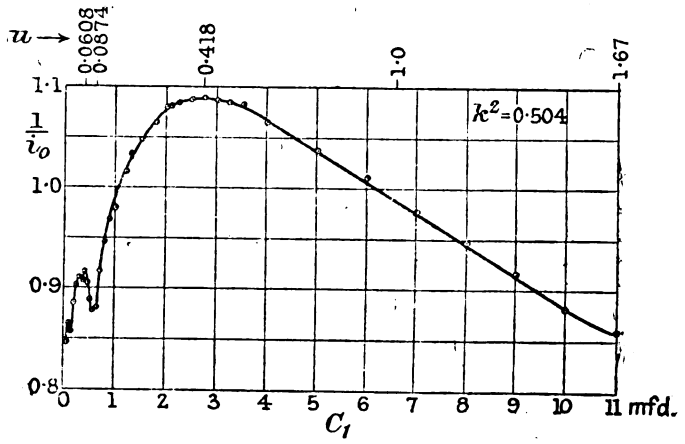

Fig. 13.

On the whole the experimental curves, Figs. 8–11, and the theoretical curves, Figs. 1–5, agree so well as to afford strong evidence in support of the "oscillation-transformer" theory so far as the circumstances of the above experiments are concerned. So far nothing has been said, however, as to the experimental values of the frequency-ratio or the absolute values of the secondary potential. Evidence on these and other points will be described in a later section.

(To be concluded.)

Longest Span of Overhead Transmission Line in the World.—Claims are not infrequently put forward for exceptionally long transmission spans, that they are the largest in the world. That employed by the Stavanger Electric Power Co. for the transmission of 12,000 H.P. from the Lyselfjord station across Hoegsfjord to the transforming centre at Oltedaal, seems at all events to be well in the running. The three wires of this system are supported from three towers 7 metres high on either side of the fjord. The total free span is stated to be 1,384 metres, the sag 80 metres and the distance to the water surface 40 metres at the centre. The biggest span actually built is that across the Strait of Carquinez, in America. (A span of 1,500 metres across the St. Lawrence River is projected, and, when completed, will presumably form a record.) Owing to the shortage of materials, armoured copper or aluminium cable could not be obtained and ordinary steel cable had to be used. The cable uses 19 strands of wire 16 mm. in diameter, and the total stress in the cables, when there is no wind, is estimated at 4 tons. With a strong gale this may, however, be nearly doubled. It is stated that similar schemes have been projected for the west coast of Norway, and, according to "Ingeniören," from which these particulars are obtained, will be undertaken very shortly.

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British Scientific Products Exhibition.

(*Concluded from page* 384.)

ELECTRO-MEDICAL EXHIBITS

In this section there are several exhibits of interest, mainly by Messrs. SIEMENS BROTHERS, LTD.

X-ray Outfit for General Practitioners.—This outfit is suitable for operation from a direct current. The apparatus is fitted with a mercury interrupter, 12 in. spark induction coil and switchboard. The coil is mounted upon a pedestal, and the whole apparatus forms a most convenient installation for use either in a general practitioner's consulting room or small hospital, as it obviates the necessity of setting apart a large room for the accommodation of an X-ray installation. The main portions of the apparatus are in a compact and convenient form. The induction coil is mounted on the top of the wooden screen, which is adapted to form a protective screen for the operator. This is accomplished by lining the inside with lead and fitting a lead glass observation window. Beneath this window a switchboard is fitted, and on this is mounted the variable resistance, switches, measuring instruments, &c. A shelf is also provided for the mercury interrupter, so that the whole of the combined apparatus, including the induction coil, switchboard, mercury interrupter and overhead wiring for the X-ray tube can be wheeled into position for work and afterwards wheeled back into a convenient corner of the room.

Diathermy Apparatus.—This apparatus forms a convenient method of producing high-frequency currents for use in electro-therapeutics, and enables the temperature of the body to be raised in the treatment of diseases, and deeply-seated regions of the body to be heated, and not merely the superficial tissues. The apparatus consists of the necessary transformer for raising the pressure to about 2,000 volts, a spark gap similar to that which is used for wireless telegraphy, a hot wire ammeter, variable inductance, adjustable resistance and condensers, all being suitably arranged on a table fitted with large castor wheels to render the apparatus tractable.

Mercury Interrupter (New Model).—Complete with motor, fitted with switch for varying the number of interruptions per revolution, and another switch for converting the time of the "make" current; complete with gas taps for connecting to a gas supply for use with a gas dielectric.

Heliodescent Lamp Outfit.—This lamp has considerable therapeutic value, as its chemical and heat radiation have been found very advantageous in the treatment of many complaints. It is very abundant in ultra-violet and violet radiation, as the filament glows at a very high temperature. The outfit comprises a large nickel plated reflector fitted with a wooden handle to enable the lamp to be moved into position for treatment. The reflector is suspended from a bracket, so that it can be adjusted in any direction and then secured by the clamping screws provided.

Coolidge Tube Control Outfit.—This outfit is intended for use with a Coolidge tube to provide, by means of a small generator, the necessary energy for heating the filament. This motor generator is adequately insulated and mounted on porcelain feet; it has an output of 5 amperes at 12 volts.

The WESTINGHOUSE COOPER-HEWITT Co. show a medical lamp fitted with quartz and mercury vapour burners for ultra-violet light, which is used in the treatment of many diseases. Also a small domestic type of water steriliser, sterilisation being effected by means of ultra-violet light. At the present time such sterilisers can be supplied in units capable of dealing with 3,000 gallons per hour.

Messrs. SCHALL & SON exhibit both in the X-ray and in the electro-therapeutic rooms. In the former they show a complete X-ray outfit, consisting of a 12 in. coil, Tesla centrifugal mercury interrupter and a trolley switchboard, all mounted on an oak cabinet. In addition there are two tube stands, one of wood, for light therapy work, and one of steel for all-round heavy radiography work, a viewing box, a Mackenzie-Davidson interrupter and some measuring instruments.

The electro-therapeutic exhibit consists of galvanic and galvanic-faradic dry cell batteries, switchboards to use the main current for galvanism and faradism, and the necessary accessory apparatus.

In addition, a pantostat for converting the main supply current to a suitable form for cautery, light, galvanism and faradism is shown, and a small trolley for producing galvanism and a special faradic current to effect painless muscular contraction.

An exhibit of X-ray tubes is shown by Messrs. NEWTON & WRIGHT, and the MEDICAL SUPPLY ASSOCIATION show a selection of electro-medical apparatus, including a large static machine, such as we described recently. It is stated that about 75 per cent. of such apparatus came from Germany before the war.

MISCELLANEOUS APPARATUS.

The WESTINGHOUSE COOPER-HEWITT Co. show their silica mercury lamps, the particular one that is shown being for 3,000 c.p., suitable for operation on 200–250 volts continuous current at a consumption of only 3½ amperes. The renewable burners have an average life of 3,000 to 4,000 hours. Since the outbreak of war the company have specialised in this type and also on lamps for 2,500 c.p. on 100–130 volts and 2,000 c.p. on 200–250 volts. Polar curves show that the maximum candle-power is obtained at an angle of about 70 deg. with the horizontal. Large numbers of Cooper-Hewitt lamps are supplied for industrial purposes, more particularly for cinematograph work and for studio lighting. The company also have a speciality in blue-printing machines. These consist of a glass cylinder on which the tracing and printing paper revolve together with a series of endless belts, so as to secure good contact. The mercury lamp passes down the centre of the cylinder, which is cooled by means of a fan. Blue-print, washing and drying machines are also a feature. A small mercury vapour rectifier is also shown for battery charging. These can be supplied up to a capacity of 80 amperes, suitable for the operation of cinematograph arcs, &c.

The WESTMINSTER ENGINEERING Co. show one of their projection arc lamps, which are largely used in enlarging work as well as for projection purposes. This lamp is illustrated in Fig. 7. It will burn for about half an hour or more at 200 volts without attention, and may be used on both continuous and alternating circuits. The carbons being at right angles, the light is projected in one direction, which is a great advantage. By lengthening the arc a light of high actinic value is obtained.

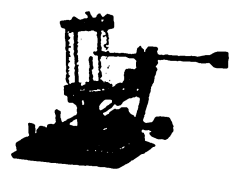

FIG. 7.

PROJECTION LAMP OF THE WESTMINSTER ENGINEERING Co.

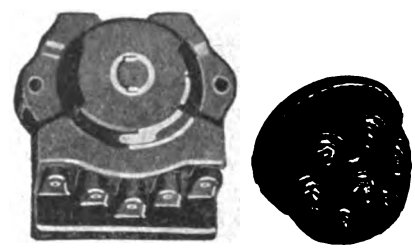

FIG. 8.

MOULDINGS BY FLEMING, BIRKBY & GOODALL (*see our last issue*).

Messrs. JOSEPH LUCAS exhibit some signalling lamp apparatus. In one of these there are two spring triggers, one for operating the lamp and the other for oscillating a mirror for the purpose of signalling. Such equipments are also provided with telescopic sights. Engine starting equipment and electric generating units are also shown suitable for operating wireless apparatus and other purposes.

The ELECTRIC WELDING Co. show a semi-automatic welding machine of neat design, suitable for welding iron, steel and copper wires, also harness rings, buckles and miscellaneous wire articles. One great advantage of the machine is that it can be operated by unskilled boy or girl labour, whose sole duty is to place the pieces to be welded in the clamps, close a switch and remove the welded article. The machine comprises a special single-phase welding transformer, having a primary winding of many turns and a secondary circuit of one turn only. The latter consists of a heavy copper casting terminating in a pair of gunmetal clamps, one of which is stationary, while the other is arranged to slide from right to left under the pressure of a powerful steel spring. The amount of pressure is adjustable by means of a hand wheel, and is indicated by a pointer and graduated scale. The primary circuit is controlled by a knife switch mounted on the welding transformer, and during welding is held in position by a catch. The latter is tripped automatically when the sliding clamp has moved a predetermined distance, and this distance is adjustable by means of a slotted quadrant and thumb-screw, the quadrant also having a graduated scale marked thereon. The pressure and cut-off once ascertained by trial for any given size of wire can be recorded to enable the machine to be re-set instantly with the assurance of obtaining uniform and satisfactory results. The transformer is of 4 kw. capacity, and the machine is suitable for welding iron and steel up to No. 6 S.W.G., and copper up to No. 7 S.W.G. The weld is made almost instantaneously, and several

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hundred welds can be made with an expenditure of 1 unit of electrical energy. The same principle of welding is applied to heavy sections, such as 12 in. × 1 in., except that the automatic cut-off is dispensed with and the pressure applied by a powerful hydraulic ram, machines of 250 kw. being employed for this class of work.

The Edison Swan Electric Co. (Ltd.) are showing some of their products at this exhibition, chief amongst which are their standard lines of mould blown and lamp-blown bulbs, glass tubing of various sizes and coloured bulbs, including Admiralty blue and green for signal lights, also copper ruby bulbs and well glasses. This company have always had their own glassworks, and so have had over 30 years' experience in the manufacture of glassware. A section of the exhibit is devoted to the Vitrite lamp caps in a variety of patterns and sizes. Previous to 1914 these were almost entirely imported, but as soon as war was declared, with characteristic energy the Ediswan Company determined to manufacture these important components themselves, and erected a plant forthwith. The output of the first machines which were installed not being large enough for the company's requirements, a new factory for this manufacture was recently erected, and is now in full working order, producing the standard sizes and types required for the many varieties of lamps and holders in present use. A feature of the exhibit is the "Pointolite" tungsten arc lamp, the invention of Mr. E. A. Gimingham, which was worked out in the research laboratory of the Edison Swan Electric Co. Many improvements have been made in the design and manufacture of the lamp, and it is now made in three sizes—30 c.p., 100 c.p., and 500 c.p.—which is largely used in lanterns for optical projection to replace carbon arc lamps and Nernst lamps, being much more steady and giving a concentrated point source of light. It is also used in a large variety of photographic work for printing, enlarging and in special cases where an intense point of light is essential. In addition to their other manufactures, the Edison Swan Company has a complete plant for the production of molybdenum wire from the ore to the finished product, and samples, showing the various stages of manufacture, are exhibited. The process consists chiefly in purifying and roasting the ore, reducing this to the metallic state in the form of a fine powder, and pressing the metal into ingots under very powerful hydraulic presses in steel moulds. These ingots are then sintered by passing an electric current through them, by which means they become more coherent and metallised, after which they are hammered, and finally drawn through diamond dies to the sizes required. The chief use of this wire is to support the filaments in the drawn tungsten wire lamps. Prior to 1914 this wire was largely imported from many countries, but the manufacture of all necessary supplies for home consumption is now assured.

In electric heating and cooking we notice an exhibit by the British Electric Transformer Co., in which is shown one of Mr. A. F. Berry's electric fires having a natural flame effect. Also an electrically-heated suit for airmen, an electric oven and accessories connected with electric heating and cooking.

The Dowsing Radiant Heat Co. show various heating elements, electric flat irons and the Belenus brander.

Silk-covered wires for instrument work are exhibited by the Concordia Electric Wire Co. (Ltd.). In pre-war days such wires came chiefly from Germany.

There are also exhibits of the well known products of the Fuller Accumulator Cable & Carbon Works, and of Simplex Conduits, Ltd. The Central Electrical Co., Ltd., show hand lamps, wall plugs and similar apparatus specially designed for efficient earthing; and there is an exhibit of the Wild Barfield annealing furnace, which we described recently.

The Labour Outlook.

BY OUR LABOUR CORRESPONDENT.

The outstanding event of the week, so far as the Labour world is concerned, has been the Trade Union Congress at Derby. To those who are unfamiliar with the Labour movement the relations between its various central organisations are confusing. Our American allies may perhaps be forgiven for assuming that the General Federation of Trade Unions is the chief industrial labour organisation in this country. Its comprehensive title and the resemblance the name bears to that of the American Federation of Labour is primarily responsible for the mistake. In point of fact, the General Federation is by no means so powerful a force as its name would imply, and it carries next to no authority compared with the Trade Union Congress, which really stands at the head of the trade union movement.

The Labour Party Conference, which is the supreme authority of the political Labour Party, consists largely, though not entirely, of delegates from trade union bodies, and a large number of those attending are to be seen at the Trade Union Congress. Trade unions supply a considerable proportion of the funds of the Labour Party. The Labour Party Conference consists of representatives of trade unions, social bodies, and local labour parties. Its annual meetings are held in January.

The Trade Union Congress is attended only by delegates from trade unions. It is, therefore, a purely trade union body. It holds its annual meetings in September. This year the Congress celebrates its jubilee. Though there had been national meetings previously, the Trade Union Congress is usually regarded as beginning its history with the gathering at Manchester in 1868. Since then, with but few setbacks, the Congress has increased steadily in size. During the present year the membership of the unions affiliated to the Congress has increased from rather over three millions to nearly four and a half millions. This large increase has been due to the continued growth of trade unionism amongst the workers and to new affiliations. The Amalgamated Society of Engineers, with a membership of 260,000, has now rejoined the Congress, after an absence of some years. The Workers' Union, with 590,000 members, has also affiliated.

Representation at Congress is based upon the number of members, as also is the subscription paid by each union. Practically all the important unions in the country are affiliated to the Congress, and all the prominent leaders of the trade union movement attend its gatherings. Robert Smillie, J. H. Thomas, J. R Clynes, Will Thorne, Harry Gosling, Ben Turner, to mention but a few names, are to be seen at every Congress. At the annual Congress resolutions submitted by affiliated bodies are discussed, fraternal delegates are welcomed, and reports received of the year's work. The accounts which the daily newspapers give of "scenes" at the Congress give an entirely false picture of the proceedings, which are for the most part marked by great seriousness and orderliness.

The Executive Committee, known as the Parliamentary Committee of the Trade Union Congress, is elected by ballot at the Congress. This body is re-elected each year, and its chairman presides at the Congress following his year's tenure of office. The Parliamentary Committee conducts the general business of the trade union movement, interviews members of the Government, watches and initiates legislation, deals with the domestic questions which arise within the trade union movement, and generally carries out the policy decided by the Congress.

Though there is a large common membership, and though even the subjects of discussion overlap considerably, the Labour Party Conference and the Trade Union Congress are distinct and independent gatherings. Nevertheless, more particularly during the war, close co-operation has been achieved, and the Executive of the former and the Parliamentary Committee of the latter hold regular joint meetings for the purposes of consultation on the wide range of matters of common interest. These two arms of the Labour movement are on cordial terms with the Co-operative movement, and there is now a large measure of understanding between the political, industrial, and co-operative organisations. The close observer must be struck by the gradual consolidation and growth of unity amongst the various working-class movements. The war has, of course, led to deep differences of opinion, and efforts are being made, for example, by Mr. Havelock Wilson, to render those differences permanent. But all who know the organised Labour movement, whether political or industrial, realise that those efforts will never be really successful. In a slow and cumbrous way Labour is working for unity. Those who fasten their attention upon heated scenes at Trade Union Congresses, and upon the obvious discrepancies between Mr. John Hodge and Mr. Havelock Wilson on the one hand and Mr. Smillie and Mr. Thomas on the other, will be misled. The truth is that the cleavages caused by the war are passing away in the face of the need for unity after the war.

Standardisation of Aircraft Materials and Parts.—Since January this work has been under the auspices of the British Engineering Standards Association, the Sectional Committee being under the chairmanship of Sir Arthur Duckham, K.C.B., and various sub-committees have been formed. Among these we notice one under the chairmanship of Mr. C. C. Paterson, O.B.E., dealing with electrical parts; one under the chairmanship of Brig.-Gen. Sir Capel Holden, K.C.B., dealing with sparking plugs; and one under the chairmanship of Lieut.-Comm. E. F. Saunders, R.N.V.R., dealing with magnetos.

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The Electrician.
FRIDAY, SEPTEMBER 6th, 1918.
Editorial and Publishing Offices:—
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The Committee for Scientific and Industrial Research.

The third annual Report of the Committee of the Privy Council for Scientific and Industrial Research has been issued, and a short abstract of its contents will be found in another column. As would be expected, the present Report is considerably more definite than its predecessors. The Department has now got thoroughly to work, and it is more easy to see what is desirable in the national interest than was the case some three years ago. Very substantial progress has been made, as will be gathered from the fact that some 30 industries are already actively engaged in preliminary work for the establishment of research associations. The Board of Trade has issued licences to three of these, while a number of others are approaching completion. It is also interesting to note that a conference has been held at the Ministry of Labour, at which an agreement was reached that the Department would consult the joint industrial council of an industry, where one exists, before proceeding to establish a research association for that industry.

Although the bulk of the research work in this country is likely to be carried on by research associations set up by the various industries, it is, nevertheless, a fact that there are also other bodies which are capable of doing a great deal of useful work. We refer to the technical societies, such as the Institution of Electrical Engineers, and others of that class. Before reading the present Report we were a little afraid that our engineering societies might not be looked upon very favourably by the Committee of the Privy Council, and that the whole of the research work would be turned over to research associations. We are glad to find, however, that this does not appear to be the case. It is recognised that important work can still be carried out by the bodies to which we have referred, and grants are still being made for this purpose.

A state of affairs on which emphasis is laid, and which is generally recognised, is the present dearth of men capable of carrying on research. So much is this felt to be the case by the Committee that a number of grants have been made to students who appear to be sufficiently promising, according to the reports of their professors, and to research assistant and to other research workers. This is an important development, and we think it is on the right lines. If young men of this character are desired, then the necessary encouragement must be given. This also brings us to the point raised recently by Sir J. J. THOMSON's Committee as to the difficulties under which many professors carry on their work, their time being so far filled up with routine work that they cannot give adequate attention to research. Further, in many cases salaries are distinctly inadequate for professors and assistants alike. While agreeing with this view, the Committee, although prepared to recommend maintenance allowances for students, or salaries for additional research assistants, feel that any further assistance will merely mean relieving the University funds from providing adequate salaries. In other words, Universities must not look to the Committee for assistance in paying their staffs properly.

The last paragraph of the Report deals with the difficult question of assisting inventors. It is stated that applications for assistance have been received from eleven inventors, and that the Committee have been unable to recommend a grant in any case. The view is expressed that "only occasionally will an inventor who has a good idea and the capacity to work it out seek Government assistance. He will, as a rule, prefer to rely upon his own resources, or to approach a firm known to be interested in discoveries of the kind he has made, and likely, therefore, to give him an immediate remuneration, even if they are not prepared to use his discovery or place it on the market. If such a firm is prepared to turn the invention to practical use, the inventor naturally sees in this a more direct means to his end than any offer we can hope to make for further facilities for experiments and tests." These sentiments show a sad lack of knowledge of the inventor's lot. The average inventor seldom has resources such as are necessary to prove the value of an invention, and if he goes to a manufacturing firm to assist him in carrying out the experimental work, the chance is he will get scant encouragement, or such terms as will not make it worth his while to continue his work. In their policy we think that the Committee might be more generous. It is notorious that, although the inventor is a national asset, he receives but scant encouragement in this country, and finds a much more useful outlet in the United States. "Sympathetic consideration" is not very material help for an inventor.

The present Report shows undoubtedly a very distinct advance in developing national research in this country, and there is every prospect that the results achieved will be worthy of the efforts that are being made.

The Reluctance of an Air Gap Having Slots in Both Opposing Surfaces.

By F. W. CARTER, M.A.

In your issue for February 8th* Dr. S. P. Smith refers to work of mine on the reluctance of a slotted air-gap, and suggests a method of adapting my results to the case of a gap slotted both on stator and rotor surfaces. I have for some years employed the approximation proposed in Dr. Smith's article, in the first instance as an intuition, and later, as the result of reasoned analysis. I cannot agree, however, that the methods by which he arrives at the approximation are either well founded or satisfying, for although there are any number of equipotential surfaces in the slotted gap, none of them are the plane surfaces to which alone his reasoning would apply. Even with slots directly opposite each other no such surface exists, except in the case of equal slots; the correct formula for the equivalent reduction in periphery with unequal opposing slots was, in fact, given by me in the course of a short Paper on "Magnetic Centering of Dynamo-electric Machinery,"† and is as follows, S_1 and S_2 being the slot widths, g the gap, and w the reduction in periphery required to give the actual reluctance

$$w=\frac{2}{\pi}\left\{\frac{S_1+S_2}{2}\tan^{-1}\frac{S_1+S_2}{2g}+\frac{S_1-S_2}{2}\tan^{-1}\frac{S_1-S_2}{2g}-\frac{g}{2}\log\left[1+\left(\frac{S_1+S_2}{2g}\right)^2\right]\left[1+\left(\frac{S_1-S_2}{2g}\right)^2\right]\right\}. \quad (1)$$

This formula includes as a particular case that for a slotted

* Page 659.

† Minutes of Proc. Inst. Civ. Engs., Vol. CLXXXVII., page 313, footnote (Session 1911-12, Part I.).

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opposed to an unslotted surface ($S_2=o$), from which my air-gap coefficients were deduced.* The formula in this case reduces to

$$w_1=\frac{2}{\pi}\left\{S_1\tan^{-1}\frac{S_1}{2g}-g\log\left[1+\left(\frac{S_1}{2g}\right)^2\right]\right\}. \quad . \quad . \quad (2)$$

The local nature of the disturbance in the flux distribution produced by a slot, led me some years ago to develop a method of treatment to suit the case where there were slots in both stator and rotor, a method which, although less secure in its theoretical basis than that developed for a single slotted surface, was yet logically founded and has now stood the test of somewhat extended application. The method in question was given by me in the course of the discussion on a Paper entitled "The Reluctance of Some Irregular Magnetic Fields," read before the American Institute of Electrical Engineers, by John F. H. Douglas,† and it would hardly be necessary to do

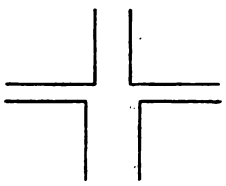

FIG. 1.

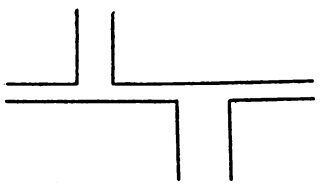

FIG. 2.

more than direct attention to the discussion here, were it not that the results were left involved in a general equation, and were therefore not in form convenient for the designer.

The following notation will be used :—

	Stator.		Rotor.
Number of slots	n_1	...	n_2
Width of slot (at mouth)	S_1	...	S_2
Slot pitch	a_1	...	a_2
Peripheral reduction per slot, given by equation (2)	w_1	...	w_2
Total periphery of armature	$n_1a_1=n_2a_2=p$		
Number of opposite slots	n		
Peripheral reduction per pair of opposite slots given by equation (1)	w		

The slots will be considered opposite as long as their centres are not more than $\frac{1}{2}c$ apart, where c is a linear quantity of the order of the width of a slot, whose approximate value has been deduced from the following considerations : The total flux between the opposing surfaces when slot is opposite slot (Fig. 1) is proportional to a constant diminished by w, given by equation (1), whilst the total flux when slot is remote from slot (Fig. 2) is proportional to the same constant diminished by w_1+w_2, given by equation (2). The total variation between the opposite and the remote positions is therefore known ; if the curve of variation were also known the mean value of the flux would be determinable. At considerable labour and with much cross-plotting I have computed the curve of variation in a few particular cases of equal slots in the two members (really for equal gaps in two opposing planes), and have determined the value of c such that if the flux has its maximum value for distance c and its minimum value elsewhere the integral value of the flux will be the same as in the actual case ; Fig. 3 shows one of the curves of variation in question. The value of c does not vary greatly fron one case to another, being 1·25 times the slot-width, when this is twice the gap, 1·13 times when it is three times the gap, and 1·07 times when four times the gap. The number of slots opposite to slots is

$$n=\frac{c}{a_1}n_2=\frac{c}{a_2}n_1=\frac{cp}{a_1a_2}.$$

The total equivalent reduction in periphery due to the slots is

$(n_1-n)w_1$ for stator slots opposite rotor teeth.
$(n_2-n)w_2$ for rotor slots opposite stator teeth.
nw for rotor slots opposite stator slots.

The equivalent periphery of the armature is therefore

$$\begin{aligned}p'&=p-(n_1-n)w_1-(n_2-n)w_2-nw,\\&=p-n_1w_1-n_2w_2+n(w_1+w_2-w),\\&=p\left[1-\frac{w_1}{a_1}-\frac{w_2}{a_2}+\frac{c(w_1+w_2-w)}{a_1a_2}\right]. \quad . \quad . \quad . \quad . \quad . \quad (3)\end{aligned}$$

The quantity within square brackets is the multiplier of the permeance, or the reciprocal of the air-gap coefficient ; writing k for the latter quantity accordingly

$$\frac{1}{k}=1-\frac{w_1}{a_1}-\frac{w_2}{a_2}+\frac{c(w_1+w_2-w)}{a_1a_2}. \quad . \quad . \quad . \quad . \quad . \quad (4)$$

It is desirable, however, to express k, if possible, in terms of quantities readily accessible to the designer.

Let k_1 be the air-gap coefficient for the slotted stator with unslotted rotor, the actual air-gap being assumed, and k_2 the corresponding figure for slotted rotor and unslotted stator ; k_1 and k_2 were given originally in Fig. 6 of the "Electrical World" article already referred to, and can now be found, in some form, in most text books and pocket books of the subject.

Then

$$\frac{1}{k_1}=1-\frac{w_1}{a_1} \qquad \frac{1}{k_2}=1-\frac{w_2}{a_2},$$

and equation (4) may be written

$$\begin{aligned}\frac{1}{k}&=\frac{1}{k_1}+\frac{1}{k_2}-1+\frac{c(w_1+w_2-w)}{a_1a_2}\\&=\frac{1-(k_1-1)(k_2-1)}{k_1k_2}+\frac{c(w_1+w_2-w)}{a_1a_2}. \quad (5)\end{aligned}$$

Thus, k is less than $k_1k_2/[1-(k_1-1)(k_2-1)]$, since the last term in equation (5) is always positive ; this equation may, however, be written

$$\frac{1}{k}=\frac{1}{k_1k_2}+\frac{c(w_1+w_2-w)-w_1w_2}{a_1a_2}. \quad . \quad . \quad . \quad . \quad . \quad (6)$$

The last term in equation (6) is small and generally negligible. It still appears, however, to be usually, though not

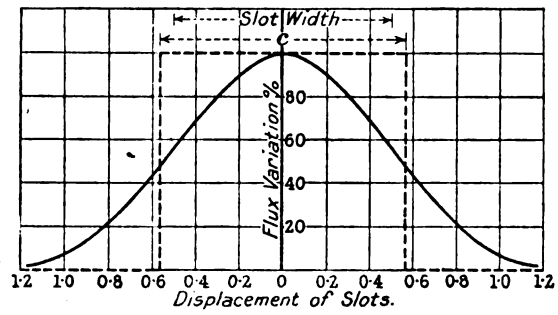

FIG. 3.

invariably, positive, so that k is generally somewhat less than k_1 k_2, and the simple approximation $k=k_1+k_2-1$ suggests itself as giving a little smaller value to k. This requires the neglect of a quantity of value

$$\frac{c(w_1+w_2-w)}{a_1a_2}-\frac{w_1w_2}{a_1a_2}\quad\frac{k_1+k_2}{k_1+k_2-1},$$

which in most practical cases is inappreciable.

Of course, in most cases the difference between the two last approximations is within the limits of error of the subject and either may be taken with equal confidence. Personally I usually prefer the approximation $k=k_1k_2$ in computing excitation, as giving a slightly greater value than the approximation $k=k_1+k_2-1$, and as having been found the nearer in certain extreme cases in which the difference was of consequence.

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"Sir William Ramsay as a Scientist and Man." By Tarini Charan Chaudhuri, M.A. (Calcutta : Butterworth & Co.) Pp. ix.+66. 2s. net.

"Income Tax Up to Date." By H. J. Gully, F.C.A. (London : "Financial News.") Pp. 20. 9d.

* See "Electrical World," Vol. XXXVIII., page 884 (November 30, 1901).

† Trans. Amer. Inst. Elec. Engs., Vol. XXXIV., p. 1067.

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Correspondence.

"APPROXIMATE INTEGRATION."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of Aug. 23 Dr. Russell mentions a method of approximate integration (p. 359, line 14). Surely this is a misprinted form of Weddle's rule ("Math. Journ.," II, 79, 1854). Line 14 should read :—

$$\tfrac{1}{3}(c-b)/20\}\ \{y_0+y_2+y_4+y_6+5(y_1+y_5)+6y_3\}.$$

Bletchley, Aug. 26. E. V. APPLETON.

We have submitted the above letter to Dr. Russell, from whom we received the following reply :—

SIR: Mr. Appleton is quite right. The suffix of the final y in the formula as printed in your issue of Aug. 23 should obviously be 3 and not 6. A proof of the formula is given in Boole's "Finite Differences," but a much simpler and more instructive proof by elementary algebra is given in Russell's "Alternating Currents," Vol. II., p. 122, 2nd Ed., where also a complete reference to Weddle's original Paper will be found.

Faraday House, Sept. 3. ALEXANDER RUSSELL.

WAVE VELOCITY AND CAPACITY OF HORIZONTAL HELICES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Permit me to thank Mr. Phillip R. Coursey for the illuminating remarks on my Paper of June 7 last, as appearing in your valuable weekly for July 5, 1918.—I am, &c.

Washington, D.C., U.S.A. A. PRESS.
Aug. 9.

TEMPORARY INCREASE OF CHARGES FOR ELECTRIC SUPPLY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should like to draw the attention of the provincial electric supply companies to the new Act (Statutory Undertakings (Temporary Increase of Charges) Act, 1918) referring to the above. Under this Act the Board of Trade is empowered to grant relief to electric supply companies whose financial position has been adversely affected by the war. The relief given would be by authorising an increase in the statutory charges, the relief being limited to sufficient to enable three-quarter pre-war rate of dividend being paid. Any applications can now, therefore, be sent to the Board of Trade accordingly. —I am, &c.

The Provincial Electric Supply Committee of the United Kingdom, Moorgate Court, London, E.C., Sept. 3. T. W. COLE.

Scientific and Industrial Research.

The Report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1917-18 has been issued. This is the third annual report of the Research Department, and covers the year ended July 31, 1918. The Report of the Committee, which precedes the Report of the Advisory Council, contains a summary of the year's expenditure and of the more important questions of policy, &c. The Committee state :—

As from April 1st last we assumed responsibility for the maintenance and development of the National Physical Laboratory. The Executive Committee of the Laboratory reported to us through our Advisory Council that the salaries of the Laboratory staff have long been gravely inadequate, and, with the sanction of the Treasury, we have introduced the amended scheme of salaries recommended by the Committee. We have approved extensions of the Laboratory which will enable it to undertake the testing of the higher grades of chemical glass and the testing of all clinical thermometers.

We have also established a Research Board under the chairmanship of Sir Lionel Phillips, Bart., to continue and develop the researches into the production of tin and tungsten in Cornwall, hitherto conducted with the aid of a grant from the department by the Institution of Mining and Metallurgy.

Satisfactory progress has been made during the year with the negotiations between the Department and the industries of the country for the establishment of industrial research associations. Our Advisory Council had reached the conclusion recorded in our last Report that co-operative associations of manufacturers under the Companies Acts, working without the distribution of profits and limited by a nominal guarantee, promised to be the most hopeful line of advance. Experience has shown that in all essential points the model memorandum and the conditions of grant have been suitable to the circumstances of widely different industries. The negotiations have led us to make certain changes of detail in the memorandum, and have enabled us to prepare a body of common form articles which will save time and expense in the formation of future associations. As regards the conditions of grant, it has been found convenient to deal with these in an official letter, which is addressed to each association after the receipt of its licence by the Board of Trade, in cases where the industry desires financial aid from the Government. A model letter, such as is used in normal cases, is printed in an appendix. But it is open to an industry to establish an approved association without seeking assistance from Parliamentary funds, and associations of this kind will have exactly the same privileges and will receive the same assistance in the way of advice and information, as associations in receipt of grant. The Department has found in the course of its conversations with leading manufacturers that there is sometimes a certain hesitancy to establish relationship with the Government for the purposes of research, because they fear that the Department will interfere in the work of the new associations, and will use its powers in such a way as to prevent the results of research from reaching the firms which have subscribed to its cost, or to give the results to competing firms which have not joined or have left the association. In general they seem inclined to believe that they are being invited to submit to a departmental yoke, which, especially if it is embellished with gold, will grow heavier and fit closer as time goes on, until at last the too complacent trade will find itself harnessed to the Government car, and led, if not driven, at the will of the paymaster. Such an issue would be fatal to the success of our scheme, and entirely opposed to the policy our Advisory Council have formulated and we have approved. Our intention is that the Associations shall manage their own affairs and benefit by their own discoveries. We believe that the Department can help each by keeping it in touch with the work of the rest; that the limitation of Government grants, in all ordinary cases, to a short period of years, and the provision under which an Association can either forego grants altogether or abandon them at any time, are evidences of our intention. The power of the Department to interfere in cases in which the national interest is concerned or in which the funds provided by Parliament are not being used for the purposes for which they were granted is surely the minimum safeguard that a democratic country could require. But if the firms in an industry will undertake research either for themselves or in combination on any other plan which they think better suited to their needs, they will as certainly receive the sympathetic consideration of the Department and such assistance as is in its power to render. We have never thought that the industrial research association would meet the case of all industries.

Out of the fund of a million voted by Parliament in order to enable the Department to enter into agreements with the new industrial research associations for the payment of grants over a period of years, the Department have guaranteed to the British Scientific Instrument Research Association an expenditure of £36,000 on approved research during the next five years. We have agreed to pay a grant of £1,500 a year during the same period to the British Photographic Research Association, and we have promised a yearly contribution of £ for £ to the forthcoming British Cotton Industry Research Association, and to the future British Research Association for the Woollen and Worsted Industry on condition that the subscriptions from the firms reach in each case an annual sum of at least £5,000.

During the past year three patents have been taken out by the Trust in conjunction with the respective inventors. We have approved during the past year 15 recommendations in respect of individual researches, inquiries and schemes of research, to be directly controlled by the Department. Five other researches which were begun last year have been continued under the control of the Department. We have also considered and approved recommendations in respect of aid to 21 scientific investigations of industrial importance conducted by other bodies. Fifteen of these had already received aid during the year 1916–17; the remaining six were new proposals. During the academic year 1917–18 we gave allowances or grants for equipment to 25 students under training in methods of research, and to 36 workers who were either undertaking independent researches or acting as assistants to research workers. In view of the urgent importance of increasing the supply of trained investigators, the expansion on this side of the work of the Department is very encouraging.

In the report of the Advisory Council it is stated that 22 meetings were held and the Applications Committee met 18 times. The various Standing Committees and their Sub-Committees and Sections held 14 meetings. Throughout the past year our attention has been devoted in growing measure to the organisation of those fields of research "which we can never hope to cover by means of Research Associations." We make no apology for calling attention again to the grave situation which would arise after the war from the demands for trained research workers if no adequate supply should then be forthcoming. The outlook to-day is at least as serious as it was when we made our first Report (1915-16). We have encouraging evidence on all hands that there is constantly increasing realisation of the need for organised research in connection

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with industry, but the movement for the formation of research associations will receive a serious set-back if the supply of trained researchers cannot be expanded in proportion to the increasing demands, and there is considerable danger of this happening. We therefore regard the expenditure on grants to students and other persons engaged in research as being an essential part of our organisation of the national resources for the application of science to industry. We must, however, again emphasise the partial and insufficient effects of anything which we can do to increase the supply of trained workers. The Department can help to make the career of the original investigator attractive but it cannot encroach upon the sphere of other departments. The responsibility for recruiting the army of men and women we need must lie upon the Education Authorities of the country. The Committee on the "Position of Natural Science in the Educational System of Great Britain" advocated (*inter alia*) that steps should be taken "to relieve the Professor" who in smaller institutions is often single-handed "of some part of his routine work and leave him more time for the organisation and supervision of research." We have announced our willingness to consider this last class of case as a temporary measure, but hitherto we have found that applications of this kind were in effect proposals that we should supplement inadequate salaries.

Industrial Research Associations.

Some 30 industries are already actively engaged in preliminary work for the establishment of Research Associations. The Board of Trade have already issued licences to three of these, the British Photographic Research Association, the British Scientific Instrument Research Association, and the British Wool Research Association, while the memoranda and articles of the British Cotton Industry Research Association, the British Portland Cement Manufacturers' Research Association, the British India-rubber Manufacturers' Research Association, and the British Motor and Allied Manufacturers' Research Association are approaching completion. Six other industries are engaged in drafting articles for their respective associations, and the remainder are conducting the necessary introductory negotiations.

We called attention in our last report to the importance of including some representation of labour wherever possible on the governing bodies or Councils of all Research Associations, and we expressed our belief that the Standing Joint Industrial Councils recommended in the Whitley Report would, if established, "greatly help the formation and development of Trade Research Associations." As the result of a conference recently held at the Ministry of Labour, at which our Chairman and Departmental Officials were present, an agreement was reached that the Department would consult the Joint Industrial Council of an industry, when one existed, before proceeding to establish a Research Association for that industry. And in cases where a Research Association had come into existence before the Joint Industrial Council the Department would help to bring the two organisations into touch.

There are many reasons why purely local associations would be probably less effective than those which include the whole of an industry or group of closely-allied industries, but one argument appears to be conclusive in itself. If a number of local associations were established within a single trade the question of making the results achieved by each available to the others, and the conditions to be attached to their availability, would of necessity fall upon the Department—a difficult and invidious task since the firms in the different groups might be in mutual competition.

Our consultations with the various groups of manufacturers engaged in the production of different types of internal combustion engine have confirmed our belief, gradually attained, that it is only possible to secure co-operative action for research among the firms of a single industry or between the firms in different groups of industry if the firms and the industrial groups are conscious of the existence of a number of unsolved problems which are of common interest to them all or to a large majority of them. To some extent no doubt the work of research will reveal common interests previously unsuspected, but it cannot be expected that firms should expend their funds in an unreasoned faith. The informal committee of the internal combustion engine makers which met us in conference soon discovered the absence of sufficient common ground for common action although all agreed that research was necessary and should be conducted on a co-operative basis.

For reasons somewhat similar the conference summoned on the initiative of the Faraday Society (and referred to in the last report) has not made as rapid progress as some of the other movements towards organising research upon a national scale. The aim of the conference was to unite both makers and users of refractories in a common attack upon problems involved in their manufacture and use. But though the interests of different classes of users are ultimately the same as those of the manufacturers they do not realise it, and they are in consequence not so easily brought into a single movement as the makers would be. We think it likely that the most accessible line of advance will be found in the makers organising themselves and then encouraging the users to come in as and when they feel inclined to do so. We have recommended the Committee of Council to make a grant of £1,500 to the authorities of the Pottery School at Stoke towards the erection of a new research building for refractories, on the condition that should approved Associations for either pottery or refractories come into existence they should be allowed to use the building free of rent charges.

(*To be concluded.*)

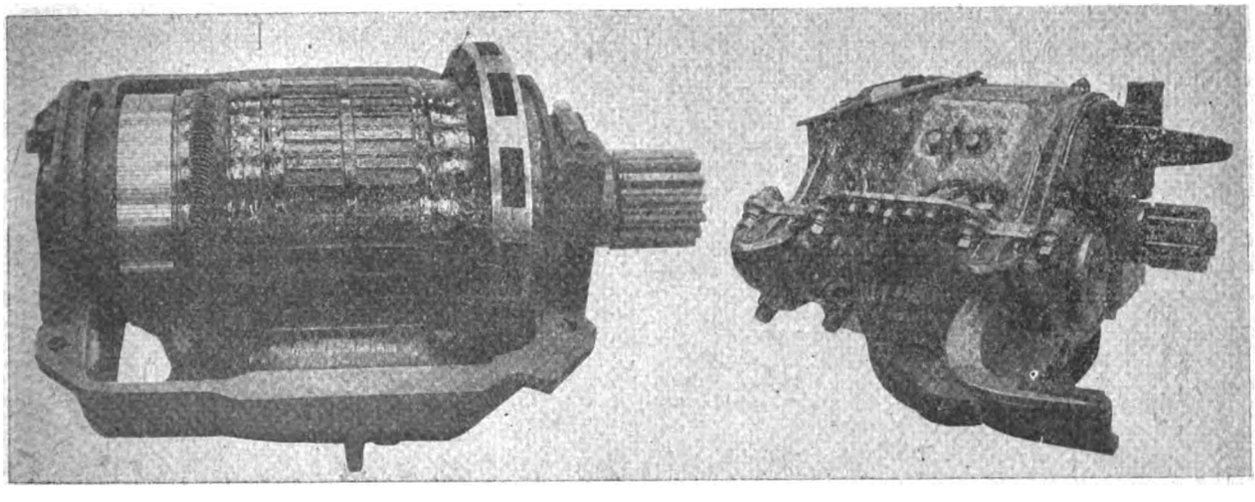
The Dick, Kerr Ventilated Tramway Motor.

The conditions under which tramway motors operate are well known to be the reverse of ideal; such motors owing to their location are necessarily of limited dimensions, and have to operate for lengthy periods without attention, and this despite the inherently dirty conditions of their employment below the car.

For this reason the totally enclosed type of motor has been very largely favoured by tramway engineers in the past, as being practically dust proof and watertight, although total enclosure naturally reduces the continuous rating of such a machine owing to temperature limitations, due to the difficulty of dissipating the heat generated in the motor.

Many of the difficulties associated with the design and operation of tramway motors would be obviated if a really satisfactory system of ventilation could be provided, and with this object in view Messrs. Dick, Kerr & Co., Ltd., have recently placed on the market a positively ventilated type of traction motor, which embodies all the features which the firm's long experience in this class of apparatus has shown to be essential to successful operation, and will strongly appeal to those engineers who favour the ventilated type of motor.

This machine, known as the D.K. 30, is of the interpole type, and in general design follows the firm's standard practice.



Ventilated Tramway Motor by Dick, Kerr & Co., Ltd.

It is, however, supplied with either split frame (as illustrated) or box frame, which latter construction is now finding favour particularly abroad, the frame itself is of high-permeability cast steel, fitted with separately cast armature bearing boxes on either side, which are firmly bolted to the frame.

This gives a very rigid construction, and one which facilitates dismantling for inspection as the armature can be retained in position while the bottom half of the (split) frame is removed or can be removed with it if necessary. The solid armature bearing boxes are also an effective preventive of oil creepage into the interior of the shell.

The main pole pieces are built up of laminated steel punchings, riveted

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together, and are interchangeable and fitted with former wound coils; these coils are specially insulated to withstand moisture and high temperature conditions, and are firmly held in position by flat steel springs, by means of which any shrinkage of the coil is automatically taken up. The interpoles are solid steel, with field coils clamped into position by screws.

The armature is of the firm's standard construction, special air ducts being provided in the core for ventilation purposes. To ensure that this ventilation is satisfactory and positive, a double-flow exhaust fan of compact form is fitted to the armature which draws one current of air through the armature laminations, and another air current over the field coils.

This air enters the motor casing through inlets of considerable area, which are located behind the commutator lid, where they are protected from dust and water, and is discharged through outlets at the pinion end, in a similarly protected position; both the air inlets and outlets are fitted with coarse protective screens, shaped so as not to restrict the volume of air entering or leaving the air ducts.

The volume of air and its velocity are such that any dust entering the casing is carried right through and expelled, an operation which the smooth direct air-passages greatly facilitates, as also the fact that no reversal of direction of air current occurs in the motor.

The cooling effect resulting from this positive system of ventilation increases the continuous capacity of the motor to 70 per cent. of the one hour rated capacity, as compared with a value of only 40 per cent. with the unventilated type of motor.

It is unnecessary to emphasise the value of this feature,as it is obvious that in tramway operation, the capacity of the motor for continuous operation during periods of 8 or 10 hours is far more important than its one-hour rating, and due to the cooler running conditions the life of the insulation is greatly increased, as it is unlikely to suffer from the effects of overheating.

Furthermore, owing to the improved utilisation of materials, a greater output can be obtained for a given weight or stated in another way a reduction in weight to be hauled can be made which represents a material saving in cost of operation.

The bearings of the armature as well as those for the axle suspension are lubricated by means of wool waste and horse-hair saturated in oil, a special channel being cast in the bearing box for oiling; the motor is also adopted for ring-lubrication, and owing to the oil storage capacity provided, the bearings will operate for long periods without attention.

The motor is fitted with the firm's standard brush gear; the axle is provided with a forged steel pinion cut from the solid, which meshes with a cast steel gear wheel, the gearing being enclosed in a malleable iron cast supported from the frame.

It is claimed that the D.K. 30 motor which is designed for a narrow (one metre) gauge, and rated at 40 H.P. when operating on 500 volts at a speed of 520 revs. per min., represents a great advance on existing designs, even of the ventilated type, both in efficiency and all-round reliability, and is specially adopted for use under the conditions met with in British tramway operation.

Coal Conservation Committee.

As was stated in our issue of Aug. 23, the final report of this Committee has now been published. Owing to the large field to be covered, five sub-section Committees were appointed to deal with different phases of these questions, namely, with mining method, power generation and transmission, metallurgy, carbonisation and geology. At a later date the sub-Committees on carbonisation and metallurgy were amalgamated. The reports of these various sub-Committees have been approved and adopted by the main Committee, and they are now published along with the final report in the form of appendices. The report of the Power Generation and Transmission Committee was published separately; it was given in THE ELECTRICIAN of Dec. 28, 1917, and its recommendation of a national scheme of electrical generation and transmission attracted wide attention. This report is reproduced in the final report which forms a comprehensive survey of the place of coal in the industries of the future.

Considerable attention has been given to the part which the carbonisation of coal is calculated to play in reconstruction and all known methods of preparation and treatment have received full examination. Steps are suggested not only for making more efficient use of those grades of coal at present burned in a raw state but also for putting to valuable use inferior coal, shale and coal dust, now regarded as waste. Another matter of which the Committee emphasise the importance is the necessity of obtaining fuel oils, motor spirit and the raw materials for explosives, drugs and dyes. It is considered practically certain that larger supplies can be obtained from coal by the new methods of working which are proposed. The report does not, however, carry us as far as we anticipated, as this part of the subject has been largely handed over to the Fuel Research Board.

The Committee recommend the combined working in groups or units of coke ovens, blast furnaces, steel furnaces and rolling mills, each unit to have a capacity of from 300,000 to 500,000 tons of finished steel per annum. One of the conditions of success will be the grouping of these united plants in suitable districts.

A definite conclusion has been reached regarding the production of electric power on a large scale, and it is felt that there is also a definite field for the use of gas engines of the ordinary type. Research work is in progress with a view to forwarding the design and production of internal combustion engines. The necessity of replacing old with modern plant, especially in the smaller colliery undertakings, is pointed out as a further means of economising in fuel.

The establishment of a Ministry of Mines and Minerals is recommended. It is proposed that, with certain exceptions, those functions connected with the coal mining industry now vested in various Government Departments, shall either at once or after the war be transferred to a Ministry presided over by a Minister with a seat in Parliament. It appears that no fewer than seven Government Departments are now intimately concerned with mines and minerals.

It is pointed out that considerable possibilities in connection with the location of new coalfields and the extension of those already being worked, lie within the scope of the geological survey now being made. It is possible, the report shows, that a large increase in our mineral wealth might be found were systematic exploration carried out by this body.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

SPECIFICATIONS, 1918.

111,478 BRITISH INSULATED & HELSBY CABLES & BLADES. Terminal box electrical or conductor insulators. (29/5/17.)
117,490 B. T.-H. CO. (G. E. Co.) Illuminating device containing electric incandescent lamps. (17/7/17.)
117,498 MOYSE. Device for guiding the trolley pulley of an electric car into contact with its overhead wire. (20/7/17.)
117,499 SIMPLEX CONDUITS & WATERHOUSE. Electric radiators. (20/7/17.)
117,505 SCHOLEY & WOODROFFE. Electric drilling apparatus. (25/7/17.)
108,482 SYNDICATE GRAAMANS PATENT. Electric batteries. (29/7/16.)
117,533 KIMURA. Apparatus for the electrolysis of water. (19/9/17.)
110,354 WESTERN ELECTRIC CO. Telephone exchange systems. (11/10/16.)
717,546 ENGELHARD & SOC. AUTOMATISME ET APPAREILLAGE. Electric time-relays. (19/10/17.)
111,489 PFLEUMER. Thermo-electric generator. (28/10/16.)
117,559 DAVIDSON. Electrically heated sheets, rugs, mattresses, foot warmers and the like. (17/11/17.)
116,496 MARAZZI. Terminal for the attachment of magnetic wires to sparking plugs of engines. (21/3/17.)
117,604 BASSI. Ignition magneto for explosion engines. (30/6/17.)
117,821 MORRIS. Electrostatic machines. (24/2/17.)
117,822 ALEXANDER VINT & IMBERY. Process of annealing metal wire by electricity. (30/7/17.)
117,825 VALENTE DA CRUZ. Magnetometers for measuring weak magnetic fields. (23/4/17.) (Cognate application, 7,444/17.)
117,830 WEST & Co. and BOSSOM. Electromagnetic lock-out switch. (28/6/17.) (Cognate application, 13,616/17.)
117,838 MARKS. (Sparks-Withington Co.) Electric diaphragm horns. (30/7/17.)
117,849 MIDGLEY and VANDERVELLE & Co. Self-regulating dynamos. (4/8/17.)
117,853 GEHRIG. Automatic regulator for electric machines. (8/8/17.)
117,867 B.T.-H. Co. (G.E. Co.) Systems of electric transmission. (23/10/17.)
117,872 BOLTON & WALKER. Deposition of metals by electrolysis. (8/11/17.)
117,881 PETERSEN & ALLMANNA SVENSKA ELEKTRISKA AKTIEBOLAGET. Electrically operated diaphragm horns. (4/1/18.)

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

July 12, 1918.

1,444 B.T.-H. Co. (G.E. Co.) Electric locomotives or cars.
11,459 GITSHAM. Instrument for fixing short ends of carbon in arc lamps.
11,461 TELEGRAPH CONSTRUCTION & MAINTENANCE CO. Lighting buoys.
11,478 ELEKTRO-MATERIAL GES. Insulation of electric installations. (11/4/18, Germany.)
11,483 CALLENDER'S CABLE & CONSTRUCTION CO. & BOOTHROYD. Supporting devices for tubes, electric wires, &c.
11,484 NIHON DENKI KOGYO KABUSHIKI KRISHA & YANAI. Leading-in conductors for electric lamp bulbs, &c.
11,485 OHTANI. Leading-in conductors for electric lamp bulbs, &c.
11,486 CALLENDER'S CABLE & CONSTRUCTION CO. & BOOTHROYD. Junction boxes, &c., for electric wiring installations.

July 13, 1918.

11,500 KIRK. Electrical burglar alarms.
11,515 KORESSIOS. Centrifuge electric speed governor.

July 15, 1918.

11,562 SIEMENS SCHUCKERTWERKE. Energy-regulating arrangements for electric circuits. (13/6/17, Germany.)
11,573 B.T.-H. Co. (G.E. Co.) Electric locomotives or cars.
11,577 BOWERS & MASON. Magnetic tray control for use in biscuit-making machinery.
11,582 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. & KUYSER. Windings for dynamo-electric machines.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W.1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain of the Week.—Capt. E. G. Fleming.
Next for Duty.—Capt. W. Hynam.
Monday, Sept. 9 to Saturday, Sept. 14.—Drills as usual.
Sunday, Sept. 15.—Commandant's Parade at Waterloo Station, 8.45 a.m. for work at Esher. Drill Order without rifles. Mid-day and tea rations to be carried.
Recruits' Drill, 6.30. Ambulance Section, 6.30. Signallers, 6.30. Band, 7.0.
Friday, Sept. 13.—Range, 5.30.

SPECIAL NOTICES.—All drills will take place at headquarters unless otherwise stated.

The medical officer will attend for the examination of recruits at 6.0 p.m. on Thursday evening.

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Commercial Topics.

Royal Commission on Decimal Coinage.

A Royal Commission has been appointed to consider and report whether it is advisable to make any changes in the denominations of the currency and money account of the United Kingdom with a view to placing them on a decimal basis, and whether, if an alteration of the present system is recommended, it is desirable to adopt with or without modification the proposals embodied in the Bill recently introduced into the House of Lords by Lord Southwark or some other scheme, and in the latter alternative to make specific recommendations for consideration by Parliament.

The members of the Commission are—Lords Emmott, Southwark, Faber, Ashton of Hyde and Leverhulme; Sir R. V. Vassar-Smith, Sir Joseph Larmor, Sir Geo. Croydon Marks, Sir Alfred W. Watson, Messrs. John W. Cawston (Deputy Master and Controller of the Royal Mint), Sydney A. Smith, Charles Godfrey, James Bell, Joseph Burn, Harold Cox, Geo. Hayhurst, Theodore McKenna, Geoffrey Marks, James F. Mason, Albert Smith, Geo. Murray Smith and Gilbert C. Vyle.

* * * *

Wages of Men and Women Workers.

The Government have appointed a Committee "To investigate and report as to the relations which should be maintained between the wages of women and men, having regard to the interests of both as well as to the value of their work. The recommendations should have in view the necessity of output during the war and the progress and well-being of industry in the future."

The Committee will consist of the Hon. Mr. Justice Atkin (chairman), Dr. Janet Campbell, Sir Lynden Macassey, K.C., Sir W. W. Mackenzie, K.C., and Mrs. Sidney Webb. Lieut.-Col. the Right Hon. Sir Matthew Nathan, G.C.M.G. (Secretary to the Ministry of Pensions), has been appointed as Secretary to the Committee.

Communications on matters concerning the Committee should be addressed, till further notice, to the Secretary, 2, Whitehall-gardens, S.W. 1.

* * * *

Australian Telegraphs and Telephones.

The report of the Postmaster-General for the year ended June 30 1917, states that for the first time there was a profit shown on the working of the telephones of £17,234 Contracts have been let for the supply of automatic switchboards at the City North (Sydney) and Malvern (Victoria) exchanges.

The following statistics of the various States are given in the "Telegraph and Telephone Journal":—

	Telegrams received and despatched.		No. of Offices.
New South Wales	11,678,845	(11,504,271 in 1916)	2,231
Victoria	7,243,763	(7,071,588 ")	1,711
Queensland	4,955,874	(4,084,880 ")	795
South Australia	4,611,598	(4,386,774 ")	516
Western Australia	3,222,825	(3,327,470 ")	503
Tasmania	1,137,744	(1,105,753 ")	433
Total for Commonwealth.	32,850,649	(32,201,736 ")	6,189

Telephones.

	No. of exchanges.		No. of stations.	
New South Wales	765	(705 in 1916)	72,884	(69,010 in 1916)
Victoria	622	(586 ")	51,820	(48,812 ")
Queensland	256	(248 ")	22,616	(21,430 ")
South Australia	189	(143 ")	14,521	(13,404 ")
Western Australia	111	(105 ")	10,760	(10,852 ")
Tasmania	401	(95 ")	5,136	(4,908 ")
Commonwealth	2,044	(1,882 ")	177,737	(168,416 ")

The number of telephone subscribers in Sydney was 34,082, in Melbourne 25,665, in Brisbane 7,170, in Adelaide 7,837, and in Perth 4,981. As the proportion of "lines" to "stations" in the Commonwealth was as 137,000 to 177,000, there should be over 43,000 stations in Sydney, 33,000 in Melbourne and 10,000 in Adelaide.

Electricity Supply.

General.

Cavan.—The Guardians have asked the consulting engineer (Mr. J. P. Tierney) to expedite the work on their electric lighting scheme.

Darwen.—An application has been received by the Corporation from the electrical workers for an increase of 3s. 6d. per week.

Electricity versus Gas Supply.—At the recent meeting of the Wandsworth, Wimbledon & Epsom District Gas Co., the chairman (Mr. H. E. Jones) referred to the report of the Board of Trade Electric Power Committee and its probable effect on gas supply.

Mr. Jones said that their company was founded to supply gas for lighting, but gradually they had extended it to heating and cooking. In his opinion no one would get that business away from them, because there was no other form in which coal could be so scientifically and economically used. Electricity could not touch them in that respect. They were dependent on the workmen's homes, where 22,000 ft. or 23,000 ft. of gas was consumed annually for domestic use. That was the class of business which, he believed, could never be taken from them. The rich man with gas in his kitchen and passages, might like to have electric light in his drawing-room. Their works were never built with the idea of supplying large ironworks. It was impossible to have anything of that sort in London. The electrical conduction of power from a large central installation was economical and he did not pretend it was not. There was not the slightest fear of their property being damaged, much less extinguished, by anything the electricians could do, and when he looked at the market prices of their stocks, and saw the miserable level to which they had fallen, he could only beg of them not to sell them. "Hold fast," and all would be well.

Glasgow.—On Friday last the members of the Electricity Committee paid an official visit to the new Dalmarnock power station after having lunched together in the City Chambers.

At the luncheon, Mr. JOHN TRAIN, who proposed the toast of the Electricity Department, said that the output of the department was last year 151,000,000 units against 77,000,000 units for the year 1914, and during the period since the outbreak of war the total output was equal to the output for the previous 20 years.

Bailie HANNAY, Convener of the Electricity Committee, in replying, traced the history of the department and showed by figures the phenomenal success of the Corporation's electrical undertaking.

Forty-five acres of ground have been acquired at the site of the power station at a total cost of £63,100. In August 1914 offers were accepted for the inlet and outlet water culverts and the foundations. This work was completed at the end of 1916, the cost being £83,000. The inlet water supply is in duplicate. The previous decision to suspend during the war the erection of the super-structure and installation of plant was rescinded in 1916 owing to the large increase in the demand for power for shipbuilding and engineering concerns, and in the summer of 1916 contracts were fixed for reinforced concrete buildings, brick and mason work and joiner work constituting one-half of the generating station, one-half of the switch house, two boiler houses and complete coal storage. These contracts amount in all to £120,000. Since April, 1917, orders have been placed for four 18,750 kw. (25,000 H.P.) turbo-alternators and condensing plant, together with eight boilers and accessories necessary for the complete equipment of one boiler-house. A contract has also been fixed for a complete coal-handling plant. The buildings inspected are laid out as follows:—

The turbine room (230 ft. by 75 ft.) is the main building. On the north side of the turbine room and at right angles to it there will be two boiler houses each to contain eight boilers. On the south side of the turbine room the switch house is being erected. This building will contain the main switchgear as well as 20,000 volt transformers. The coal store has an area of 2½ acres and is capable of accommodating 60,000 tons of coal. The walls and half the roof of the first half of the turbine room are completed. One boiler house is two-thirds completed, but the switch house is erected to the ground floor only. Owing to restrictions in the use of steel, reinforced concrete has been used throughout in place of steel girders. Ample railway sidings for the delivery of coal are provided. The coal handling plant has been designed for the rapid and economical handling of an amount of coal amply sufficient for the ultimate maximum requirements of the station. The boiler house is a three-story building. The basement will contain forced draught fans and give space for the entry of trucks to take away ashes; the first floor will accommodate the boilers and accessories; and the second floor will house economisers and induced draught fans. The turbine room is a two-story building, the basement containing condensing plant, the first floor housing the turbo-alternators and accessories. The switch house being a separate building will enable the operating staff to perform their duties undisturbed by the noise of rotating machinery. A workshop is erected alongside the first boiler house at the end of the turbine rooms. The workshop crane will run out over the railway track for the lifting of heavy machinery from the railway into the turbine room where the turbine-room crane will deal with it. The machinery and accessories on order for the turbine room, boiler house, switch house, &c., will cost £860,000.

Manchester Ship Canal.—Among improvements which the Manchester Ship Canal Co. proposes to carry out at the Manchester docks are the provision of railway sidings, warehouse extensions and additional electric lighting installations.

Electric Traction.

Bristol.—The Board of Trade has ordered that the period during which the Corporation of Bristol are entitled to give notice of their intention to exercise their option of purchasing the Bristol tramways undertaking shall be extended for one year from Oct. 51, 1918.

Edinburgh.—A public inquiry will be held on the 1st prox. into the application of the Corporation for power to construct an electric tramway to Queensferry.

Tramway Workers' Wages.—The Committee on Production has issued its award on the questions arising out of the recent strikes of motor omnibus and tramway workers.

Among the claims was one for equal total payment to be made to women and men for equal work in the tramway and omnibus undertakings, parties to the awards of March 8 and July 9, 1918.

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After giving an explanation of previous awards, the Committee grant to women aged 18 and over whose terms of employment include an undertaking that they shall be paid the same rates as the grades of men whose places they have filled, such advance as shall give 25s. per week over the pre-war rates of the grades concerned, payment to be made on the basis of a week of six days or six shifts. In the case of women aged 18 and over not covered by the above clause an additional increase of 5s. a week, subject to a maximum of 25s. a week over the pre-war rates of the grades concerned, payment to be made on the basis of a week of six days or six shifts.

The increases to take effect as from the beginning of the first full pay following July 9, 1918.

The committee recommend that the whole question of women's wages and advances should be made the subject of a special inquiry, in which women can take part, and at which all the facts and circumstances which must be taken into account before any general guiding principle can be safely or properly formulated may be fully investigated.

The committee approve of the principle that when general changes of wages are under consideration the wages of women as well as men should be considered, and they recommend that the parties should formulate an agreement providing for a regular procedure for the periodical consideration and review of wages in the industry concerned.

As regards the claim submitted in the case of the Croydon Corporation for the extension to that authority of the awards of March 8 and July 9, the committee suggest that the parties should meet with a view to arriving at a settlement between themselves on the matter.

Wallasey.—In order to economise coal the number of stopping-places has been reduced, and it is now proposed to limit the services and to reduce the hours of service.

Telegraphy and Telephony.

Swedish States Telephone Extension.—The A.B. Stockholmstelefon (formerly Allmanna Telefon) is to be taken over by the Swedish Telegraph Administration, and amalgamated with the Rikstelefon (the State Telephone System).

The sum to be paid by the Telegraph Administration for the company's telephone lines, plant, apparatus, &c., is about 47,000,000 kronor. A conditional agreement has been sanctioned by the Government, but it must be approved by the Riksdag. The Stockholm Telephone Co. has a capital of 18,000,000 kronor and the competition between the company and the State Telephone systems has been very severe.

Wireless Telephony in China.—It is announced that the Marconi Company signed a contract on Aug. 24 with the Chinese Ministry of War to supply 20 wireless telephone installations for military purposes.

The company will lend the Government £600,000, bearing 8 per cent. interest, half for the purchase of the telephones, half for unspecified expenditure. This is regarded as a test of the scope of the Japanese wireless loan, the terms of which were unknown, but were supposed to give the Japanese a monopoly of the wireless business in China.

Imperial Notes.

Australasia.—At a recent meeting the Tasmanian Premier (Hon. W. H. Lee) referred to the State's hydro-electric power scheme and the opportunities it would offer for the establishment of new industries in Tasmania.

Mr. Lee suggests that after all the State requirements have been met and provision made for the future, consideration might be given to the question of carrying cables across the Bass Straits to Victoria, and thus give Australian manufacturers interests cheap power. The numerous lakes and rivers in the mountainous country of Tasmania would enable electric power to be generated on a big scale, and as the distance between Tasmania and Victoria is only about 100 miles, there would be nothing impracticable in the Premier's suggestion. At present the problem of supplying electric power in Melbourne is an acute one, electricity is generated by steam plant, and it is estimated that it will require an expenditure of £2,000,000 to supply all the power which has been applied for in Tasmania. The British Government cannot see its way clear at present to give the necessary authority for the necessary machinery to be constructed in England, and inquiries in America have not (it is reported) had any satisfactory result.

The General Electric Co. of Australia has submitted to Wagga (N.S.W.) Council a scheme for supplying the municipality with electricity for lighting and power. The scheme will cost about £34,000.

Coburg (Victoria) Council has resolved to instal a municipal electric supply scheme. Mr. V. J. Crowley estimates the cost at £12,500. There are 80 local ratepayers who take electricity from Brunswick.

Rockhampton (Queensland) City Council has invited applications from persons qualified to supply plans and specifications and estimates of the cost of installing plant for the supply of electricity to the city of Rockhampton.

Fitzroy, Northcote and Preston Tramway Trust propose to invite tenders for the construction of the electric tramway.

A petition, signed by ratepayers and residents of Armidale (N.S.W.), has been presented to the Minister for Local Government, urging that permission be granted to light the city of Armidale by electricity generated by water power.

The Victorian Hydro-Electric Power Co. has asked the Victorian Premier (Mr. Lawson) to introduce a Bill to authorise the Company to use the water-power of the Kieiva river for 50 years.

Canada.—On behalf of the Department of Mines, Dr. Alfred Stansfield, professor of metallurgy at McGill University, is conducting an investigation into the possibility of the electrical smelting of iron ores in British Columbia.

Sir Adam Beck, chairman of the Hydro-Electric Power Commission of Ontario, has announced the probability of another hydro-electric power development in the neighbourhood of Port Arthur on the Nipigon River. There are two sites on the river with a combined possibility of about 70,000 H.P. each, and at the site it is proposed to develop first there are two main falls within a short distance of each other, with a combined head of 105 ft. The first development will be planned to include the whole head of 105 ft. for an ultimate capacity of 75,000 H.P., and an order-in-council has been passed for an initial development of 30,000 H.P. This will probably require four units and an expenditure of $4,500,000. The site is about 65 miles from Port Arthur, to which there will be a 110,000 volt transmission line.

Canadian Water Power Development.—Work is progressing rapidly on the power line of the West Kootenay Power Co. to Copper Mountains, and the Canada Copper Co. is also making good progress with the construction of its concentrating mill.

The mill is to be ready for operation as soon as power and transportation facilities are available. It is expected that the mill will receive from 2,000 to 3,000 tons of ore per day, and a ten years' supply of ore is stated to be available.

Niagara Falls Power Supplies.—War industries use 85·29 per cent of the power generated by means of the Niagara Falls by the Hydraulic Company and the Niagara Falls Power Co., and 54·29 per cent. of the power generated by other co-operating companies.

The supply falls short of the demand by about 200,000 H.P. This is to be relieved by enlargements of the steam plants of the Buffalo General Electric Co. and the Niagara, Lockport & Ontario Power Co. The proposed additions to these two plants will aggregate 62,000 H.P. By means of a further development by the American hydro-power companies at Niagara Falls their existing supply of power, amounting to about 250,000 H.P., will be increased by about 160,000 H.P.

Foreign Notes.

Japanese Electrical Exports.—A party of Chinese business men and journalists recently visited, by special invitation, the electrical exhibition in Uyeno Park, where domestic electric appliances, lamps, electro chemical plant, wireless telegraph and telephone apparatus, &c., were exhibited.

It is stated that the opportunity afforded by the stoppage of German, British and American supplies of electrical machinery to China is being turned to good account by Japanese manufacturers. The latest figures available show that the exports of electric lamps and apparatus from Japan are already valued at 7,300,000 yen (nearly £750,000 at par rate) per annum.

Reconstruction in Germany.—According to the "Board of Trade Journal," reconstruction schemes have been severely criticised in German political and commercial circles, and the Imperial Department of Economics has been compelled to issue a statement of their ideas for the organisation of industry and trade in the transition period.

This statement points out that some form of State control of trade and industry in the transition period is necessary, chiefly for the sake of improving the exchange and because of the scarcity of tonnage which will exist at the conclusion of peace. Such control will not be necessary for all industries. It will be chiefly required in the textile trades, in certain Colonial importing trades, indiarubber, fats, oils, hides, leather and in the shipping industry.

It is not intended to exclude private trade, in principle, from a share in the organisation, but rather to hand over the solution of the questions of self-government connected with it to the circles concerned. A number of Economic Boards will be set up, on which representatives of the branch of trade or industry concerned may sit, and which will exercise control over the distribution of the foreign exchange and of tonnage. The Imperial Department of Economics has no intention of creating compulsory syndicates. The Economic Boards are to have an official character; they are to levy fees and taxes to cover cost of administration. Without interference with the development of national economy, the Imperial Department of Economics will endeavour to build up again the position of the middle classes, who have been most severely injured.

For the sake of the exchange it is proposed to maintain in force the Foreign Bills Order, in order to be able to distribute with security in foreign countries payments for important imports. The Reichsbank will co-operate with the Department for this purpose.

In shipping circles it has lately been asserted that the tonnage prospects after the war are highly favourable. The Imperial Department of Economics finds itself unable to agree with this view. It is the duty of the Department to take measures in good time to meet the situation, but the task will be entrusted to the shipping industry itself, and the prospective Tonnage Distribution Office of the German shipping industry will only decide questions of a technical nature. The adjustment of interests between the shipping industry and freight users and consumers calls for state control of the Tonnage Distribution Office. The Imperial Controller will be chosen from shipping circles.

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The situation with regard to Colonial goods may be regarded as extremely favourable. There will be no scarcity here after the war, but rather a superabundance, and organisation will be necessary to prevent a flooding of the German markets, a waste of tonnage and bad effect on the exchange.

In an article in the "Frankfurter Zeitung" it is stated that of the pre-war imports (of which the value was 10 milliards of marks) 5 milliards were raw materials and 3 milliards food-stuffs and tobacco. Some of these have been done without during the four years of war, while for some substitutes have been found. In the cotton trade, of 1,700 spinning and weaving factories, only 70 large ones are working; in the silk trade, of 45,000 looms, only 2,500 are at work; in the oil industry, only 15 out of 720 businesses are still active. And after the war much raw material will be required . . . many war substitutes will continue to be used. If there should be a scarcity of tonnage, it is necessary to provide for two things: (1) that the first place should be given to absolutely necessary imports—food and raw materials; and (2) that the available tonnage should be used for German and not foreign requirements. These considerations have led to a number of Federal Council war orders. Freight contracts made after Dec. 1, 1916, lose their validity on the declaration of peace unless they are approved. No such contracts for the period after the war may be made without permission of the Imperial Department of Economics. The plans of the Imperial Department of Economics for the transition economy of shipping, which have been so vigorously opposed by Hamburg in the last few weeks, have but one object, the scrapping and re-casting of these orders. A Tonnage Distribution Company is to be set up in Hamburg, which is to control all German merchant ships of more than 500 gross tonnage during the transition period. The orders of this Company, especially those dealing with exports and the kind of goods to be carried, have to be observed by the shipping companies; freight contracts may only be made with the approval of the company and reports and returns must be made to it. The Company itself will be under the supervision of the Imperial Chancellor, who will nominate a Standing Commission for this purpose. It is this Commission which is the chief cause of the Hamburg opposition to the whole scheme.

Miscellaneous.

Alien Enemy Patents.—Messrs. J. S. Highfield, A. A. Campbell Swinton and P. D. Tuckett have been granted licences to develop 34 German electro-chemical patents granted to the Gesellschaft für Elektro Osmose (m.b.H.), the Farbwerke vorm. Meister, Lucius & Brüning and Schwerin.

Enemy Firm Wound Up.—The Board of Trade has issued further Orders requiring certain businesses to be wound up including Winter & Almenraeder, 48 and 49, Great Sutton-street, London, E.C. 1, importers of vulcanite, &c., successors of H. Traun & Sons, 25, Goswell-road, London, E.C. 1, manufacturers of ebonite. Controller: J. D. Pattullo, 65, London-wall, London, E.C.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during July, 1918, and (*b*) the aggregate figures from Jan. 1 to July 31, with increase or decrease compared with corresponding periods of 1917:—

Electrical machinery, (*a*) £35,218 (decrease £83,555), (*b*) £443,430 (decrease £405,500); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £14,001 (decrease £15,347), (*b*) £80,966 (decrease £70,929); and electrical machinery unenumerated, (*a*) £21,217 (decrease £68,208), (*b*) £362,464 (decrease £334,571); telegraph and telephone cables other than submarine, (*a*) £90 (decrease £3,337, (*b*) £1,936 (decrease £47,344); telegraph and telephone apparatus, (*a*) £9,344 (increase £7,556), (*b*) £33,007 (increase £13,622); other electrical wires and cables, rubber insulated, (*a*) nil (decrease £2,670), (*b*) £657 (decrease £28,068); with other insulations, (*a*) £33 (decrease £1,319), (*b*) £760 (decrease £6,172); carbons, (*a*) £2,837 (increase £543), (*b*) £25,339 (decrease £25,851); glow lamps, (*a*) £14,520 (increase £11,485), (*b*) £78,244 (increase £13,402); parts of arc lamps and searchlights (other than carbons), (*a*) £19 952 (increase £14,468), (*b*) £62,991 (decrease £6,013); primary and secondary batteries, (*a*) £7,261 (decrease £16,787), (*b*) £99,724 (decrease £88,963); meters and measuring instruments, (*a*) £8,891 (increase £3,351, (*b*) £16,738 (decrease £5,169); switchboards, (*a*) £1,865 (increase £1,431), (*b*) £2,131 (increase £1,650); electrical goods and apparatus unenumerated, (*a*) £52,080 (increase £2,184), (*b*) £310,113 (increase £1,607. Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £116,873 (increase £16,905), (*b*) £631,640 (decrease £177,377).

Exports.—The exports of electrical machinery, material, &c., (*a*) during July, 1918, and (*b*) from Jan. 1 to July 31, with increase or decrease compared with corresponding periods of 1917, were as follows:—

Electrical machinery, (*a*) £71,705 (decrease £75,702), (*b*) £620,113 (decrease £249,772); including railway and tramway motors. (*a*) £2,889 (decrease £3,666), (*b*) £22,991 (increase £4,748); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £54,770 (decrease £23,457), (*b*) £381,803 (decrease £130,709); and electrical machinery unenumerated, (*a*) £14,046 (decrease £48,579), (*b*) £215,319 (decrease £123,811); telegraph and telephone cables, submarine, (*a*) £23,300 (increase £23,300), (*b*) £365,531 (increase £251,990); other than submarine, (*a*) £34,509 (decrease £39,012), (*b*) £172,949 (decrease £319,171); telegraph and telephone apparatus, (*a*) £16,098 (decrease £40,570), (*b*) £116,210 (decrease £35,775); other electrical wires and cables, rubber insulated, (*a*) £4,113 (decrease £1,581, (*b*) £37,636 (decrease £121,961); with other insulation, (*a*) £15,070 (decrease £3,585), (*b*) £51,794 (decrease £149,762); carbons, (*a*) £277 (decrease £913), (*b*) £3,306 (decrease £12,575); glow lamps, (*a*) £6,779 (decrease £3,322), (*b*) £48,955 (decrease £32,719); arc lamps and searchlights, (*a*) £2,107 (increase £2,047), (*b*) £13,836 (increase £2,406); parts of arc lamps and searchlights (other than carbons), (*a*) £576 (decrease £14,620), (*b*) £11,306 (decrease £34,464); primary and secondary batteries, (*a*) £8,261 (increase £2,253), (*b*) £60,854 (decrease £3,217); meters and measuring implements, (*a*) £11,183 (decrease £6,223), (*b*) £70,515 (decrease £11,275); transformers, (*a*) £2,103 (decrease £4,172), (*b*) £16,638 (decrease £26,927); switchboards, (*a*) £2,235 (increase £302), (*b*) £19,867 (decrease £1,713); electrical goods and apparatus unenumerated, (*a*) £34.392 (increase £167), (*b*) £246,881 (decrease £136,186). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £161,003 (decrease £85,929), (*b*) £1,236,478 (decrease £658,349.

Educational.

University of London, University College.—The session commences on Sept. 30, and in the faculty of engineering degree and diploma courses are provided. Students who have already undergone a partial training elsewhere, and who have attained a sufficient standard, may enter for a course occupying less than three years, and may obtain a general certificate of engineering after not less than two consecutive sessions' attendance. Graduates in science or engineering, or students who have done the work equivalent to a degree, may be admitted to special courses of study, or to prosecute original research. A Goldsmid Entrance Scholarship (value £90) tenable in the faculty of engineering, will be competed for, and application for entry forms must be made not later than Sept. 10. Particulars may be obtained from Mr. Walter W. Seton, M.A D.Lit., secretary, Gower-street, W.C.

King's College (London).—In the faculty of engineering there are complete courses of study, extending over three or four years, in civil, mechanical and electrical engineering, for the engineering degrees of the University of London and for the diploma and certificate of the College. The four years' course also provides opportunities for practical training in works, and there are five well equipped laboratories for practical work and research. The next term begins on Oct. 2. Particulars may be obtained from the Dean of the Faculty, or the secretary, King's College, Strand, London, W.C. 2.

University of Edinburgh.—The next session commences on Oct. 8, and the preliminary or entrance examination is held in September. The University provides complete courses in civil, mechanical and electrical engineering, qualifying for the degree of B.Sc. Eng.

Royal Technical College, Glasgow.—The session 1918-19 begins on Sept. 24.

The diploma of the college is granted in the departments of civil, mechanical and electrical engineering, mining, naval architecture, chemistry, metallurgy, building, &c. The college is affiliated to the University of Glasgow, and the degrees of the university in engineering and applied chemistry are open to its students. A full course of instruction in wireless telegraphy is also provided. Prospectuses (free) from the Director.

Manchester College of Technology.—The prospectus of the courses for the 1918-19 session is now available.

The head of the electrical engineering department is Prof. Miles Walker, M.A., B.Sc., M.I.E.E., and the mechanical engineering department is under thhe charge of Prof. G. Gerald Stoney, M.A.I., M.Inst.C.E., while each is assisted by a large staff of lecturers and instructors, and there are well-equipped laboratores for practical work. The course of study for a degree (B.Sc.Tech.) or a certificate of proficiency extends over three years. A new degree of doctor of philosophy has been instituted in order to encourage advanced study and research. Its standard will be higher than that of the M.A., M.Sc. and M.Sc.Tech.

Tenders Invited.

Transformers.

ATHERTON Urban Council require tenders by Sept. 16 for the supply of two 110 kw. single-phase transformers. Particulars from the Resident Electrical Engineer.

Electric Tipping Wagon.

MANCHESTER Electricity Committee require tenders by 10 a.m. Sept. 13 for the supply of a 3½ ton electric tipping wagon. Specification and form of tender from Mr. F. E. Hughes, Town Hall, Manchester.

Electrical Accessories.

THE COMMISSIONERS OF H.M. WORKS, &c., require tenders by 11 a.m. Sept. 12 for the supply of electrical accessories. Forms of tender from the Controller of Supplies, King Charles-street, Westminster, S.W. 1.

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Telegraph and Telephone Apparatus, &c.

The UNION OF SOUTH AFRICA Post and Telegraph Department requires tenders by 3 p.m. Oct. 23 for supply of copper wire, telephone apparatus (bells, blocks, boxes, coils, protectors, switchboards, &c.). Forms of tender from the Controller, Post Office Stores Room, 62, Palace of Justice, Pretoria.

The NEW ZEALAND Post and Telegraph Department require tenders by 4 p.m. Sept. 9 for supply of 7 tons of copper binding wire and 5 tons g. i. binding wires. Forms of tender from the Controller of Stores, Wellington, the Storekeeper, Christchurch, or the Telegraph Engineers, Auckland or Dunedin.

Appointments Vacant.

A north of England firm advertise for an assistant with knowledge of d.c. or a.c. machine design.

A boiler-house superintendent is required by the Borough of Salford Electricity Dept. Applications to the Borough Electrical Engineer, Frederick-road, Salford, by Sept. 16. *See advertisement.*

A lecturer in mechanical engineering and a lecturer in electrical engineering are required for the Plymouth and Devonport Technical Schools. Salary scale £200 to £370. Forms of application, &c., from the Education Secretary, Plymouth Education Authority, Applications by Sept. 11. *See advertisement.*

The Council of the University College of South Wales, Monmouthshire, invite applications for the post of temporary assistant lecturer and demonstrator in physics for the Michaelmas and Lent terms of the 1918–19 Session. Salary £100, with certain additional fees. Applications to the Registrar (Mr. E. J. A. Brown), Cathays Park, Cardiff, by Sept. 16.

A lecturer in industrial administration is required for the Manchester Municipal College of Technology. Salary £600 a year for five years. Conditions, &c., from the Registrar and applications must be in by Sept. 22.

Business Items.

Mr. D. G. Robertson has vacated the position of sales manager to Messrs. George Ellison, which he has held for the past 9¾ years, on his appointment as assistant general manager.

Plant for Sale.—Accrington Electricity Dept. has for sale a 175 kw. direct-current generating set.

Patent Development.—The proprietor of patent No. 17,345 of 1913 relating to cut-outs wishes to sell same or to grant licences thereunder. Applications to Messrs. Boult, Wade & Tennant, 111/112, Hatton-garden, London, E.C. 1.

Moon Charts.—We have received from Messrs. C. A. Vandervell & Co. (Ltd.), of Acton, some copies of their Moon Chart for September.

Municipal Accounts.

Brighton.—The accounts of the electric supply department for the year ended March 31 show gross capital expenditure £845,957 (increase £844,490), and £466,735 has been provided for redemption.

Revenue was £116,728 (compared with £106,880 in previous year), gross profit £42,978 (£47,065) and net profit £2,887 (£5,140). Average price obtained per unit was 2·63d. (2·53d.) and costs were 1·78d. (1·51d.) exclusive, and 2·66d. (2·50d.) inclusive of loan charges. Units generated were 12,278,205 (11,452,040) and sold 10,242,007 (9,771,615). Maximum load on sub-station was 4,613 kw. (4,312 kw.) and load factor was 25·3 (25·9) per cent.

The engineer and manager (Mr. John Christie) in his report advises that steps be taken to obtain a new modern 3,000 kw. turbo-alternator unit in place of an old, inefficient 1,800 kw. set.

Chester.—The accounts of the electricity department for the year ended March 25 show total capital outlay £168,051, including £25,110 contributed out of revenue, and £110,470 has been repaid or provided for repayment.

Income was £26,649 (compared with £24,375 in previous year), working expenses were £13,774 (£11,323) and special expenditure £348 (£207), leaving gross profit £12,526 (£12,845), and, after providing for interest and sinking fund, the net profit was £2,944. Total costs were 1·02d. (0·925d.) per unit sold, exclusive of capital charges. Total maximum supply demanded was 1,765 kw. Units generated were 3,842,643 and sold 2,917,148.

Rochdale.—The accounts of the electricity department for year ended March 31 show gross capital expenditure £250,217 (increase £7,765), of which £77,237 has been repaid or provided for repayment.

Revenue was £74,341 and total expenditure was £53,870, leaving gross profit £20,038. After providing for capital charges, depreciation (£2,495), allowances to men on active service (£518) and war bonus (£1,137), the net deficit was £3,674, or £1,179 deducting amount applied to depreciation. Maximum supplies demanded were 1,166 kw. d.c. for tramways, 1,415 kw. d.c. for other purposes, and 5,780 kw. a.c. Units generated were 17,579,912 (increase 9 per cent.) and sold 16,193,410.

Companies' Meetings and Reports.

LANCASHIRE DYNAMO & MOTOR CO. (LTD.).—The report for 1917 states that, after providing for interest, income-tax, depreciation and special expenditure, the profit was £26,315 (against £29,321 in 1916), to which has to be added £6,791 brought forward. The present distribution on the ordinary shares is to be 2½ per cent. in the shape of a bonus, making 12½ per cent. (tax free) for the year. It is proposed to place to reserve £10,000 (equal to 10 per cent. on ordinary shares) and to carry forward £7,193.

LISBON ELECTRIC TRAMWAYS (LTD.)—At the meeting last week the chairman (Mr. L. Breitmeyer), in moving the adoption of the report and accounts, said that the net profit was £16,678, and after taking into account the amount brought forward, providing for depreciation and paying the preference dividend for the first six months of the year, £3,135 had been carried forward. He gave particulars of the difficulty experienced in getting authority to increase the fares. After the revolution in December last an arrangement was arrived at with the newly elected municipality of Lisbon which enabled the Company to put up the rate of its season tickets by 40 per cent. as from Jan. 1 of this year, but that was all absorbed in meeting further demands for higher wages. It then became imperative to bring about an increase of revenue to meet the ever-growing working expenditure. All railways in Portugal for some time past had been permitted to raise their fares, and it was considered the Company should be allowed similar privileges, but in the month of May last, after endless negotiations and pressure, it was at last possible to increase the tariff in certain directions. The Municipality of Lisbon appeared most zealous in the interests of the public, and to gain popularity opposed every reasonable argument to the putting up of fares on their system. Without fair treatment the Company would suffer, and the public a great deal more in consequence. It was a great matter of regret to the directors that it was not possible to pay the preference dividend for the second six months of the year.

City Notes.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—A quarterly dividend of 1½ per cent. has been declared on the preference shares.

CLYDE VALLEY ELECTRICAL POWER CO.—An interim dividend of 2 per cent. (less tax) has been declared, payable on the 20th inst. Last year a dividend of 1½ per cent. was paid.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—An interim dividend of 2½ per cent. has been declared on the preference and ordinary shares.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—A dividend of 5 per cent. (6d. per share) on the ordinary "A" and "B" and the "B" preference shares has been declared for the past half-year.

TYNESIDE TRAMWAYS & TRAMROADS CO.—At the half-yearly meeting on the 28th ult., it was reported that the divisible balance of £9,245 and a dividend of 2½ per cent. was declared; £3,600 was added to reserves and £1,696 carried forward.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—Interest on the six per cent. first cumulative income debenture stock for the half-year to June 30, at three per cent. and on the six per cent. income bonds at two per cent. has been paid.

WASTE HEAT & GAS ELECTRICAL GENERATING STATIONS (LTD.)—An interim dividend of 2½ per cent. has been declared for the half-year ended July 31.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared a dividend of 3s. per share and a bonus of 4s. per share (both tax free), making, with previous dividends, a total distribution for the year ended June 30, 1918, of 8 per cent. The register of transfers will be closed from the 30th inst. to Oct. 8 inclusive.

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, September 3, 1881.]

OPTICAL TELEGRAPHY.—"Télélogue" is the latest word coined for an optical telegraph apparatus about to be introduced into the French Army, and somewhat similar to the English heliograph. Electrical science is now under a heavy obligation to the Greek language.

ORGANISATION AGAINST PATENT INFRINGEMENTS.—It is stated that the principal electric lighting companies, comprising the Brush, the United States, the Fuller, the American, the Jablochkoff and the Western have united in an organisation to enforce their numerous and important patents against manufacturers and users of infringing patents.

AN ELECTRIC STEERING APPARATUS.—Referring to the electric steering apparatus of Mr. King, of Edinburgh, which has lately been tried on a steamer between London and Glasgow, in which the compass regulates the helm, "La Lumière Electrique" remarks that so far back as 1859 M. Achard designed an apparatus, founded on the same principle as his brake, which allowed the rudder to be electrically controlled from the captain's cabin, but that the compass played no part in this device.

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CONTENTS.

NOTES 409
Arrangements for the Week 411
Some Applications of Electromagnetic Theory to Matter. By A. C. Crehore.—*Concluded* 412
Scientific and Industrial Research.—*Concluded* 414
Scientific Signalling and Safety at Sea. By Prof. J. Joly, D.Sc., F.R.S. 415
The Capacity-Potential Curves of an Induction Coil. By E. Taylor Jones, D.Sc. Illustrated.—*Concluded* 416
Improvements in the Spherical Photometer. By R. von Voss. Illustrated 418
The Cumberland Electrolytic System for the Prevention of Scale and Corrosion. Illustrated 419
ADULT EDUCATION 420
Electrical Developments After the War 421
CORRESPONDENCE 421
Electrical Power Engineers' Association. Illustrated 422
The Labour Outlook. By Our Labour Correspondent 422
Volunteer Notices 422
Patent Record 423
Commercial Topics 423
Electricity Supply 424
Tenders Invited and Accepted 425
Companies' Meetings and Reports 426

Notes.

The Trade Union Congress.

IT may be remembered that last year a discussion took place at the Trade Union Congress on the Whitley Report, and on that occasion the principles of the Report were approved. At the Congress which has just terminated some further discussion took place on this Report, the resolution having reference to the application of joint committees and councils to all departments of State service. We regret to note that there was a certain amount of prejudice shown against the establishment of joint committees. As is well known, the recommendations of the Report are based on the idea that much will be gained by both sides recognising the claims of the other and reaching solutions that are just and best for both, having regard to the fact that Labour must work with Capital and Capital with Labour. On the other hand, prejudice, such as was noticeable at the Trade Union Congress, is based on the idea that Labour can disregard the welfare of Capital and can extort terms from the employers irrespective of whether such terms are beneficial or harmful to the industry as a whole. We must, perhaps, expect views of this kind to be still maintained to some extent, though we hope that increased knowledge of the conditions under which industry is carried on will cause such ideas to be abandoned.

An Illustration from Russia.

IN this connection the events which are taking place in Russia should be a sufficient object lesson. An interesting account was given recently in "The Times" of the way in which factories carry on their labours in Russia at the present time. In the particular works to which reference is made, when demands were put forward by the workers it was usual for the Board to meet their representatives to discuss the points at issue. In those cases in which the demands were of an exacting character the representatives of the men came to the meeting fully armed, and the directors, being unarmed, there was obviously only one way in which the business could terminate, all demands being conceded. Results so obtained cannot be satisfactory in the long run even to Labour. After a time the workers put forward the demand that their representatives should attend every meeting of the Board. The directors agreed, and they found this course to have some advantage, because the workers' representatives soon began to realise the difficulties with which the Board were confronted. Being convinced that the difficulties were not all upon the side of Labour, these representatives tried to put the case of the directors before their fellow workers. This, however, proved unsatisfactory to the mass of the workers, with the result that fresh representatives were nominated to attend the Board meetings. These in turn were deposed as they came to realise the difficulties of the situation, and so it went on. The moral of this little bit of history is, of course, that there is a great advantage in having joint committees, because they enable the workers to see that there are difficulties in carrying on a business which are not usually appreciated, and they are soon able to appreciate the fact that more is to be gained by conciliation than by continual strife. Similarly the points of view of the workers can be appreciated by the employer. It is, however, a matter entirely of education, and it is highly desirable that the rank and file should be educated through the establishment of Works Committees, so that this knowledge may be spread as widely as possible.

The Vicious Circle.

IT is with great misgivings that we see the endless increases in wages which are constantly being awarded—not that we have no sympathy for those who wish to counterbalance the increased cost of living, but it is constantly borne in upon us that the alleviation produced by such increases can only be temporary. Each increase necessarily re-acts upon the cost of living in various directions, and makes it still harder for those who are not able to enforce their demands. In due time the cost of living goes up still further owing to the increase in wages, and then a further demand is made for another increase, and so the vicious circle goes on. We do not suppose there has been a more harmful award than the notorious 12½ per cent. The state of affairs is illustrated by the position of the Doncaster municipal tramways. In 1911-12 the expenses were 6d. per car-mile, but with the additional expenditure on wages and other increased costs the expenditure next year is estimated to be nearly 11½d. per car-mile. The inevitable result is an increase in fares, and in order to meet this increase we do not doubt that a further increase in wages will be demanded by those workers who depend largely upon the tramway service. There is no question that it would have been far better if the Government had subsidised all the staple articles of food, as has been done in the case of bread, from the beginning of the war and to have regulated wages throughout so that they were kept down to a reasonable figure consistent with the cost of living. The additional cost of the food would of course, have been met by the State, but it would have been much cheaper in the long run, and have caused less hardship. Also the position is very unfair. For example, because staff engineers are unorganised, their salaries remain generally without any increases, though we are glad to note some exceptions. Thus, MR. NICHOLS MOORE has obtained increases for his staff at Newport.

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Scientific Exhibits and the Public.

THE successful termination of the British Scientific Products Exhibition suggests some after-reflections. In view of the limited resources available and the many special difficulties incidental to war time the results must be most gratifying to the promoters. We need scarcely say that the exhibition proved of interest to technical and scientific men; but what we regard as much more striking, and indeed, the most encouraging feature, is the large number of members of the general public who attended. The thirty thousand visitors must have included many people with little scientific knowledge, and this is borne out by the impressions of anyone who observed those passing and listened to the questions they raised. It may be assumed that exhibitions, if properly oragnised, and not too frequently repeated, form a highly promising means of educating the general public, and as we understand that the exhibition is to be an annual feature, we should like to make a few suggestions for future action. In the first place an exhibit of scientific products for the benefit of the public is essentially different in its aims from an ordinary trade exhibition. To the layman the exhibits do not tell their own story, and without some explanation he cannot appreciate the skill and research embodied in an apparently insignificant looking article. We think, therefore, that in future more printed literature describing individual exhibits should be available, written with a view to interesting the public rather than with a view to sales. Such information might also be conveyed through a larger number of demonstrations, though the arrangements made at the exhibition in this respect were quite good, so far as they went. Some of the most interesting exhibits, however, stood almost without exposition, and we think that if a few engineers and men of science could be induced to act as guides at periodical intervals, taking parties through and explaining the features of interest, the trouble and organisation involved would be well repaid. Finally, we think that in future it would be wise to guard against conveying the impression that some people seem to have gathered—namely, that our manufacturers have succeeded within three or four years in doing what Germany did in fifty. It is no belittlement of the very encouraging results already secured to suggest that this is a somewhat superficial impression, apt to lead to disappointment, and to react ultimately to the prejudice of science. In future, our aim should be to dwell upon the good start made, but also to emphasise the essentially laborious and gradual nature of scientific progress and the necessity of systematic and not spasmodic encouragement.

Municipal Tramways Association.—The annual conference of this Association will be held at Leicester on the 26th and 27th inst.

Institute of Metals.—At the autumn meeting of the Institute on Tuesday the President, Prof. H. C. H. Carpenter, was nominated for a second term of office for the year 1919-20.

Long Distance Transmission in Germany.—It is announced that the work of erecting a transmission line between Golpa (Prussian Saxony) and Berlin has been completed. The distance is 132 km. (about 82 miles) and the maximum tension 100,000 volts. The conductor is of aluminium, and it is stated that it will save the transport to Berlin of 120,000 to 150,000 tons of pit-coal annually.

Institution of Electrical Engineers.—STUDENTS' SECTION. The Committee of the Students' Section of the Institution of Electrical Engineers invite offers of Papers from student members for reading before the Students' Section during the forthcoming session, 1918-19. Full particulars of the Papers, giving titles, probable date of reading, &c., should be sent as soon as possible to the hon. secretary of the Students' Section, Mr. R. L. Smith-Rosé, B.Sc., 76, Maryon-road, Charlton, S.E. 7.

Modern Uses of Asbestos.—In a note under this heading we stated in our issue of the 16th ult., on the authority of "La Nature," that "the asbestos of commerce comes largely from Italy, although supplies are also available from Canada, &c." The Turner Brothers Asbestos Co., Ltd., of Rochdale, write to say that "The bulk of the asbestos of commerce is derived from Canada. There is very little obtained from Italy, and marketable supplies of the latter are now almost nil."

Researches on Weston Cells.—A publication issued by the Electrotechnical Laboratory of the Department of Communications, Tokyo, contains a Report by Mr. J. Obata on Weston standard cells exchanged with the Bureau of Standards and the National Physical Laboratory (in whose recent annual report a reference to the matter was also made). Since the initiation of the work of the laboratory in Japan, about seven years ago, more than 200 Weston cells have been set up and tested, and certain selected cells, used as standards of reference, show very small variations indeed. The method of preparation of the cells is described and the results of several series of comparative tests summarised. It is concluded that the standard of E.M.F. in use in Japan agrees very closely, probably within one part in 100,000 with those of the American and British national laboratories.

Wood Firing for Locomotives.—The efforts to economise coal by the use of wood appear to have been extended to locomotives in Sweden. It is stated that the Swedish railway administration felled something like 3,000,000 cubic metres of timber in forests adjoining the railways during last winter. This was regarded as equivalent to about 500,000 tons of coal. Apparently the locomotives can be operated satisfactorily, except that full steam pressure cannot always be maintained, and accordingly trains have to be run light or at a lower speed. The non-stop distance is also said to be less than with coal-firing. On the Norwegian railways wood is also being used. Birch, fir and pine are chiefly employed. Steep mountain gradients present special difficulties to locomotives with wood-firing. The present coal shortage will, no doubt, tend to hasten the electrification of the railways in these two countries. This has been under consideration for some time.

New Form of Electrical Cooker.—The "Elektrotechnische Rundschau" describes a form of electrical cooker which is designed on lines somewhat different from those usually followed. In most electrical cooking implements heating is effected by passing the current through metal wire or strip resistances. In this case, it appears, no such metallic heater is necessary, the water used to cook the food itself being itself the conductor. Two carbon electrodes pass through the base of a porcelain dish, which contains the water. The passage of the current through the water raises it to boiling point, arrangements being made to facilitate the condensation of the steam which then drips back into a trough. When all the water has been evaporated and has collected in the trough the current is automatically interrupted, and it is stated that the length of time during which food is to be cooked can be predetermined by varying the quantity of water initially introduced into the vessel.

Resistances for Battery Charging.—In the United States low voltage electric lighting plants are very much favoured by farmers in remote agricultural districts, who also use automobiles to a great extent. They have thus frequent occasion to charge their cells, used for ignition and lighting on the car, off their lighting voltage. The pressure of these small lighting sets is in general about 32 volts, while the battery for the car is usually of the 6 or 12 volt type. To facilitate charging the batteries a compact and convenient form of resistance has recently been put upon the market and is illustrated in the "Electrical Review and Western Electrician." These resistance units are of a standard type, rated at 6·4 ohms and capable of carrying up to 5 amperes. They are protected and sealed in a standard porcelain recep-

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tacle with a plug end, and have just about the right value for charging a 6-volt battery off the pressure prevailing in country lighting sets. They can also be easily worked in parallel or series if applied to other voltages.

Electricity in National Kitchens.—We have received a copy of the "Bulletin" of the British Commercial Gas Association for June, which contains what may be described as a heated attack on the use of electricity in National Kitchens, the object being to promote the use of gas in preference to electricity. Space does not permit us to follow the writer's argument in detail. Whatever may be written on this subject, the fact remains that electrical plant is being used in increasing numbers for cooking and is giving satisfaction, as is evident by the fact that repeat orders continue to come in. It is easy to make up a case by taking special items of plant and to show that, for example, the cost of upkeep is much less for gas. As an instance to the contrary, we might take the case of gas-heated copper urns, of which the maintenance is very high; and as to operation, we might take the case of fish fryers, in which the fat lasts much longer if electric heating is adopted. Under present conditions it would be much better if writers such as "An Associate Member" were to content themselves with a broader outlook. Actually, the combination of electricity, gas and steam, which is being used in present National Kitchens, gives excellent results, and there is a great deal to be said in its favour.

Illuminating Engineering in Peace and War.—In a lecture on the above subject at the British Scientific Products Exhibition on Sept. 2, Mr. L. Gaster quoted many instances of the utility or knowledge of illumination, gained in time of peace, in connection with the war. Not only had such knowledge been applied to actual naval and military problems, but also in connection with such general matters as the lighting of streets, shop-windows, &c., in war time and the proper methods of achieving lighting economies. The difference in the conditions in the streets now and before the war was strikingly illustrated, attention being drawn to the fact that in war time, as in peace, a well-diffused and uniform illumination was desirable. The control of lighting conditions under a central authority had been very beneficial in promoting uniformity of method, and it was to be hoped that even after the war the lessons in this respect would not be lost. Mr. Gaster also referred to a number of examples of progress in the electric lamp industry, mentioning cases in which special units had been adapted to military requirements. Modern warfare had to be conducted by night as well as by day, on land, at sea and in the air. In the future the "illumination of the air" might form an important new branch of illuminating engineering. Our object would then be the exact converse of that pursued at present, namely to enable the aviator to distinguish as clearly as possible landmarks beneath him, instead of concealing them by camouflage. Illuminating engineering, he concluded, was an excellent example of applied science. No country had a monopoly of science, but countries differed in their readiness to encourage its application to industry. The object of the Exhibition was to bring about, both among manufacturers and the general public, a fuller appreciation of what applied science could achieve.

Works Committees.—Last Tuesday a conference was held under the auspices of the Industrial Reconstruction Council, when the chair was taken by Mr. E. J. P. Benn, and Mr. Robert Wilson, of the Ministry of Labour, gave an address on the subject of Works Committees.

Mr. Wilson remarked that the value of Works Committees was due to the appreciation of the human element in industry. This appreciation had come in advance of the Whitley Report, and Works Committees had been in existence before the war. The main influence in the movement had been the shop stewards, who had been a feature long before the war. In this way the workers were obtaining an influence on the conditions under which the work was carried on. With the setting aside of trade union conditions the position of the shop stewards became more important. The Whitley Report had helped the movement forward on the employers' side. In considering the subject it was necessary at the outset to distinguish between two classes of committee. Committees consisting of equal representation of the management and of the employers, and where there was freedom of voting on either side, were practically non-existent. On the other hand, there were many committees which might be described as "double-sided"—that is, on which one side was essentially labour and the other side was essentially management, and on which it was realised, as it generally must be realised, that there could not always be a community of interests. There was great variety in the methods of election, which on the side of the employees might be based on trade union qualifications, or by vocations, or according to shops. The tendency of the Whitley Report was to base election on trade union principles. With regard to the work to be handled by such committees, they might deal with certain defined aspects, such as safety, or they might deal with more general matters. In a large works it might be necessary to have one committee for each shop and a further committee for the works as a whole. It was desirable that the management side of the committee should include at least one responsible member, who could carry out suggestions on which agreement was reached. It was not necessary for the management to have as many representatives as the men, as the conclusions reached would not be regulated by voting. It was desirable that meetings should be held at regular dates, and a clear division should be made between questions to be dealt with by such committees and those which must be relegated to Joint Councils. Welfare was one of the subjects which should be considered by a Works Committee, and it should be borne in mind that there was good welfare and bad welfare. Unwarranted interference with the rights of individuals should be avoided. Another subject was that of law and order, and committees could see to it that methods of payment were fully understood. There were questions of discipline, and some code of etiquette should be developed, so that unfounded allegations on one side against the other should not be made. There should be tolerance and give and take. The committee should also be consulted on questions of management, such as organisation and method and the selection of foremen, as the labour side could bring valuable experience to bear on such questions. Nothing but good could result by each side learning the other side's point of view, and the time so spent would not be wasted.

The address was followed by an interesting discussion, in which one of the speakers stated that, in his particular firm, the men themselves settled the rates of wages, such rates being in excess of the standard rates, and they called upon their co-workers for a certain standard of work in accordance with the wages paid.

Obituary.

SIR RATAN TATA.—The death occurred on the 5th inst. of Sir Ratan Tata, who was associated with the Tata Hydro-electric Co., of Bombay, and other industrial schemes. He was also a liberal benefactor of Anglo-Indian scientific and educational establishments.

DEATHS ON ACTIVE SERVICE.—The following deaths are reported:

Lieut. Eric Morton, aged 26, has died of wounds. He was formerly an electrician in the service of Whitehaven Corporation and the Mersey Railway Co. He rendered valuable services to the Admiralty, and was given a commission in January, 1916.

Lieut. Harry W. F. Ponter (Queen's Royal West Surrey Regt.), aged 29, is reported to have died in action. He was formerly an electrical engineer, and held appointments at Rugby and Manchester, and later with the Metropolitan Railway.

Pte. Hy. Rigby (Accrington "Pals" Batt.), 22 years of age, formerly an Accrington tramway employee, has died of wounds.

Pte. Percy Mayman (Cheshire Regt.), a Preston tramwayman, has died from enteritis while a prisoner of war in Turkey.

Pte. G. Thompson (King's Liverpool Regt.), formerly a Blackpool tramway employee, has died of wounds.

Personal.

WAR HONOURS.—The following honours have been conferred:—

Air-Mechanic Wireless Telegraphist Cyril R. Deeley, of Birmingham, has been awarded the Distinguished Flying Medal. He is only 18 years of age.

Pte. F. Temple (Grenadier Guards), formerly a Cardiff tramwayman, has been awarded the Military Medal. The Cardiff tramway employees presented him with a gold watch and chain last week.

The Croix de Guerre has been awarded Norman E. Gripper, who was killed in May last. He and his brother L. A. Gripper (who has also won the Croix de Guerre) were formerly employed in the Blackburn electricity department.

WAR CASUALTIES.—The following casualties are reported:—

Pte. D. J. Fry (M.G.C.) and Pioneer W. Daynes (R.E.), both formerly in the general offices of the India Rubber Co., have been wounded.

Arrangements for the Week.

FRIDAY, Sept. 13th (to-day).

IRON AND STEEL INSTITUTE.

10 a.m. and *2.45 p.m.* At the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. 1. Several Papers will be discussed.

SATURDAY, Sept. 14th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. At the Swan Hotel, New-street, Birmingham. Paper to be read on "Graphs and Calculating Diagrams," by Mr. J. F. Avila, A.M.I.E.E.

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Some Applications of Electromagnetic Theory to Matter.*

By A. C. CREHORE.

(*Concluded from page* 393.)

(*g*) *Equation of Force Unsymmetrical.*—You see by the expression (2) that the speed β_1 of the electron, upon which we are getting the force is not present, indicating that the force does not depend upon the velocity of the first electron. If we should write down the force of the first electron upon the second we would merely put β_1^2 in place of β_2^2. Therefore, unless both these velocities were the same, the force of the second on the first would not be the same as the first on the second. This has led me to suspect that the square of the velocity of the first electron should also appear in the force-formula. The order of magnitude of this is 10^{-4}, so that this alone could not possibly account for the discrepancy of 10^{-31} above mentioned. It reduces the discrepancy, however, to 10^{-27}. Now the mass of the electron itself at slow velocities is 90×10^{-27} grams. If the mass of the electron is also included, equation (1) takes the very symmetrical form,

$$F=\frac{m_0}{2K}e_1e_2\beta_1^2\beta_2^2[1-(-X\sin\alpha+Z\cos\alpha)^2]r^{-2}, \quad . \quad (3)$$

and the average force on one single electron due to another is

$$F=\frac{m_0}{3K}e_1e_2\beta_1^2\beta_2^2r^{-2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where m_0 is the mass of the electron at slow velocities, and K, the specific inductive capacity of the ether, equal to unity, has been introduced for the sake of keeping the dimensions of the equation right.

(*h*) *When a Factor is Introduced to Make the Equation Symmetrical, the Force-Equation Agrees with the Law of Gravitation.*—By means of this equation we may easily show that the magnitude of the attraction agrees to a surprising degree of accuracy with the attraction obtained from the law of gravitation. It may be applied to any two masses of matter equally well, but I will illustrate it by calculating the attraction between two average atoms of hydrogen, because the atomic theory gives the velocity of the electrons in the atom. When the formula is to be applied to two masses of matter containing a large number of electrons, it is only necessary to replace the β_1^2 by the $\Sigma_1\beta^2$, and the β_2^2 by $\Sigma_2\beta^2$, the summations being taken of the velocities squared of all the electrons in each of the two bodies in question. The formula for the total attraction between the two masses then reads

$$F=\frac{m_0}{3K}e_1e_2\Sigma_1\beta^2\Sigma_2\beta^2r^{-2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

We have seen above that the value of β^2 for any single ring of electrons is $p\frac{\pi^2e^4}{c^2h^2}$, and the sum of β^2 for all the electrons in the ring is p times this. If we are writing the attraction between two atoms of hydrogen, the two summations in (5) are the same, and we get by substitution of the above value,

$$F=\frac{m_0}{3K}p_H{}^4\frac{\pi^4e^{10}}{c^4h^4}r^{-2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where the p_H denotes the number of electrons in the hydrogen atom.

If this force is to be identified with the gravitational force, it should be numerically equal to the attraction as given by Newton's law, which is usually written

$$F=kmm'/r^2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Putting m_H in place of m and of m', as denoting the mass of the hydrogen atom, this becomes

$$F=km_H{}^2r^{-2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Equating (6) and (8), as being different expressions for the same force, the r^{-2} cancels out, and, dividing through by $m_H{}^2$, we find a value for k,

$$k=\frac{p^4}{3}\frac{m_0}{m_H{}^2}\frac{\pi^4e^{10}}{c^4h^4}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

The K is omitted because it is unity and does not affect the numerical value, and also because it is not at all certain that it should not also appear in the Newtonian equation (7). The value of k as determined by the astronomers is $666{\cdot}07\times10^{-10}$. In the right member occur constants that have been independently determined by physicists. The following values are those in current use.

$m_0=0{\cdot}90\times10^{-27}$ grams (from Bucherer's value of e/m_0 and Millikan's value of e).

$m_H=1{\cdot}662\times10^{-24}$ grams. Millikan's value.

$h=6{\cdot}547\times10^{-27}$ Planck's constant. Millikan's value.

$c=2{\cdot}9987\times10^{10}$ cm. per second = velocity of light.

If with these values we use for e, $4{\cdot}750\times10^{-10}$, we get the value of k exactly as determined by the astronomers above given by putting $p=2$. This value of e is just *one half of one per cent.* smaller than Millikan's value of e which is $4{\cdot}774\times10^{-10}$. Values of e determined by other observers and by other methods vary from perhaps 4·65 to 4·81, and it is quite possible that 4·750 is a very accurate value of e. In fact, if it is admitted that equation (9) is a true relation it will be a very accurate way to determine e itself, because the value of k is accurately known, and we would get a value of e^{10} with a fair degree of accuracy, and hence would have e with precision.

The fact that the number of electrons in the ring for the hydrogen atom, p_H, must be equal to 2 to satisfy the expression for k numerically is significant as indicating again that hydrogen has two electrons per atom.

The argument for this atomic theory, on account of the numerical agreement with the Newtonian constant, is of the same nature as the argument for the Bohr theory above mentioned, on account of the numerical agreement with the Rydberg constant; but it is doubly cogent, because both these constants are adduced from this theory.

(*i*) *Certain Features of Electromagnetic Theory brought into Question.*—It is for these good reasons that I have ventured to question the correctness of certain fundamental assumptions in the current form of electromagnetic theory. We are forced to question it or to abandon altogether the idea that the electrons describe circular orbits within the atoms. Of the two alternatives, I venture to think that the proper one has been chosen. As above stated, as we look back over the history of the development of electromagnetic theory from Maxwell's beginning to the present time, a process of gradual evolution has been at work. I had formerly supposed that the commonly accepted electromagnetic theory is complete as we have it, or finished, so to speak, but I have been led to believe that it is yet in its infancy. To avoid being misunderstood, some further remarks on this subject seem to be required. The changes in the theory that seem to be demanded are not very great, and will probably not affect most of the applications of the theory. They relate more particularly to the inverse square of the distance terms, which only come into the account in such problems as we have been considering. It may seem impossible to you that any change can be made in the theory, because the equations already express with complete satisfaction all the phenomena in the subjects of electricity and magnetism dealing with gross matter, with which we are acquainted. It was pointed out before that all these things represent very special cases; in fact, the older form of equations of Maxwell's day are just as good for these things. The applications to gross matter are not affected by the modern change in the introduction of the ideas of retarded potentials.

(*j*) *Direct Experimental Verification of Electromagnetic Equations Desirable, but Probably Impossible.*—We really need an experimental verification of the general electromagnetic equations. Prof. H. A. Rowland charged the circumference of a wheel and set it revolving at a rapid rate. He succeeded at best in detecting the magnetic force at the centre, and showed that the magnitude agreed with the theory. What we really want, however, in order to test the theory is to have the charge at one point only of the wheel and to measure the instantaneous, not the average, mechanical force upon a second electrical charge in its neighbourhood both as to direction and magnitude. Needless to say, this has never been accomplished and we may almost say never will be accomplished. We should need a recording apparatus that had no time lag, and that is capable of indicating a force in any direction equally well, and of a very insignificant amount. The conclusion is that we are compelled to resort to indirect methods of testing these equations. It seems that we may legitimately regard

* Lecture delivered before the American Institute of Electrical Engineers, slightly abbreviated.

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the process above described as one of these indirect methods. In such methods, if one assumption fails, we ought not to hesitate to try another, for the original theory itself rests upon assumptions that seem to us correct, but which can only be tested by the indirect method.

XII. THE RESULTS OBTAINED ABOVE (XI.) AGREE WITH THE FORM OF ATOMIC THEORY DEMANDED BY ELECTROMAGNETIC THEORY.

The gravitational formula above is so simple and has so many points in its favour that I have proceeded as though it were true, and have endeavoured to find some of the consequences that it implies for atomic theory. We shall next consider some of these, and you will note that they are in complete harmony with the conceptions of atomic properties that we have been considering. First, let us take the earth as one of the bodies, and a single atom on the earth's surface as the other body, and write down the force of attraction according to the equation. We get the very simple expression,

$$F = k\Sigma_A \beta^2, \quad \ldots \ldots \ldots \quad (7)$$

where the constant,* k, involves the constant charge on the electron, the mass of it, and the summation of the velocities squared for the electrons in the earth, all of which does not vary when we substitute one atom for another.

(a) *The Weight of an Atom is Proportional to the Total Kinetic Energy of the Electrons it Contains, Relative to the Centre of the Atom.*—Now this attraction is merely the atomic weight, and we, therefore, have the suggestion that the atomic weight is merely proportional to the sum of the squares of the velocities of all the electrons in the atom, that is, to the total kinetic energy of the electrons, and it should be added that the velocities must be those relative to the centre of the atom. If the whole atom moves, this would add nothing to the weight, because the effect of the positive nucleus would exactly annul that of the electrons. But we know that atoms of the same kind, say, hydrogen, have the same weight in a given locality. We may, therefore, conclude that the velocities of the electrons in the atom must always be the same in the different states of these atoms. This is in exact conformity with the theory of the atom above described. The velocity in any ring, according to electromagnetic theory, is a constant quantity dependent upon the number of electrons in the ring. So long as we leave the rings in an atom undisturbed they must always have the same velocity, but, when we change the number in the ring the velocity must suddenly change to a new value, and then the weight will change. We then really have a different atom. It has suddenly changed over to one of a different class.

The atomic theory above outlined also shows that any ring may change its radius without affecting the velocity of the electrons, the kinetic energy remains fixed independent of changes in the radius. The Bohr theory, on the contrary, demands a change in the kinetic energy with any change in the radius. On the one hand, we keep a constant weight, and in the Bohr theory the weight must change, if the weight has anything to do with the kinetic energy. But it is a matter of measurement that the weight does not change. I may refer again to those crystals in which the same kind of atoms, sulphur, for example, are required to have different radii in different circumstances, although the weight remains the same. This is in accord with the modified theory.

(b) *The Weight of any Ring of Electrons in an Atom is Fixed Independent of its Radius, and always Contributes the Same Amount toward the Total Weight of the Atom.*—According to these ideas, therefore, a ring of two, three, &c., electrons in any atom must always contribute the same amount to the weight of the atom whether its radius be large or small. Having received this suggestion from the theory, I have endeavoured to ascertain whether it might not be possible to find out, from the known atomic weights of the different kinds of atoms, what the probable combinations of rings in such atoms are. The result of this has been more successful than I had reason to hope, knowing the very great irregularities that atomic weights exhibit. In the light of the theory it is possible to write down the approximate weights of any ring of electrons. I say approximate because it is not supposed that the speed is absolutely independent of the radius of the ring, but only so to a first approximation. Taking the speeds as strictly proportional to the number of electrons in the ring, the theory gives the weights of the rings as the squares of the number of electrons per ring, as the numbers, 1, 4, 9, 16, 25, for rings of 1, 2, 3, 4 and 5. Taking hydrogen as a ring of two and atomic weight 1·008, we get the numbers 2·268, 4·032, 6·300 and 9·072 as the weights of rings of 3, 4, 5 and 6 electrons. These are the strictly proportional figures, but I have found by trial that, if the following figures, differing very slightly from the above, are used, namely, for a ring of two 1·008, three 2·269, four 3·99975, five 6·2898, and six 9·137, it is impossible to get the atomic weights of all the elements from hydrogen to uranium within the probable error of experimental measurement in a large majority of cases. For most of the elements only the first three figures have to be used, corresponding to rings of 2, 3 and 4 electrons. Only a few elements require rings of five, namely, the halogens, Cl, Br and I, and the elements selenium and tellurium. The element iron is the only one based upon rings of six, with the possible exception of glucinum. In other words, most of the atomic weights have been accurately obtained by the use of but three numbers, rings of 2, 3 and 4. Of the 70 elements calculated (the rare earths having been omitted) 52 of them fall very near to or within the experimental error of the chemist in measuring the weight, while 18 fall outside of this accuracy. Of these 18, however, the weights of 15 of them come nearer than one part in 1,000 to the measured weight, and most of them considerably nearer. Only three of these exceed a difference of one part in 1,000. These are Li, 7·3 parts in 1,000, K 1·2 parts, and Yt 2·26 parts. The largest difference by considerable margin is in the case of Li, which, however, is less than 1 per cent.

The system of rings as built up in this way seems to be based upon rings of four electrons, the number or rings of four increasing steadily with increasing atomic weight, the number of rings of two and of three being few. The cases of iron and the halogens are most interesting, as being built upon a different foundation. Rings of four will not fit these elements.

I would not give you an account of this matter here, were it not for the fact that the weights come out in this way remarkably close when based upon three numbers for the most part, and that these numbers agree so closely with the numbers arrived at by the theory above outlined.

XIII. THE NUMBER OF ELECTRONS PER ATOM ACCORDING TO THE ABOVE SATISFIES BOTH THOSE WHO HAVE THOUGHT THAT THE NUMBER IS APPROXIMATELY EQUAL TO THE ATOMIC NUMBER AND THOSE WHO HAVE TAKEN IT AS THE SAME AS THE ATOMIC WEIGHT.

There are a few important matters which have been passed over without notice, that may now be mentioned. It has been an object among physicists for some time to discover just how many electrons the different kinds of atoms contain. This table of the elements made in this way just mentioned gives the number of electrons for each atom. Many have come to the conclusion that the number of electrons must be approximately equal to the atomic number, which is roughly one half the atomic weight. Others on different grounds have made the number approximately equal to the atomic weight. This table makes the number approximately the same as the atomic weight, but it will be observed that hydrogen has two and not a single electron. So the table satisfies both views of the matter, while it makes the number nearly the same as the atomic weight, the ratio of the number in an atom to the number in hydrogen is one half the atomic weight.

XIV. THE NUMBER OF ELECTRONS IN THE HYDROGEN ATOM.

You have a right to be surprised that any question can be raised at this time as to the number of electrons in hydrogen. I can find, however, no experimental observation to prove there is but a single electron, and it seems that this view of the matter has been adopted along with the Bohr theory, which requires the single electron.

A few remarks upon this matter seem called for. If the velocities of electrons in rings are regulated as above described through the action of the tangential forces due to the other electrons in the ring upon the one according to electromagnetic theory, then we are deprived of this means of regulation when there is one isolated electron only. We do not have in such a system the perfectly symmetrical dynamic balance that obtains with two electrons.

Then, again, our present view of the matter does not neglect the radiation and loss of energy from the atoms. In electromagnetic theory the relative amounts of loss of energy through radiation for rings of 1, 2, 3, &c., using the speeds as above determined, diminishes very rapidly as the number in the ring increases. The loss from a ring of two is about 4,000 times less than from the single electron, and from the ring of three about 40 million times less, and from four nearly a million million times less. For this reason it seems reasonable to suppose that the single isolated electron does not exist in the atoms. I shall not take the time here to answer the obvious objections to admitting loss of energy by radiation on account of the quantum theory, but may assure you that they can be met satisfactorily.

* This is not the same constant as the Newtonian constant above.

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XI. THE ORDER OF MAGNITUDE OF THE ORBITS OF THE ELECTRONS IN ATOMS.

Another matter which has been passed over relates to the order of magnitude of the orbits of the electrons. There are a number of things that have a very evident bearing upon this question. One of the things we know now with precision is the distance between the centres of the atoms in certain crystals. These distances in different crystals vary from, perhaps, 10^{-8} cm. up to four or five or possibly six times as much, and we may think of the order of magnitude as roughly 10^{-8} cm. Now, if the radii or the orbits of electrons in any of the atoms in the crystal approach close to the same order of magnitude, the electrons must necessarily approach each other much nearer than they are from the nucleus to which they belong. Unless we are to assume that such electrons have no mutual influence upon each other, which seems uncalled for, there must occur in crystals an enormous perturbation with an ensuing radiation of energy. This could not possibly be a stable condition. Our exact knowledge of crystals alone ought to be considered a direct proof that the order of magnitude of the orbits of the electrons is much smaller than 10^{-8} cm.

Again, the kinetic theory of gases has been cited to show the order of magnitude of the radii. This theory has established the fact that the centres of the atoms in a gas approach each other on the average to within about 10^{-8} cm. before being deflected. If the orbits of the electrons were of this order, too, they must at times come into very close proximity or even collision, and the result would be that some of the electrons would be separated from the nucleus, thus ionising the gas under ordinary conditions. This does not occur. We may, I think, regard the kinetic theory as another direct proof that the orbits must be of a much smaller order. These matters, when taken in connection with the fact that the radii come out between 10^{-10} and 10^{-9} cm., when the forces due to the motion of the electrons is included, which was omitted from the Bohr theory, and with the fact that these radii agree with the values indicated by an application of the theory to crystals, do not leave much doubt as to the true sizes of the orbits of the electrons.

I can picture the thought that is probably occurring to many of you while listening to this description of a difference of opinion affecting the radii of the orbits between 10 and 100 times. In what condition would astronomers find themselves so long as they were in doubt about the value of the radius of the earth's orbit by a factor of some 10 or 100 times? Evidently, until this matter is determined with some precision, all attempts to place atomic theory upon a firm mechanical basis cannot be very successful. It will have to be acknowledged, however, that the physicist does not find any such single simple law applying to atoms at close range as governs the motions of the heavenly bodies, and the reasons why we are not further along are not difficult to understand.

Scientific and Industrial Research.

(*Concluded from p.* 402.)

NATIONAL PHYSICAL LABORATORY.

Practically all of the work done at the Laboratory is for national purposes. We have approved a proposal of the Ministry of Munitions that the Laboratory should undertake the testing of the highest grade of graduated glass vessels for use in chemical laboratories and should supervise and certify the tests of the lower grade products which will be carried out by the manufacturers themselves.

The Board of Trade are arranging, subject to the approval of the Treasury, for the transfer of their Electrical Standards laboratory to the National Physical Laboratory. The work of the Board of Trade, which was responsible under Act of Parliament for the custody and maintenance of the primary electrical standards and the testing of electrical instruments for use as secondary standards, has for some years been in co-operation with the Electrical Standards Division of the Laboratory, the electrical standards of the two laboratories being kept in accurate agreement. The Board of Trade will in future exercise its duties by recognising the work of the Laboratory for this purpose, thus avoiding the uneconomical maintenance of dual standards. The larger part of the cost of the new buildings which its continual growth necessitated had been provided by the gifts of generous donors, and the balance by the Treasury. As a result the scientific and technical staff had been seriously underpaid. Recruitment grew constantly more difficult while the abler members of the staff were continually lured away by the offer of more lucrative posts elsewhere. We are convinced of the necessity for a complete overhauling of the scales of salary paid to the scientific and technical staff of the Laboratory, and we think that adequate provision for superannuation should also be made.

THE FUEL RESEARCH BOARD.

The Second Report of the Fuel Research Board outlined "A Scheme of Research and the Establishment of a Fuel Research Station." The scheme was approved by the Lord President; and the Director, with the assistance of Mr. W. J. Burton, proceeded with the preparation of the plans for the Research Station. By October 5, 1917, the plans were so far completed that it was possible to present a preliminary estimate for the cost of its erection. The buildings are now making rapid progress. The director and his engineer are still closely engaged in the designing of the plant and apparatus for the station and contracts for certain items have already been placed, but much still remains to be done.

In preparation for the experimental work which will be started at Greenwich directly the buildings are finished the Lord President, on the advice of the Director of Fuel Research, has appointed Dr. Thomas Gray, professor of Technical Chemistry at the Royal Technical College, Glasgow, to be Superintendent of the Laboratories at the Fuel Research Station. The Governors of the College have in a most public spirited way seconded Professor Gray with the concurrence of the Scotch Education Department for this important service during the period of the war, and he is already engaged in planning the lay-out and equipment of the laboratories in consultation with the Director.

The Director of Fuel Research has continued during the past year to give advice to the Admiralty and Ministry of Munitions in connection with urgent war problems and in particular has been acting as an expert advisor to Lord Crewe's Committee on the Production of Fuel Oil from Home Sources. The Fuel Research Board have followed with interest during the past year the growing use of coal dust firing for steam boilers and furnaces, and they have appointed a representative to make inquiries in the United States of America and to report to them. The Department, on the advice of the Board, have continued their grants to the Meteorological Office for the work on atmospheric pollution.

The Report gives particulars of the formation of the Tin and Tungsten Research Board. The steps taken to carry out timber research, research into building materials, &c., and the developments in the organisation of research in the overseas Dominions.

AIDED RESEARCHES IN PROGRESS.

The Air Council have asked that Capt. Bengough and Mr. Hudson should be allowed to extend the researches they are conducting for a Joint Committee of the Institute of Metals and the British Electrical and Allied Manufacturers' Association, with the aid of a grant from the Department, so as to include the atmospheric corrosion of certain metals. We have gladly acceded to the request with which the Joint Committee of the Institute and the British Electrical and Allied Manufacturers' Association have unanimously concurred.

Dr. Mellor and Mr. Bernard Moore, who carried through their researches into the production of a marketable hard porcelain manufactured from British materials, have presented a most interesting report of their work. Several members of the Council accompanied by officers of the Department recently visited Stoke, and were impressed with the simple and practical means adopted in the solution of the problem. The solution, which we have every reason to believe has been carried to the point at which it can usefully be put to the test of manufacture on a commercial scale, has been reached at little more than half the cost which was anticipated. After consultation with the Stoke Research Committee and the investigators we recommended the Committee of Council to permit the recipes for the new body and glaze to be communicated freely to those firms who satisfy the Research Committee that they are likely to make *bona fide* use of the discovery, and in this recommendation your Lordships have concurred. Over 50 firms have asked for the recipe. There is no doubt that the progress of these investigations has been an encouragement to the pottery manufacturers, and we are glad to be able to report that the movement for the formation of a Research Association which will take over the direct responsibility for these and other allied researches is now rapidly taking shape.

NEW AIDED RESEARCHES.

Arrangements have been made with the Institution of Electrical Engineers and the British Electrical and Allied Manufacturers' Association that certain researches into insulating materials, for which each of these institutions had asked assistance from the Department, should be supervised by a Joint Committee, to be entitled the Electrical Research Committee, under the chairmanship of Mr. Wordingham, president of the Institution. A series of panels are attached to the Joint Committee in connection with the several investigations. The Committee of Council on our recommendation have accordingly made their grant to this Committee to which contributions from the Institution

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and the Association are also paid. In addition the payment of a grant has been recommended to the British Electrical and Allied Manufacturers' Association in aid of an inquiry into the existing information as to the phenomena of arcing and switching. We have also recommended that a subscription should be made to the International Commission of Publication of Constants and Numerical Data, and we understand that the Committee of Council have made a grant of £200 for the current year which will be renewed for a further four years if we are satisfied that the work is proceeding satisfactorily and provided the French Government, who have been the principal supporters of the Commission since its foundation in 1909, should continue their subscription of 3,000 francs.

GRANTS TO STUDENTS AND RESEARCH WORKERS.

We have carefully reviewed the policy of making personal grants to students and research workers and have submitted a special report to your Lordships upon the experience already gained and on our proposals for the future.

Our aim in recommending these grants has been to select a body of leaders in scientific research who by choosing and training students in its methods, and by gathering round themselves bodies of competent investigators, will supply the needs of the nation in the future. To attain this aim the Council have made grants from the sum allocated for the purpose by the Committee of Council to workers and students in Educational Institutions. In making these awards to students we have been guided primarily by our knowledge of the quality of the research work undertaken by the Professor or Head of the Department who recommends the student, by the opportunities which he has for engaging in research work and by his personal recommendation of the student as one who shows promise of becoming a competent research worker after a suitable period of training.

We have also decided (1) that save in quite exceptional circumstances not more than two annual grants should be made to one student to enable him to undergo training in methods of research; (2) that save in exceptional circumstances not more than five annual grants in the nature of Fellowships should be made to one research worker; (3) that out of the sum placed at our disposal by the Committee of the Privy Council for grants and allowances to research workers and students no grants should be made to investigators for the solution of specific problems in connection with industrial processes. With regard to the third conclusion our view is that if such investigations are to be aided from public funds they should as a rule be supported by some contribution from industry and that they will normally fall within the province of Research Associations when these have been established.

It is pointed out that it is not in the national interest that results of commercial value obtained by the expenditure of national funds should be made available for other countries to the detriment of our own. The Government are better able to prevent this leakage than any private persons, but they cannot do so unless they have early knowledge of the facts and are in the position to advise the discoverer how best to proceed. In the second place it is not in the national interest that results obtained with national funds should go to a single firm to the detriment of other firms in the same industry. Lastly, it is not in the national interest that successful research workers should be unfairly exploited by manufacturers or company promoters, and where the means for research has been found by the Government the Department intend to secure a generous reward to the discoverer or inventor.

During the past academic year 21 grants were made to pure science students, 5 to applied science students, 5 to research assistants in pure science and 5 to research assistants in applied science, 8 to research workers in pure science, and 14 to research workers in applied science.

We are prepared to recommend maintenance allowances for students under training or salaries for additional research assistants, or in special cases grants for unusual apparatus or equipment: we think, in other words, that the Committee of Council may properly supplement the means of suitably equipped University departments to undertake special researches, either for the Government or of their own initiative. But the remuneration of the permanent staffs of the Universities must fall upon the general University funds which are, and ought to remain, under the sole control of the Universities themselves. Grants-in-aid of these funds are made by other authorities than the Department of Scientific and Industrial Research which was established for clearly defined purposes of a different kind, and it is important that the Universities themselves should recognise this.

APPLICATIONS FROM INVENTORS.

We have considered applications for assistance from 11 inventors, but we have been unable to recommend a grant in any case, though we have given most careful attention to their claims. We think that it will only occasionally be the case, that an inventor who has a good idea and the capacity to work it out will seek Government assistance. He will as a rule prefer either to rely upon his own resources or to approach a firm known to be interested in discoveries of the kind he has made and likely therefore to give him an immediate remuneration, even if they are not prepared to use his discovery or to place it on the market. If such a firm is prepared to turn the invention to practical use the inventor naturally sees in this a more direct means to his end than any offer we can hope to make of further facilities for experiment and test. It is possible that the Research Associations now coming into existence may be more successful in encouraging inventors than a Government Department.

Scientific Signalling and Safety at Sea.*

By Prof. J. JOLY, D.Sc., F.R.S.

The lectures deal mainly with signalling in relation to (*a*) approaching the coast and (*b*) avoiding collision. One of the most urgent problems confronting the sailor is the determination of his position when approaching the coast. In the Admiralty Sailing Directions to Pilots it is remarked that sound is conveyed in a capricious way through the atmosphere. Apart from wind, large areas of silence have been found in different directions and at different distances from the fog-signal station, in some cases even very near to it. These facts should induce the utmost caution in closing the land in fogs. It would, nevertheless, be wrong to assume the general worthlessness of aerial sound signals, especially those based on recent advances in science. Thus, "synchronous signalling"—*i.e.*, the use of signals propagated in different media, but timed so as to start at the same instant—may be of great assistance. Such signals permit the determination of distance sufficiently accurate for the sailor to fix his position. The combination of synchronised light and sound is a good instance of such methods. Automatic bell-buoys and buoys which show an occulting light are common. Both functions may be performed by one buoy, the bell stroke and light being operated by energy from the motion of the waves and a controlling mechanism, limiting the number of strokes to, say, three per minute. Matters can then be so arranged that the sailor has only to count up the flashes till he hears the bell, and the result is the number of cables which separate him from the buoy.

The same principle can be applied to submarine signalling. If an air sound and a water sound be started simultaneously from the same point, the lag of the atmospheric sound on the submarine is 4·3 seconds for each nautical mile. The idea is an old one, and the author many years ago used the principle for determining the depth below a ship. The dropping of a sinker would detonate a small charge of explosive on contact with the bottom, and the interval of time between the moment of releasing the sinker and hearing the explosion, knowing the rate of descent of the sinker, gives the depth with sufficient accuracy. Submarine bells are now very widely used on light ships, on the bottom of the sea, at the pier head and on ships.

The recognition of sound by those on board ship is a problem of equal importance to methods of producing the sound. The sound must be received in such a manner as to enable the sailor to tell the direction from whence it proceeds. This is accomplished by a system of microphones mounted in tanks attached to the ship's plates, both for and aft and both on port and starboard. The operator, listening to the microphones on both sides of the ship alternately, can adjust the course of the ship until both speak equally loudly. The bell is then right ahead. Of all methods of synchronous signalling, the combination of underwater sounds and wireless dots is the most free from liability to failure.

The Fessenden oscillator may ultimately replace the submarine bell on the more important ships. Its advantages include greater radius of audibility (up to 30 miles), easy use of Morse code and receipt and emission of signals by the same apparatus; other points are the determination of depth and the location of icebergs by means of echoes. The wireless telephone may play an important part in the future. Already speech has been submitted from the United States to the Eiffel Tower. The idea is to produce, through the agency of a gramophone, a voice which calls out the name of the station regularly every five seconds, a much feebler voice, which can only be heard when the ship is quite near, giving warning when the vessel is getting too close.

Similar methods may be employed for communication between ships with a view to avoiding collision, and in the future a vessel's distinguishing signal may be her own name called out automatically at regular intervals, together with particulars of her course and speed; simultaneously with these wireless announcements submarine signals may be sent out which would enable ships 10 or 20 miles away to estimate her distance. In the original communication many of the measures possible to prevent collision are discussed in detail, among the most interesting being the collision predictor, which is claimed to enable the navigator to follow the approximate positions of the two ships by merely looking at a dial, and thus steer a safe course.

* Abstract of Tyndall Lectures delivered at the Royal Institution and communicated to the "Philosophical Magazine."

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The Capacity-Potential Curves of an Induction Coil.

By E. TAYLOR JONES, D.Sc.

(*Concluded from p,* 397.)

Summary.—An expression is given for the maximum secondary potential of an induction coil calculated on the theory that two oscillations are set up in each circuit at break. The relation between the primary capacity and the secondary potential, and that between the maximum efficiency of conversion and the coupling, are shown by means of calculated and experimental curves. The present results are compared with those found in previous experiments on the relation between capacity and spark-length. The uses of capacity-potential curves in the determination of the constants of induction coils are discussed, and examples are given of the calculation of optimum capacities. A repetition of Rayleigh's rifle-bullet experiment is described, the result further confirming the present theory.

Comparison with Previous Experiments.

Reference may be made here to previous experiments on the relation between the primary capacity and the secondary spark-length. As far as the writer is aware, all previous experiments on the subject, viz., those of Walter,* Mizuno,† and Beattie,‡ failed to show the existence of more than one maximum of spark-length as the primary capacity was reduced. The capacity-spark length curves obtained by the experimenters referred to simply rise gradually to a maximum and then fall rapidly as the capacity is diminished. In the absence of information as to the values of k^2 and u in their experiments, it is difficult to compare their results with those of the experiments here described, or to explain with any certainty the cause of the discrepancy. One thing should, however, be remarked, viz., that the earlier experimenters did not connect the secondary terminals with a condenser; consequently the value of L_2C_2 would be small, and to produce a value of u considerably less than unity would require a very small primary capacity. One conceivable explanation, therefore, is that the primary capacities used by those experimenters were not small enough to bring the value of u into the region of the second arch of the capacity-potential curves; or if they were small enough for this purpose they may have been too small to prevent sparking at the interrupter, in which case the theory, which assumes perfect interruptions, would break down. It should also be remarked that the primary currents used by the above-named experimenters were greater than 1 ampere, which was about the value used in determining the curves of Figs. 8–13. This would increase the sparking tendency at the interrupter, which would require a condenser of greater capacity in order that matters should proceed according to theory. The theory would break down at a greater value of the primary capacity if the primary current were strong than if it were weak.

Probably one of the most important factors upon which the sparking tendency depends is the initial rate of increase of the potential difference of the plates of the primary condenser. These plates being supposed to be connected directly with the contact surfaces of the interrupter, we may take dV_1/dt as being also the rate of increase of the potential difference of the contact surfaces. Now the initial, and greatest, value of dV_1/dt is numerically equal to i_0/C_1, the ratio of the primary current immediately before break to the primary capacity. Consequently i_0/C_1 determines the least rate at which the contact surfaces must be separated in order to prevent sparking in an interrupter of a given type, it being assumed that the appearance or non-appearance of a spark between the poles of a given interrupter depends only upon their difference of potential and their distance apart.

In the experiments in which the curves of Figs. 8–13 were obtained the greatest value of i_0/C_1 was about 20, i_0 being expressed in amperes and C_1 in microfarads. In the working conditions of an induction-coil, however, the ratio i_0/C_1 may greatly exceed this value, and it therefore appeared desirable to determine a capacity-potential curve under conditions in which considerably greater values of this quantity were attained.

The following experiment was made with the object of extending the range to greater values of i_0/C_1 by increasing the primary current. The secondary (oil) condenser was replaced by a Leyden jar of nearly the same capacity, viz., 0·00102 mfd., and the zinc spark-electrodes were separated to 14·3 mm. The capacity-potential curve was again determined, the least sparking current varying this time from about 3·4 to 4 amperes. At this current the state of magnetisation of the core is such that the inductances have practically their maximum values. The interrupter was again worked by hand, but certain precautions were found necessary in its use in order to get the spark to pass at the least possible value of the current. No satisfactory results could be obtained by jerking the copper rod rapidly out of the mercury. The sparking current was found to be both smaller and more regular in value when the rod was raised very slowly, in which case the actual break is the unaided work of capillarity. This was the plan adopted in determining most of the points of the curve shown in Fig. 14. Sometimes, however, especially at

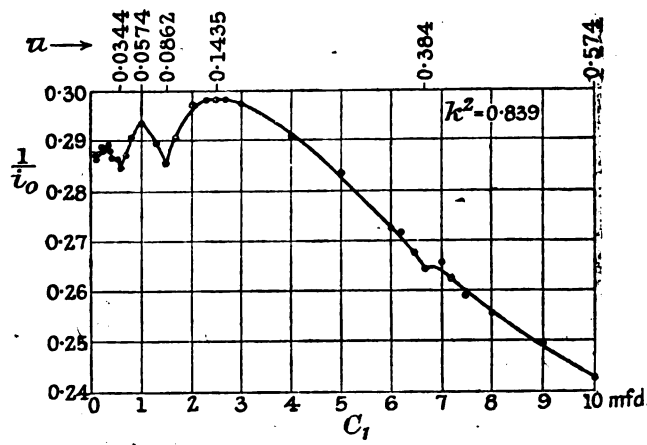

FIG. 14.

the smaller values of the primary capacity, it was found better to raise the rod slowly at first and quickly at the actual break. The points shown in the curve correspond to the smallest observed values of the primary current required to cause the secondary spark to pass. In this experiment the greatest value of i_0/C_1 was 69·5, a value well within the range of practical working conditions.* The value of k^2 for this case was 0·839, and the corresponding "ideal" curve is very similar to that of Fig. 4, for which k^2=0·835.

It will be seen that the curve of Fig. 14 possesses the same general features as the others, and consists of a series of arches whose proportions are roughly similar to those of Figs. 4 and 11. Some of the principal points of the curve were verified on several occasions, especially the greatest maximum at 2·5 mfd., the minimum at 1·5 mfd., and the bend in the curve near 6·5 mfd. There can be no doubt that these correspond to similar features in the curves of Figs. 4 and 11, though there is again considerable distortion due to the resistances. It is clear that the curve shows no evidence of a rapid and con-

* "Ann. d. Physik," 62, p. 300 (1897).
† "Phil. Mag.," Vol. XLV., p. 447 (1898).
‡ "Phil. Mag.," Vol. L., p. 139 (1900).

* On the secondary condenser being disconnected a primary current of 3·5 amperes gives (with C_1=0·06 mfd.—the optimum in this case) a 24·5 cm. secondary spark between ball electrodes 2 cm. in diameter.

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tinuous fall of spark-length, as the capacity is reduced from the optimum value, such as that observed by previous experimenters.

In order further to vary the conditions a capacity-potential curve was determined with the secondary condenser removed. In this case the sparks passed between two brass balls, each 2 cm. in diameter, 15 cm. apart, the primary current varying during the experiment from 2·245 to 2·925 amperes. The result is shown in Fig. 15. The coupling k^2 being in this case 0·768, the corresponding "ideal" curve is that shown in Fig. 3, and Fig. 10 gives the experimental curve for the same coupling, at 1 ampere and with the secondary condenser. It will be seen on comparing the three curves that in the present experiment—0·0286 was the smallest capacity tried, the greatest value of i_0/C_1 being 82—the influence of the primary capacity on the secondary potential is of the kind to be anticipated from the theory. So far from there being a continuous descent from the greatest maximum, the curve is actually rising at the smallest values of the capacity used in the experiment, showing, in fact, the beginning of the ascent in the third arch.

A curve was also determined for this case with a mean current of 0·9 ampere, the brass ball electrodes being 0·96 cm. apart. The curve obtained was almost precisely similar (with proportionally diminished ordinates) to that of Fig. 15. It showed a greatest maximum at 0·6 mfd., a minimum between 0·15 and 0·2 mfd., and a second (smaller) maximum

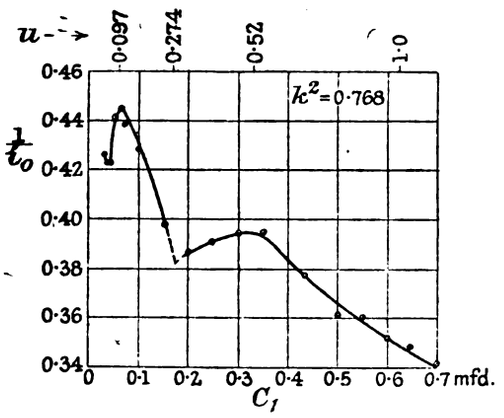

FIG. 15.

between 0·3 and 0·35 mfd. It appears, therefore, that the change of primary current from 0·9 to 2·6 amperes does not in this case appreciably affect the optimum value of the primary capacity.

USES OF CAPACITY-POTENTIAL CURVES.

The general conclusion which we may draw from the experiments just described and the theoretical curves of Figs. 1-5 is that for each degree of coupling there is a capacity-potential curve of well-marked type which is not seriously modified by the resistances in a well-constructed modern coil of the usual form. This consideration suggests that it is possible to determine approximately the coefficient of coupling of an induction-coil by spark-length (or minimum sparking current) observation alone. If two or three of the principal arches of the capacity-potential curve are thus determined—a sub-divided primary condenser is, of course, required for the experiment—a comparison with the curves of Figs. 1-5 will enable one to form an idea of the value of the coupling. A fairly accurate value may probably be arrived at by taking the ratio of the two greatest maxima, or the ratio of the values of C_1 at which these maxima occur, these features of the curve being apparently least subject to modification by the resistances. For example, if the ratio of the first to the second maximum is 1·13 and the ratio of the capacities at which they occur is about 7, the coupling is not far from k^2=0·57. Two eqnal greatest maxima at capacities in the ratio 4·8 indicate the value k^2=0·7, while equal greatest maxima with a capacity ratio of about 2·8 point to k^2=0·87.

The coupling being thus determined from the form of the capacity-potential curve, the greatest value of $U \sin \varphi$ for this coupling can be calculated or found from a graph showing values of $U \sin \varphi$ for various values of k^2. If the self-inductance of the primary coil is known, for the current used in determining the capacity-potential curve, we may at once find the value of L_2C_2, for the value of u ($=L_1C_1/L_2C_2$) is known for the greatest maximum or for any well-marked minimum in the curve. If in addition the mutual inductance L_2 is known (*e.g.*, from ballistic galvanometer measurements) we can calculate the maximum secondary potential which the coil would give if the damping of its oscillations were negligible, this quantity being given by the expression $L_{21}i_0U \times \sin \varphi/\sqrt{L_2C_2}$.

The actual maximum potential for any primary current i_0 may be found from the spark-length, so that it is possible to determine how far the coil falls short of an ideal coil of the same coupling on account of the resistances. This is probably the most convenient method of determining the constants and estimating the comparative merit of induction-coils. A more accurate method is to use an electrostatic oscillograph or some other instrument of the kind, with the help of which the quantities L_1, L_2C_2, k^2, and the maximum secondary potential can be more accurately determined.

EXAMPLES OF THE CALCULATION OF OPTIMUM CAPACITIES.

Some more examples of the above theory of the optimum primary capacity may be given here. The primary of the coil with which the above experiments were made was wound in four layers, closely upon one another, which could be connected in various ways. In the above experiments the layers were all in series. Assuming that all the layers have individually the same self-inductance, then when they are all in parallel L_1 is reduced to one-sixteenth, L_{21} and L_{12} to one-quarter of their former values, so that k^2 is unaltered, that is, with the primary at zero and no secondary condenser, k^2=0·768. From Fig. 3 we find that at this coupling the optimum value of u is 0·11. Now the value of L_1 at a primary current of 5 amperes when all the layers were in series, was 0·194 henry, and in the same state of magnetisation of the core L_2C_2 was $1{\cdot}114 \cdot 10^{-7}$ c.g.s. Thus the optimum primary capacity is

$$C_1 = \frac{0{\cdot}11 \cdot 1{\cdot}114 \cdot 16}{0{\cdot}194 \cdot 10^{16}} \text{ c.g.s.,}$$

or 1·01 microfarad.

By experiment the spark-length was found to be greatest and practically the same at 1·0 and 1·05 mfd., so that 1·025 mfd. may be taken as the experimental optimum capacity.

Again, if the layers of the primary are connected in two pairs in parallel, so that one-half the current i_0 flows through each layer, the primary self-inductance is reduced to one-quarter of its original value, becoming 0·194/4 or 0·0485 henry. L_{12} and L_{21} are each reduced to one-half, so that k^2 remains at 0·768. The optimum capacity is thus

$$C_1 = \frac{0{\cdot}11 \cdot 1{\cdot}114}{0{\cdot}485} = 0{\cdot}252 \text{ mfd.}$$

By experiment the optimum was found to be rather greater than 0·25 mfd., this value being slightly better than 0·3 and 0·3 than 0·2.

If the layers are arranged two in parallel and two in series, so that the whole current i_0 flows through two of the layers and half the current through the remaining two, L_1 is reduced to nine-sixteenths of its original value, as may easily be seen by considering the electrokinetic energy of the primary circuit. L_{12} and L_{21} being each reduced to three-quarters of their original values, k^2 is again unaltered. The optimum primary capacity is thus

$$C_1 = \frac{0{\cdot}11 \cdot 1{\cdot}114 \cdot 16}{9 \cdot 1{\cdot}94} = 0{\cdot}11 \text{ mfd.}$$

The experimental optimum was found to be about 0·1 mfd., this value being better than 0·15 and than 0·05 mfd.

The experiments described above show that the optimum primary capacity for an induction-coil of good modern con-

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struction may be calculated with sufficient accuracy from the simpler theory in which the "resistances" are neglected, and further that valuable information as to the coupling and the frequences of oscillation of the system may be obtained from the form of the capacity-potential curve. The possibility of proceeding in this way depends upon the assumption that the form of the curve is determined mainly by the coupling of the circuits and is not greatly modified by their resistances. This appears to be the case in the coil with which the above experiments were made; the assumption might, however, not be justifiable if the resistances were excessively great.

The Rifle-bullet Experiment.

Some experiments may appropriately be described here in which a very sudden interruption of the primary current was produced by cutting a portion of the circuit with a projectile. The object of these experiments was to test Rayleigh's conclusion that with sufficient rapidity of break the best effects are obtained without the use of a primary condenser—a conclusion directly opposed to the results of the theory described above, in which perfect suddenness of break is assumed. The 18-in. coil was used, with the primary at zero and no secondary condenser. The primary capacity was 0·05 mfd. (mica dielectric), being nearly the optimum for this case as tested by the ordinary mercury interrupter. This condenser was connected with the terminals of the short piece of wire, forming a portion of the primary circuit, which was to be severed by the projectile. The secondary terminals were connected with the brass ball spark electrodes.

In the first experiments an air-gun was used, which fires a pellet at about 500 ft. per second. With one storage cell in the primary circuit (i_0 about 1·1 ampere) 19 mm. sparks between the ball electrodes were obtained at every shot if the primary condenser was connected. None passed at this distance, or even at 18 mm., if the condenser was disconnected. The result is, therefore, in favour of the condenser, but it was observed that the air-gun interrupter was not sufficiently quick in action to prevent the appearance of sparks at the broken ends of the wire.

Accordingly, Rayleigh's plan of firing at the wire with a rifle was adopted, the wire now being mounted in front of a large box full of sand. A service rifle, said to fire a bullet at 2,000 ft. per second, was utilised for the experiment, one hundred rounds in all being fired.* Again with one cell and the gap at 19 mm. a secondary spark was produced at every shot when the condenser was connected, none appearing when the condenser was removed. With the condenser sparks also appeared on this occasion when the gap was increased to 2 cm. When the bullets were cut down to about one-half in order to increase the velocity sparks passed regularly at 19·6 mm. with the condenser, none without. At this distance 0·025 mfd. also failed. The results of the experiments at this current (about 1·1 ampere) are therefore conclusively in favour of the presence of the 0·05 mfd. condenser as against the smaller condenser (0·025 mfd.) and the absence of any condenser.

With two cells (i_0 about 2·2 amperes) the limiting sparking distance was not so definite, and it was consequently much more difficult to fix upon a distance (between the spark terminals) which enabled one to decide in favour of the presence or absence of the condenser. Even in these conditions, however, some evidence was obtained which was distinctly in favour of the condenser. Thus, of three successive shots with the balls at 125 mm., the first and third being *without*, the second *with* the condenser (0·05 mfd.), the second alone gave a spark. The greatest length of spark obtained without the condenser was 120 mm.

When an ampere-meter and a rheostat were connected in the primary circuit, and the current was kept at 2·0 amperes, the same condenser produced a spark at 111 mm., while at shots immediately before and after no spark appeared without the condenser. Again, at 107 mm. (reduced charge) no spark passed without the condenser, while at two shots with the condenser (before and after) a spark appeared each time. In other instances two consecutive shots with the same spark-gap showed a superiority of the condenser; in no such case did a spark pass without the condenser when it failed with the condenser.

On the whole, these experiments clearly give no support to the view that with a sufficiently quick break the longest spark is given by an induction-coil when used without a primary condenser, but rather afford additional confirmation of the theory of the optimum capacity described in the foregoing pages.

* I am indebted to my colleague Dr. Allan H. Ferguson, and to Mr. J. A. Owen, who joined me in the rifle experiments and verified the observations. I also wish to thank Sergt.-Major (now Capt.) McCracken, R.G.A., for his assistance in these experiments.

Improvements in the Spherical Photometer.*

By R. von Voss.

The object of this apparatus is to effect measurements on ordinary incandescent lamps. It is well known that the accuracy increases with the diameter of the sphere. This results partly from the size of the shield which is mounted within the sphere to prevent the light from falling directly on the illuminated aperture; this mainly depends on the size of the bulb of the lamp. Ulbricht has stated that the area of the shield should be less than one-twentieth of the diametral area of the sphere. If the sphere has a diameter of 1·5 metres, and the lamp bulb measures 20 cm., then this would require a shield

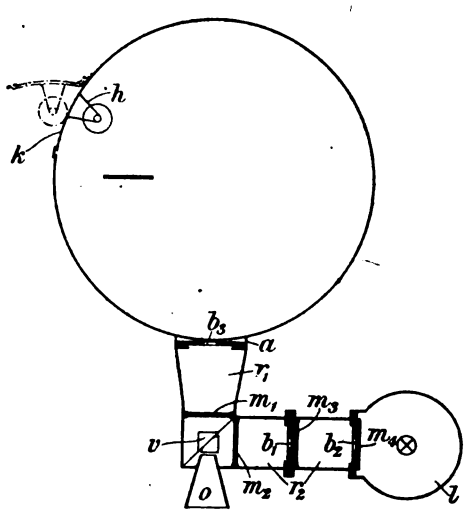

Fig. 1.—Showing Diagrammatically the Arrangement Proposed by the Author.

having an area of 750 sq. cm. In this case the ratio of the areas would be 1 to 23, which is within the permissible limits, and there is no need to increase the diameter of the shield to 2 metres. Besides which, it was much easier to make the smaller size, and to make its inner surface completely smooth. The brightness of the illuminated aperture is, of course, diminished by the presence of this shield; in this case with a ratio of 1 to 23. Ulbricht's formula gives a decrease of 3·5 per cent.; but this affects the standard lamp almost equally with the lamp to be tested. In fact, if the two lamps have the same light-distributing curves, the two are affected to precisely the same extent. The error arises from the fact that the shield obscures a portion of the illuminated wall of the sphere. The closer the lamp is to the wall of the sphere the more important does this become. The ordinary method of testing arc lamps by suspending them vertically in the axis of the sphere has certain advantages in this respect; but, after taking due regard of accuracy, the most important thing for routine work is to take account of speed and convenience. It is, therefore, best to fix the lamp on a shelf near the middle zone of the sphere, and this enables the lamps to be changed very easily. It might be possible by special lever mechanism to lower the lamp

* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 52, 1917.

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and shelf till it was at a greater distance from the wall of the sphere; but this would be a complication, and tests have shown that it is unnecessary.

Of greater importance, as deviating from one of the main principles of Ulbricht's sphere, we must regard the construction shown in Fig. 1. Here the opal glass m_1, the illumination of which is a measure of the mean spherical candle-power, does not lie on the surface of the sphere, but at the back of a space, r_1, the interior of which is also painted white. Thus, the illuminated glass does not lie on the sphere, but receives its light through the aperture b_3, the light being then transmitted through r_1. The following considerations add to the choice of this form of construction. In order to introduce the new method, it seems desirable that one size of sphere should be used for all sizes of lamp. Of course, lamps of the smallest size could be tested with the opal glass on the surface of the sphere; but then it would not have been possible to vary the aperture, and we should have had to have recourse to changing the opal glass, or to the use of smoked glass and the like, if we wished to alter the range of measurement. It would not in such case be possible to produce results on such a uniform basis. Objections to the proposed arrangement might be based on the suggestion that the light, ultimately received by the photometer, consists partly of light received directly through the aperture from the illuminated wall of the sphere, and partly by diffuse reflection from the walls of r_1. Tests have been therefore carried out to determine what the errors actually are.

It was assumed that errors were only likely to arise in such cases as there were differences in the curves of light distribution. Lamps were therefore chosen which differed in this respect. With the normal type of tungsten lamp the curve shows a maximum distribution in a horizontal direction, while with the ring-wound spirals the maximum is in a vertical downward direction. The zig-zag gas-filled lamps differ little in this respect from the normal type, but they were also considered. Finally, there are lamps with spiral bows, in which the intensity differs with the breadth of the bow; in the plane of the bow there is a minimum, and at right angles to it a maximum. The tests were first carried out in an ordinary Ulbricht sphere, and it was found that they all had the same spherical candle-power at certain voltages which were ascertained. The same conditions were then reproduced in the new apparatus. (The spiral bow lamps were tested twice in the two different critical positions.) And in order to determine that the size of the aperture b_3 had no effect on the results, different apertures were used. Thus, with lamps giving 100 c.p., the aperture was 6 mm.; with 16 c.p. the aperture was 28 mm.; with 5 c.p. the aperture was 61 mm., and in each case lamps of the different types were tested. In no case was there any difference between the results given by Ulbricht's sphere and the other systems; the differences were less than 1 per cent.

Thus it is proved that a photometer constructed on these principles gives as good results as the original Ulbricht type when applied to incandescent lamps of the type used for lighting ordinary rooms, and that if the aperture is varied from 6 mm. to 61 mm. the results, properly interpreted, are independent of any such variation.

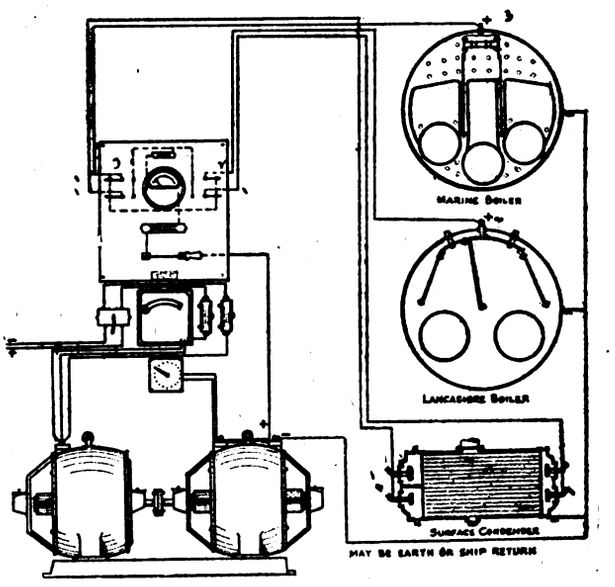
The Cumberland Electrolytic System for the Prevention of Scale and Corrosion.

The corrosion of ferrous and non-ferrous metals, and the formation of scale, constitute one of the most difficult problems met with in engineering work. The trouble is apt to occur in practically any vessel in which a metal surface is immersed in hot liquid of an acid or alkaline nature, such as condensers, boilers, economisers, feed heaters, service tanks, &c. If sea water or other water with corrosive properties is used in the circulating system of condensers the cast iron water ends become "graphitised" and the structure is gradually weakened. In the case of non-ferrous metals, commonly used for the tubes, ferrules and tube plates, the corrosion leads to contamination of an otherwise pure condensate. The water becomes polluted, and boilers, economisers, feed heaters, &c., become pitted and subject to the formation of scale. Ultimately the conditions may result in perforation and leakage from the circulating to the steam side of a condenser, and the contaminated feed water extends the trouble to the economisers and boilers. Priming then occurs, and the corrosive solution is carried further, being conveyed in suspension with the steam and affecting the blading of turbines. The trouble is thus of a very far reaching nature.

According to one theory, such corrosion is essentially due to electrolytic action which occurs when dissimilar metals, or metals of varying hardness, are immersed in a more or less acid or alkali liquid, thus becoming a series of primary cells or couples. The electro positive element then gradually perishes. Various remedies have been proposed and attempted to remedy the trouble. For example, zinc, mild steel or aluminium slabs are attached to the internal surfaces. The device only affords limited protection, however, as the surfaces oxidise and sulphate, the polarity is reversed, and ultimately the corrosive effect is actually accelerated. In many cases, feed water tanks, for example, some mitigation is afforded by water-softening processes and purifiers, but this also is only a partial remedy.

We have before us some particulars of the Cumberland electrolytic system, which is stated to overcome the trouble completely, and has been extensively employed in boilers and condensers, especially in the Navy and the mercantile marine. The process consists in introducing from an outside source a steady flow of continuous current at low voltage by means of suitably insulated and easily renewable anodes of cast or wrought iron. These are fitted by suitable attachments in the boilers and inspection doors of the condensers.

The shell of the structure to be protected is always negative, and the anodes, which gradually waste away, form the positive pole. The effect of the system is to neutralise completely the minute



electrolytic couples which cause the trouble. When air is present in the water the anode attracts and combines with it, forming ferric oxide. Hydrogen is meanwhile liberated at the negative pole, forming a protecting film. The liberation of hydrogen, coupled with the chemical effect of electrolising the liquid, causes all the scale forming properties of the water to be precipitated in the form of soft sludge, which is easily blown or washed out. If the process is applied to feed water tanks a very large proportion of the scale-forming elements can be precipitated, thus eliminating, to a large extent, the necessity for installing purifiers and water-softening plant.

The illustration gives a general idea of the apparatus and connections for two boilers and a condenser.

A switchboard, ammeter and adjustable resistance are provided, enabling the current density to be adjusted according to the conditions. In condensers a current density of 2 amperes per 1,000 square feet of surface usually affords adequate protection, but a somewhat higher density has no ill effects, except that the power consumption is needlessly high, and the waste of the anodes takes place more quickly. In boilers about 1/40th ampere per square foot is sufficient. The pressure used is of the order of 8–10 volts, and the cost of running is practically negligible.

At the present time, when the utilisation of shipping to the fullest extent is of such vital importance, the system would appear to have special applications, seeing that vessels are frequently delayed at ports for considerable periods (amounting possibly to 30–60 days in the course of the year) owing to boiler and condenser troubles.

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Adult Education.

There is much truth in the view that one half of the world does not know how the other half lives. We might even go further and say that in all probability one-tenth of the world does not know how the remaining nine-tenths live, for the simple reason that ways and means of living vary so very much, and from a social standpoint the number of divisions in the community is considerable. This view will, we think, be strengthened by the Interim Report of the Committee on Adult Education, which was published last week. This document is of more than usual interest, as educational documents go, for it is very human in character. It portrays the attempts of a large number of people to improve their education under very adverse conditions. Quite a large proportion of the population probably think that education finishes when they leave school. As a matter of fact the need for education is not felt until after the school period, for what is desirable in education is not then realised, and most of the knowledge that can be acquired in after life certainly cannot be acquired in school days. It is, therefore, highly desirable that adult education should be available.

The present Report shows that this feeling is much more widespread than might have been imagined. The need has been felt by the working classes, and not merely by those who wish to put facilities within the reach of the workers. This has been noticeable in a variety of ways and is increasingly evident. The development has been most marked since the opening of the twentieth century. The rise of the new universities has synchronised with the spread of educational effort among voluntary organisations of working people. Among the higher educational movements may be mentioned the University Extension Lecture System, which dates from 1873, and the Gilchrist Educational Trust, which has carried on work for the past 50 years. The Adult School movement dates back from the end of the eighteenth century, and the number of such schools in existence at the outbreak of war was 1,883, with a membership of over 80,000. Organisations among the workers, however, are more recent; thus the Workers' Educational Association was founded in 1903 by a small group of trade unionists and co-operators. According to the Annual Report published in July, 1917, this Association then consisted of 186 branches, embracing 2,333 affiliated societies and 10,700 individual members. As a direct result of this organisation the University Tutorial Class movement was established in 1907. The University of Oxford set up a joint committee consisting of an equal number of representatives of the university and of working class organisations to arrange for the provision of tutorial classes. The demand has expanded rapidly. A tutorial class consists of not more than 22 men and women, mainly working people, pledged to undertake a three years' course of study, which must aim at reaching, within the limits of the subject covered, a standard of university work in honours. Methodical reading and essay work, as well as regular attendance at class, are required of these students. Instruction is given by tutors approved by the University Joint Committees. It will be gathered that the demand made of the student is considerable; yet in 1914 there were 152 University Tutorial Classes in operation, consisting of 3,110 students. Although at the beginning of the war there was a temporary set-back in the work of adult education, the present volume of educational activities is larger than it was before the war.

The present Report deals largely with the difficulties experienced by workers in attending classes of this kind. Frequent references are made to cases where men and women after long hours of labour, such as 11 hours a day, attend these Tutorial Classes, and one can only feel admiration for workers who have the grit to apply themselves to mental work after heavy physical fatigue. The Committee reached the conclusion that excessive hours of labour form one of the greatest obstacles to adult education. It is obviously physically impossible for a student, after putting in 60 or 70 hours a week at his work, to apply himself with any concentration to study in the evening. At the present day there is a tendency, which we hope will become more marked, to shorten the working week. All investigations, of which there have been a number during the period of the war, show that nothing is to be gained by excessive hours of labour; indeed, much is to be lost. It is better, for example, to have a regular 48-hour week and to go fresh to the task and to complete the day vigorously than to labour indifferently for 60 or 70 hours a week and to have very little leisure. There must be something wrong with the community when some sections of it have practically no leisure in which to enjoy the amenities of life. It would make for the happiness and well-being of the nation for this state of things to be altered; and therefore, from every point of view, including the spread of knowledge and education, which is highly desirable, we feel that there will be a gain in shortening the working week.

In certain lines of activity, however, it appears to us that there must always remain difficulties in giving regularity of work and the leisure which is desirable. For example, there is the question of night work. This cannot be entirely avoided industrially, for there are certain operations which must be carried on continuously. There are also public services which must be maintained. As instances, we have blast furnaces, steel works, electricity stations, postal, telegraph, railway and police services. These, and many others, must be carried on continuously, and the only means of doing so is to work in shifts. Obviously we cannot expect one lot of workers to work always at night. That would undoubtedly be a serious evil. The best thing to be done is to vary the shifts so that night work is shared by all alike, at intervals. This has its disadvantages, and inevitably it interferes with regular attendance at any class of instruction. We do not see, however, that there is any remedy from the point of view of labour, and in such cases, therefore, it will be best for the educational movement to adapt itself to the needs of the workers. Where we come to the case of ordinary factories it is a different matter. Here there is much to be said in favour of the view that human claims should not be sacrificed to ideas of maximum output. In other words, night work is bad for the nation, and should be reduced to a minimum. Equally it may be said that overtime is an evil. It is useless to have a nominally short working week if this is supplemented by persistent overtime.

Another subject which has attracted the attention of the Committee is the monotony of certain kinds of work. Two views are expressed. Some people consider that monotony kills the vitality of the brain. Other people, but we think that they are in the minority, consider that

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monotonous work has some advantages if the worker is already given to mental pursuits, as it gives time for thought. Generally speaking, we believe the view will be taken that the monotony of repetition work has a bad effect, and that it is an evil and one that should receive attention at the hands of those who are responsible for works.

We have every sympathy with workers who have a craving for education; it is a desire that should be gratified, and we would ask employers of labour to read the present Report, so that they may appreciate the position more clearly. It will be agreed that every section of the community should have reasonable opportunities for self-improvement, and should not be expected to obtain this self-improvement at great personal sacrifice. If, then, the hours of labour can be modified, as we think they can, to give a greater amount of leisure without sacrificing efficiency—on the contrary, we believe the efficiency will be improved—it is certainly our duty as a nation to see that our present industrial conditions are materially altered.

Electrical Developments After the War.

In a popular lecture at the British Scientific Products Exhibition on September 5th, dealing with developments in the electrical industry after the war, Mr. C. H. Wordingham, President of the Institution of Electrical Engineers, after dealing with the position of electricity supply and the recommendations of the Board of Trade Committee, referred to the manufacturing side of the industry. With the uniformity of pressure and systems which a unified system of supply, such as was proposed, would bring about, would come greater standardisation of apparatus. This would have a great effect upon manufactures generally, as it would enable foreign trade to be much more readily catered for than had been possible in the past, when there had been a large number of small firms trying to cover the whole ground of electrical manufacture. The result had been that they had been manufacturing in driblets instead of on a large scale. It had come to be recognised—and he thought there was no doubt about it—that the principle to be acted upon after the war would be that each firm would lay itself out for one restricted portion of manufacture. It would then be able to manufacture in quantity, and this, in addition to enabling cheaper production, would tend also to the improvement of design, because when designers had thousands or tens of thousands of the same article passing through their hands in a year instead of tens or dozens, they were able to acquire a much wider experience of the action of the apparatus they were manufacturing and to introduce improvements more readily than when they manufactured on a tiny scale. It would be a misfortune if this were to tend towards the creation of gigantic monopolistic concerns and to the sweeping away of the small individual firms which had hitherto existed. Experience had shown that where the principals of a business were actually concerned in the design of the plant they were selling—he was speaking of engineering work—and had a personal interest in the operations of their works, the work was far better done than when it was supervised by the head of a department of a gigantic concern. In his judgment, although there would be room for a few very large firms, we should get the best results if, in addition to these large firms, there was a combination among the relatively small firms to get orders which would then be farmed out to the individual firms, each firm taking one distinct class of work in which it could specialise, and to which its principals could devote their personal attention. With foreign trade a similar arrangement should be possible, although here probably the large firms would have the pull. Various schemes had been proposed but he was confident that there would be found some way for the smaller firm getting at all events a share of the foreign trade, possibly by working in conjunction with the larger firms. It was absolutely necessary that all differences and jealousies should be sunk so that a united front could be presented to the foreign market, and that those seeking business abroad should seek it for British firms only, the orders being farmed out equitably afterwards among British firms.

Referring to "key" industries, Mr. Wordingham made particular reference to the supply of carbons for searchlight and other arc lamps. So far as he knew, the Admiralty was the only Department which foresaw the dangerous consequences of allowing this manufacture to go out of the country. There was one firm, which with the greatest patriotism, kept its works going at a loss for years in order to produce these carbons, but even that could not have been done if they had not been assisted by scientific advice and by subsidy from the Admiralty, which steadfastly refused to buy carbons except from this British firm. Every other department of the Government and the municipalities insisted on buying in the cheapest market. The municipalities thought themselves very clever in saving the ratepayers' money, and one Government Department which scraped up courage one year to pay more for British carbons got heavily hauled over the coals for doing so. The Germans were prepared to sell carbons in this country at any price to keep out the British product and to crush the firm he had mentioned, but that firm was not crushable. They had been more successful, however, in the manufacture of magnetos which, when the war broke out, were obtainable only from one German firm. It was a tall order to start designing and manufacturing an entirely new and difficult piece of apparatus such as a magneto, and it was chiefly due to the efforts of certain officers of the Naval Air Force that this had been done successfully. The manufacture of incandescent lamps was also largely concentrated abroad. The bulbs came from Holland, and for the tungsten for the filaments and other essential parts we were also dependent upon foreign supplies. That had been largely remedied now. Then there was the very important "key" industry of insulating materials for all classes of electrical machinery. All these were imported, some from America and some from Germany, and the future position would have been a serious one if the electrical industry had not risen to the occasion. Just before the war a strong committee had been formed by the Institution of Electrical Engineers and the B.E.A.M.A. to study this question, and when the war broke out the scope of this committee was broadened so as to encourage in every way the manufacture of these materials. Already there was a magnificent factory at Manchester for the manufacture of vulcanised fibre and there was every indication that the quality of these materials would surpass that of the foreign made goods hitherto employed.

Finally, labour was discussed. Humanly speaking, the future of this country depended upon whether labour put its shoulder to the wheel and did its best to ensure the maximum production or whether it did not. He referred, in this connection, to labour in the broadest sense, whether hand or brain. Labour ought to have a bigger share not only in the profits of industry, but in the direction of the work in factories. He firmly believed that if labour was allowed to come more behind the scenes and see some of the difficulties of the management many of the unreasonable demands which were often put forward would disappear. The trend of events had brought about the necessity for organisation of all classes of labour, and it had been made clear that the Government would recognise only those who were efficiently organised. This had created an extremely difficult position for the professional engineer. It had been brought home to him that if he was to be listened to he must, like the workmen, be controlled, organise his ranks, and several movements were on foot with this end in view. We might shortly expect to find that the great bulk of those engaged in every branch of work connected with electricty supply would be closely organised on similar lines to the workmen. This decision had not been come to without considerable care and, indeed, considerable reluctance on the part of those concerned, but conditions had made it necessary that combination should be effected.

Correspondence.

THE RELUCTANCE OF AN AIR-GAP HAVING SLOTS IN BOTH OPPOSING SURFACES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am very much obliged to Mr. Carter for pointing out that the development of the formula quoted in my article was neither well-founded nor satisfying. At the same time it is very interesting to see that a logical analysis of the problem justifies the use of the expression.

Engineers will be much indebted to Mr. Carter for this extension of his valuable work to the important case of two slotted surfaces.—I am, &c.,

South Kensington, Sept. 9. STANLEY PARKER SMITH.

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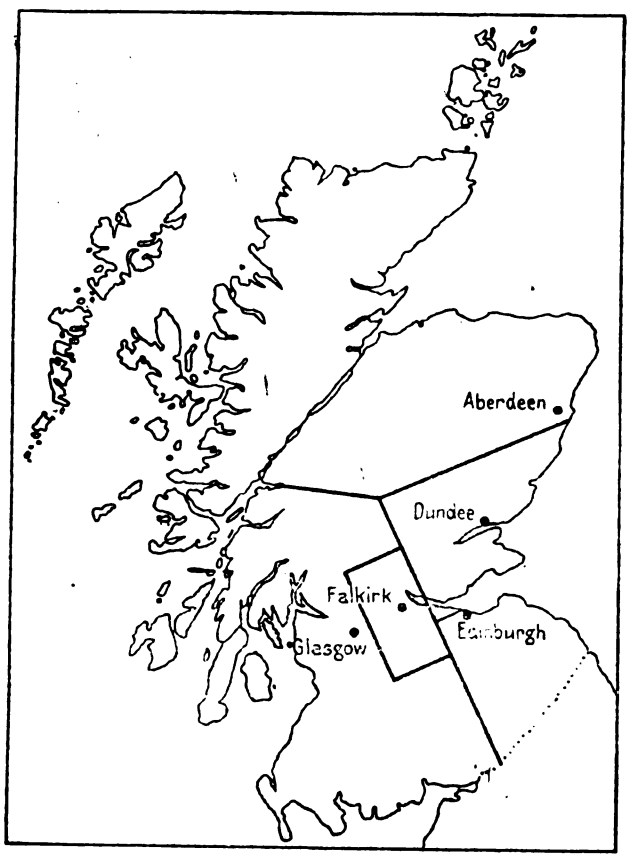
Electrical Power Engineers' Association.

The adjoining map indicates the preliminary scheme for the organisation of the Electrical Power Engineers' Association in Scotland. By consulting this map prospective members and members can see in what area they fall and to whom they should communicate regarding E.P.E.A. matters.



The secretary for the Glasgow area is Mr. Arthur H. Kelly, 5, Battle field-avenue, Langside, Glasgow; and the interim secretary for the remaining areas of Scotland is Mr. J. H. Wright, 8, Garland-place, Dundee. All communications on E.P.E.A. business for Scotland should be addressed to the respective secretaries.

The Labour Outlook.

BY OUR LABOUR CORRESPONDENT.

The Trade Union Congress last week received considerable notice in the public Press, but it is doubtful whether newspaper readers obtained more than a blurred and distorted impression of its proceedings. The political aspect of affairs was very prominent at the Congress. The telegrams despatched to Sir Douglas Haig, Admiral Beattie and Lord Weir, and the spontaneous enthusiasm which followed the announcement by the chairman of the fall of Lens and Quéant were alone sufficient to show that the trade union movement actively supports the war and more than sufficient to expose the hollowness of the charge that it is defeatist. Yet moderates, if I may use the term, like Mr. Arthur Henderson (who appeared as the fraternal delegate from the Labour Party) and Mr. J. H. Thomas carry far more weight than extremists like, say, Mr. Havelock Wilson. People do not appear to understand his attitude; but until they do, they will fail to understand the outlook of organised labour.

The view of the Trade Union Congress on the war helps to explain the proceedings on the resolution expressing condemnation of German atrocities on the seas and supporting a boycott of the German nation for five years after the war. Congress was wholeheartedly in agreement with the first part, but opposed to the second. It could not support the one without the other, and with great wisdom the previous question was moved and carried by an overwhelming majority of 3,835,000 to 493,000 votes. Organised labour has no intention of tying its hands by approving a boycott, nor of carrying on war after the war is over. In this connection reference may be made to the attitude taken by Congress on the question of Free Trade Last year, at Blackpool, it carried a Free Trade resolution by a large majority. This year the London Society of Compositors put down a resolution reaffirming Free Trade, which was adopted by 2,711,000 votes against 591,000. The prevailing feeling at the Congress was undoubtedly strongly against Mr. W. M. Hughes, who earlier in the week had addressed meetings in Derby.

Two unequal opposing forces came into collision on the resolution to form a purely trade union Labour Party. This movement, which has been widely advertised in the Press, has never been taken seriously in trade union circles. The resolution was down in the name of ten unions, headed by the Sailors and Firemen, of which Mr. Havelock Wilson is president. Most of these unions are relatively small. The railway men, miners, engineers, and other large groups of workers have decided on running candidates at the next General Election under the auspices of the Labour Party. The result of the voting on the resolution was therefore a foregone conclusion. An amendment was carried in its stead, by 3,815,000 against 557,000 votes, urging loyal co-operation with the Labour Party. This is proof enough that the trade union movement regards the Labour Party as its avenue of political expression. There are naturally numbers of trade unionists who are not in agreement with the Labour Party, but of the general trend of opinion there can be no doubt. The original resolution was criticised on the ground that it would sow dissension in the Labour movement. This argument was effective, for all who watch the movement closely of working-class thought must be struck by the efforts which are being made to heal divisions and to consolidate Labour forces. A new interest is being taken in the need for unity and consolidation. This was clearly shown in the resolution adopted by the Congress, as a result of which a committee has been appointed with the object of organising trade unionism on industrial lines and surmounting the demarcation difficulties between industry and industry, which have created friction between one union and another in the past.

There were, as usual, a large number of resolutions on the agenda; of which a good many were somewhat perfunctorily disposed, either because of general agreement or as the meeting drew to a close through lack of time. They covered a variety of subjects, both industrial and non-industrial. It is impossible even to set out a list of them. What is more important than the actual resolutions, however, is the spirit of the Congress. A membership of four and a half million members has now given it a new sense of power. There is a consciousness of the power of the trade union movement throughout the whole of the proceedings of Congress. Trade unionism, it is clear, can never recede to its pre-war position. It has now a place of importance for itself in our national life.

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"Alternating Current Electrical Engineering," by Philip Kemp, M.Sc. (London: Macmillan & Co., Ltd.) Pp. xi.+494. 17s. net.

"A History of Chemistry," by F. J. Moore, Ph.D. (London: Hill Publishing Co., Ltd.) Pp. xiv.+292. 12s. 6d.

"Works Lighting," by D. H. Ogley, B.Sc. (London: Iliffe & Sons, Ltd.) Pp. 135. 7s. 6d. net.

"The 'Financier' Rubber Share Handbook." (London: "The Financier.") 15th Edition. Pp. xv.+880. 5s. net.

"Trade Parliaments and Their Work," by E. J. P. Benn. (London: Nisbet & Co.) Pp. 91. 1s. net.

"Transactions" of the American Electrochemical Society, Vol. XXXII., 1917. (Bethlehem: American Electrochemical Society.) Pp. viii.+500. $3.

"A Calendar of Leading Experiments." By W. S. Franklin and Barry Macnutt. (S. Bethlehem: Franklin, Macnutt & Charles.) Pp. viii.+210. $2.50.

"Magnetism and Electricity for Home Study." By H. E. Penrose. (London: The Wireless Press, Ltd.) Pp. xxiii.+515. 5s. net.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain of the Week.—Capt. W. H. Hyman.

Next for Duty.—Capt. W. Darley Bentley.

Sunday, Sept. 15.—Commandant's Parade at Waterloo Station 8.45 a.m. for work at Esher. Drill Order without rifles. Mid-day and tea rations to be carried.

Monday, Sept. 16 to Saturday, Sept. 21.—Drills as usual.

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Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 SPECIFICATIONS.

102,923 ATELIERS DE CONSTRUCTIONS ELECTRIQUES DU NORD ET DE L'EST. Electric traction systems. (21/12/15.)
111,673 SOC. J. MUNIER ET CIE. Elevators for blast furnaces, kilns or the like. (28/11/16.)
113,615 MCKENZIE, HOLLAND & WESTINGHOUSE POWER SIGNAL CO. Electric relays, particularly for traffic-controlling apparatus. (20/2/17.)
115,017 WEBB. Methods for melting refractory substances by electric arcs. (16/3/17.)
117,906 WHITE. (Domestic Engineering Co.) Electric battery indicating devices. (30/3/17.)
117,931 WHITE. Celling roses and the like, electrical fittings. (2/8/17.)
117,934 CROMPTON & CO. & PENSAERNE. Dynamo-electric machines. (3/8/17.)
117,939 OSRAM-ROBERTSON LAMP WORKS & DRIVER. Means for supporting electrodes in ionic tubes for use more particularly in wireless telegraphy. (4/8/17.)
117,953 B.T.-H. CO. (G.E. Co.) Electrical induction apparatus. (10/8/17.)
117,967 MARR. Telephone receivers. (18/8/17.)
117,969 AUTOMATIC TELEPHONE MFG. CO. & GREEN. Electric signalling systems, more particularly for use in mines. (20/8/17).
117,986 B.T.-H. CO. & SHUTTLEWORTH. Phase advancers for dynamo-electric machines. (30/8/17.)
117,996 MJELVA. Electric ovens. (14/9/17.)
118,009 SIMMS & SIMMS MOTOR UNITS (LTD.). Electric condensers. (12/11/17.)
118,018 WATSON. Electric cooking stoves. (31/10/17.)
118,020 FARRELL & WARD. Means for completing an electric circuit, specially applicable to alarm clocks. (3/11/17.)
118,023 WATSON & CO. & TRAVIS. Device for closing the orifice in the roof and walls of an electric furnace through which the electrodes pass. (8/11/17.)
118,031 VAUGHAN, WOOD & BAGULEY. Electrically-operated lifting gear. (17/11/17.)
118,034 WILSON. Impulse transmitters for automatic telephones. (21/11/17.)
118,048 MELLERSH-JACKSON (Leonard & Allen.) Electric heating apparatus. (31/12/17.)
118,050 LUCAS & BREBDEM. Electric starting apparatus for motor vehicle engines. (10/1/18.)
118,062 DEAN & CHLORIDE ELECTRICAL STORAGE CO. Electric accumulators. (26/2/18.)
118,090 PHILIPS-BRINTON CO. Electrical condensers. (20/7/17.)
118,096 SPLITDORF ELECTRICAL CO. Magnetos. (1/12/16.)
118,102 AKT.-GES. BROWN, BOVERIE ET CIE. Induction electric motor with variable number of poles. (21/7/17.)

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

July 15, 1918.

11,583 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. & TALLENT-BATEMAN. Electric fuse cabinets.
11,587 PARRY. Telephone receivers.
11,595 BIERBOWER. Electrical testing devices.
11,596 RICHARD (LTD.) & HARVEY. Manufacture of electric cables.

July 16, 1918.

11,603 HAILWOOD. Miners' safety lamps.
11,613 WARDLE ENGINEERING CO. & WILKINSON. Electric lamp-holders, &c.
11,616 WOODLAND. Apparatus for teaching telegraphic codes.
11,625 CLEMENS. Electric soldering irons.
11,628 DODGE. Electric cord protector.
11,651 CHEVALLAY. Bobbins for electrical purposes.
11,657 MARKS. (Splitdorf Electrical Co.) Electric circuit controlling devices.

July 17, 1918.

11,688 ACRES. Machine for testing alternating torsion fatigue.
11,709 CHAMNEY. Telephone repeater systems.
11,710 CHAMNEY & ROBINSON. Telephone repeater systems.
11,725 LANGDON-DAVIES & SOAMES. Current regulators or transformers of the constant current type.
11,739 MARKS. (Stuart.) Electrolytic cells.

July 18, 1918.

11,779 HAIGH, VITT & PICKERSGILL. Trolley heads for electric traction.
11,804 WRIGHT. Directional aerials for wireless telegraphy.

July 19, 1918.

11,857 LAIDLAW. Automatic or semi-automatic telephone systems.
11,858 LAYTON. Incandescent lamps.

July 20, 1918.

11,903 A.-G. BROWN, BOVERI ET CIE. Induction electric motor with variable number of poles. (21/7/17, Germany.)

July 22, 1918.

11,940 BOWLE-EVANS. Separating magnetic material.

July 23, 1918.

11,984 JONES. Electric resistances.
12,011 MARKS. (Splitdorf Electrical Co.) Magneto-operating mechanism.
12,021 BUTLER. Trolley heads, &c.

July 24, 1918.

12,042 GARRARD, BONNER, JACKSON & RAILING. Electric motor starters.
12,069 CREED & CO., BAYNES & GAYDON. Fluid operated relay valves for producing, reproducing sound. &c.
12,070 BARTON. Locating faults in cables or overhead lines.
12,071 JAYNES. Tell-tale switchboards.
12,078 EDISON SWAN ELECTRIC CO. & HIATT. Valves for wireless transmission systems.
12,086 MELLERSH-JACKSON. (Prince & Waterhouse.) Electrically controlling air brakes.

July 25, 1918.

12,125 MARINO. Electro-plating metals.
12,132 MEDWAY. Portable electrical appliances.
12,134 SMITH. Automatic regulator for dynamos.
12,135 FOWLER. Electrically-driven motor or engine.
12,140 WEEKES. Boxes for fuses, &c.
12,143 SMITS. Electric heating element. (29/8/17, Holland.)
12,145 SPLITDORF ELECTRICAL CO. Ignition devices. (25/7/17, U.S.)

July 26, 1918.

12,188 WESTERN ELECTRIC CO. Cores for Pupin loading coils, magnets, &c.
12,189 ROBINSON & WORKMAN. Electric heater.
12,195 B. T.-H. CO. (G. E. Co.) Producing sure elements.
12,196 BRIGGS. Automatic destination indicator for trams.
12,201 CALLENDER'S CABLE & CONSTRUCTION CO. & KAY. Insulators for supporting conductors on transmission lines.
12,212 DAVIS & TWIGG. Electric switches.
12,214 BLOXAM. (Russische Akt. Ges. L. M. Ericsson & Co.) Electrically operating mechanism from a distance.
12,217 CHRISTIAN. Relay for electric circuits.
12,218 O'NEIL. Contacts of electrical switchgear.
12,219 BERGLUND. Extracting zinc in electric furnaces. (22/10/17, Sweden.)
12,220 GIBSON & FEHR. Wireless control apparatus.

Commercial Topics.

The Future of National Factories.

At Glasgow on Saturday Mr. Geo. N. Barnes, M.P., discussed the question how the present high standard of living of the working classes could be maintained and safeguarded in the post-war period.

Mr. BARNES did not believe that either Free Trade or tariffs would help us in the position in which we would find ourselves. Free trade was the best policy considered only from the economic point of view, and also assuming that other countries would adopt the same policy, and that we were going to have continued peace. However, that did not exhaust the subject by any means. For his own part, he had an idea of running industries on what might be called a new plan. He did not say that it was a good plan, but wanted to get it discussed. He believed that in the Whitley scheme there was the germ of a great idea capable of much expansion. He would run industries to produce the largest possible amount of goods under the most scientific conditions of labour, and to get the largest possible wages and best conditions of life in those industries. Those were the chief factors which should help us to determine those industries we were going to protect—if we were going to protect anything. There was nothing positive about Free Trade. On the other hand, he did not believe that tariffs were the right way. He hoped the country would not allow national factories to revert to private owners. Those factories should be retained by the nation and serve to lessen the national debt.

* * * *

Government Operation of U.S.A. Power Plants.

Owing to the increasing demand for power for industrial purposes and to the difficulties of the fuel situation, the Government of the United States propose to acquire authority to purchase and operate electric power plants. The "Electrical World" states that the draft of a Bill, which has been prepared by the War Industries Board as a war emergency measure, authorises the President to acquire, construct and operate power plants of all kinds in order to stimulate production of materials and articles essential to the prosecution of the war. It is explained that the proposed legislation will enable the authorities to take advantage of steam power as well as water power during the war and that it is intended as an amendment to the pending Administration Power Bill now before the House of Representatives. The new Bill provides for compensation for property taken and also gives power to operate and maintain the plants taken over or constructed, "but only for such time as the President may deem necessary or advisable in the interests of the United States."

* * * *

Electrical Manufacture in China.

An important step has been taken by the Chinese Ministry of Communications which has recently formed, in conjunction with the Western Electric Co. (of Chicago) and the Nippon Electric Co. (of Tokyo), a new company entitled the China Electric Co., Ltd., for the establishment of works in China for manufacturing telephone and telegraph apparatus and other electrical materials.

The new company has a capital of one million dollars (gold), one-half being held by the Ministry of Communications and the remainder by the electric companies in equal shares. The company has been formed for the express purpose of manufacturing and supplying the telephone, telegraph and general electrical material required by the Chinese Telegraph Administration, as well as other Chinese companies. The head office will be at Pekin, but a branch office will be maintained at Shanghai. Under the terms of the contract between the Ministry and the electric companies, the China Electric Co. will become sole agents in China for the Western and the Nippon Electric Companies, and will have the privilege of all the patents, inventions, advice and experience of both companies. The China Electric Co. will sell all kinds of electrical material and apparatus, and is already prepared to transact business.

* * * *

Miners' Electric Safety Lamps.

By a recent order under sec. 33 of the Coal Mines Act, 1911, the Home Secretary approved the "Fuller" miners' electric safety lamp, and allowed certain amendments to the schedules of previous safety lamp orders.

The "Fuller" lamp possesses the following essential features: (1) A battery case of spun or drawn sheet steel, with a protecting covering of nickel or tin. (2) A cover of steel or brass, screwed to the case and forming a flame-tight joint therewith. The cover is fitted with a magnetic lock so constructed that the plunger can only be drawn by applying the pole of a powerful electro-magnet to the top of the lock, holes are provided in the lock cover to admit of the bolt being oiled or greased without removal. The bulb-holder is on an ebonite base-plate, through which electrical connection is made to contact plates on the under side. The ebonite base-plate, the protecting glass for the bulb, upper and lower reflectors and rubber washers are held in position by a screwed ring. There are protecting pillars, crown and handle. (3) An electrical accumulator of the Fuller block type, fitted with spring terminals of large area, which establish electrical connection with the bulb through the contact plates in the ebonite base-plate. A dummy contact separates the "on" and "off" positions of the terminals. There is no escape of liquid in any position of the lamp, and the free escape of gas generated

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by chemical action is allowed. The total weight of the lamp must not be more than 6 lb., and the strength of material and attachments throughout the lamp must not be less than in the samples submitted for official tests on May 8, 1918. The lamp must be capable of maintaining a light of not less than 1 c.p. all round in a horizontal plane for not less than nine hours, and also of giving a light of not less than 1·5 c.p. over an arc of 45 deg. in a horizontal plane. It must have been made at the works of the Fuller Accumulator Co., Chadwell Heath, London, E., and be marked with its name and the name of the maker.

The amendments to the schedules of previous safety lamps orders include some modifications of the specifications of the Hailwood (Nos. 01 and 01S), Joel-Fors (Type 303 C.), Oldham, Patterson (Type E1) and the Pearson Safety lamps.

Electricity Supply.

General.

Aberdeen.—The Council has increased the salary of the city electrical engineer, Mr. J. Alex Bell, by £100, making, with £75 bonus, £850 per annum.

Belfast.—The Harbour Commissioners have authorised the Corporation electric supply department to erect a temporary timber quay on the west side of the Musgrave Channel, as, owing to the difficulties in obtaining materials it is impossible to have a reinforced concrete quay in time to meet the requirements of the Corporation in connection with their new electric generating station.

Burnley.—Last week the employees of the electricity works presented Mr. Tom Taylor, an assistant electrical engineer, with a mahogany timepiece on his approaching marriage.

Liverpool Electricians' Strike.—On the 5th inst. about 1,000 members of the Electrical Trade Union in Liverpool and district came out on strike as a protest against foreman and charge hands who were not members of the Electrical Trade Union.

Luton.—The Council has obtained the sanction of the L.G. Board to raise loans amounting to £77,686 for the electricity undertaking.

Newport (Mon).—The Electricity Committee have approved the engineer's recommendation to increase the salaries of the senior and junior engineers in charge by £40 and £25 per annum respectively.

In bringing forward his recommendation, Mr. Nichols Moore drew attention to the fact that the series of increases granted to skilled men by the Committee on Production had placed the engineers-in-charge in a very anomalous position. The engineer also reported that the progress of the extension works was most unsatisfactory, owing to the difficulty in obtaining adequate skilled and unskilled labour, and asked for discretionary powers in regard to rates of pay to men employed on constructional work. The Committee granted him these powers, but the Salaries and Wages Committee subsequently refused to confirm the Electricity and Tramways Committee's recommendation.

The application of the National Union of General Workers on behalf of the semi-skilled and unskilled men employed in the power station, claiming the recent further award No. 1,920 granted by the Committee on Production, has been refused by the Electricity Committee, and the matter referred to arbitration.

Restriction of Lighting.—A Privy Council Order, dated Sept. 4, confers upon the Minister of Munitions powers to restrict lighting and the supply of electricity, &c. The Order amends Regulation 11 A of the Defence of the Realm Regulations, as follows:—

The Minister of Munitions may direct lights of any class or description to be extinguished or their use restricted to such extent, between such hours and during such period, &c., as may be specified in the order, or prohibit, restrict or otherwise regulate and control the supply, or means of supply, of electricity to, or its use in, any premises or class of premises, or any place or undertaking.

Provided that no Order or requirement shall be made for the closing of any power station belonging to any local authority or for the connection of any such power station with any other power station except with the concurrence of the appropriate Government Department.

South Shields.—The Electricity Committee recommends the Council to increase the salary of the borough electrical engineer (Mr. Harry S. Ellis) from £550 to £700 per annum.

Stretford.—In regard to the winter load of 1918–19 the offer of the Trafford Power Co. to give a temporary supply of direct current of 300 kw. plus 10 per cent. in lieu of three-phase e.h.t. current to be metered at the works switchboard, has been accepted by the Council.

Application is to be made to the L.G. Board for sanction to borrow £26,100 for two 1,000 kw. rotary converters (£7,675), one 500 kw. rotary converter (£2,850), h.t. and l.t. switchgear (£2,200), l.t. cable and accessories (£1,650), E.H.T. cables (to be provided by the Trafford Power Co.), £4,500, the balance being for buildings, cable laying, &c.

Works Inspectors' Salaries.—An Army Council Instruction states that it has been decided to issue a war bonus to permanent inspectors of works and superintending inspectors of works whose ordinary remuneration exceeds £500 a year and does not exceed £1,000 a year.

Electric Traction.

A Scottish Electric Railway.—A scheme is being promoted for the construction of an electric railway in Lewis after the war. The line, which will be about 100 miles in length, will be worked by electrical energy generated by the water-power from Lake Grimshader, about 5 miles south-west of Stornoway.

Dundee.—In a report by the Cleansing Committee on the relative cost of horse and motor haulage, the Council is recommended to purchase an electric vehicle for the collection of refuse, &c.

Grimsby.—In future there will be no electric tramway service on Sundays.

Keighley.—The Tramways Committee has decided to increase the tramway fares as from the 14th inst., and to limit the services.

Tramway Employees' Wages.—At the recent meeting of Doncaster Corporation attention was called to the great burden put upon the tramways department by the awards of the Committee of Production in connection with the recent application for a further 12½ per cent. increase for tramway employees.

The Tramways Committee recommended that the award of an additional 5s. per week be paid to the male employees as directed; that the staff be granted the 4s. as previously awarded to female tramway employees; and that the electricity employees be granted an additional 4s. per week war bonus.

Councillor Balmforth said that when the Minister of Munitions made the 12½ per cent. "snowball," he could not really have thought of the amount it would involve. It was rolling into an avalanche, which would swamp the whole of the industries of our country. If this "snowball" kept rolling, there was only one thing to do, and that was to increase the car fares, and it became an economic study whether it was worth while to keep on changing two sixpences into one shilling. The department would be no better off at the finish than at the commencement. In 1911–12 the expenses were 6d. per car mile, and that was the outside estimate in any undertaking, but with the additional expenditure next year it would amount to nearly 11½d. per car mile.

Walsall.—The Tramways Committee recommends that the salary of the tramways manager (Mr. R. L. Horsfield) be raised to £600 per annum as from April 1 last, rising by two yearly instalments to £700 per annum. The salary of Mr. D. Mills, chief clerk in the electric supply department, is to be increased from £150 per annum to £175.

Imperial Notes.

Australasia.—Mr. G. L. Just, president of the Electrical Traders' and Contractors' Association of Victoria, in his recent presidential address, referred to the creation of two sections of the Association, one dealing with wiring contracts and shop work and the other with trading matters. Further good progress had been made with the standardisation of wiring rules.

The "Industrial Australian and Mining Standard" says Balmain, Newtown, Leichhardt and Ashfield (N.S.W.) Councils have decided to meet and discuss the question of purchasing the undertaking of the Electric Light and Power Supply Corpn. (Sydney), at a price to be agreed upon or fixed by arbitration.

St. Lawrence Power Development.—Mr. Meighen, Dominion Minister of the Interior, and Mr. Sifton, Minister of Customs, have gone to Washington to negotiate with the American Government on the question of the extension of the power plant at Longsault Rapids on the St. Lawrence River.

The Aluminium Co. of America supported by the American authorities, applied to the International Waterways Commission for authority to build a dam to develop the additional power necessary to increase the production of aluminium. The Canadian Government, while not desiring to prevent plans for increasing necessary war products, objected to a private company securing power rights on the St. Lawrence, and also claimed that under the Ashburton Treaty the Commission has no jurisdiction. The Canadian Ministers now propose that a power plant should be built by the two countries and that the work should be undertaken as a war measure.

Foreign Notes.

Argentina.—The London correspondent of "La Argentina" states that the Allied Governments will not continue to allow coal to be shipped to the Compania Alemana Transatlantica de Electricidad, which supplies the current for working the tramways of the Anglo-Argentine Tramways Co., and he suggests that its stations should be transferred to Buenos Aires municipality or its concessions should be declared forfeited and be handed over to Argentine or British-American syndicates.

The Municipal Intendent, Dr. Llambias, has declined to give any pledge of Government action in the matter. He thinks oil and wood fuel may help the stations to carry on, even if coal cannot be imported.

Spain.—The Gas Supply Co. of Palma (Majorica) proposes to erect an electricity supply station.

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U.S.A. Nitrate Plant.—The Union Gas & Electric Co., Cincinnati, O., has obtained a loan of $2,000,000 for the erection of a third unit of 30,000 kw. at its new generating station and for erecting a transmission line from the station to the new Government nitrate plant at Broadwell. The company will deliver energy to the plant by July 1 next, with a minimum of 30,000 kw. and a maximum of 40,000 kw. for the first year.

Wireless Royalty Litigation in America.—Marconi's Wireless Telegraph Co. informs us that the recent judgment in favour of the International Radio Telegraph Co. has been appealed against, and it is hoped that the decision will be reversed. The sum involved is about £60,000, or about one tenth of the amount mentioned in the original reports.

Miscellaneous.

Anchor Works Hospital and Distress Fund.—The annual report of the Hospital and Distress Fund of the Leigh works of Callender's Cable and Construction Co., gives the following particulars.

The scheme, which is subscribed to by all employees of 17 years and upwards, embraces "The Hospital and Distress Fund" and "The Special War Fund." To the former the employees contributed during the year £227. 16s.—and substantial grants were made to local and Manchester hospitals, and the balance was paid to necessitous members. Contributions to the Special War Fund were £999. 14s. 9d., of which £232 has been dispensed amongst hospitals and war charities, and £373. 6s. 5½d. expended on parcels and postal orders for "Anchor" employees with H.M. Forces. At the annual meeting presided over by Mr. A. Crooke, generous contributions were voted to hospital and war charities for the coming year. The administrative work is undertaken by a committee with Mr. W. Mort as hon. treasurer, and Mr. R. Hocken, hon. secretary.

British Westinghouse Employees' War Relief Fund.—The annual report of this fund states that from Aug. 22, 1914 to June 30, 1918, the total contributions were £57,253, of which £38,061 has been contributed by the employees and £19,191 by the Company.

A sum of £38,147 has been paid to dependents, £12,392 placed to disablement and dependent's fund, and £2,479 spent in donations to local and national funds and Christmas gifts. The number of families in receipt of weekly relief is 822. Employees who have joined H.M. Forces number 3,461.

Coal Control.—In response to the invitation of the Government to appoint a representative to assist the Coal Controller in the administration of the Coal Control, the Miners' Federation of Great Britain have replied that they do not see their way to do so, but suggest that the situation can be met by the holding of more frequent meetings of the Coal Advisory Board on which they are represented. This suggestion is to be adopted. Sir Adam Nimmo is acting as adviser to the Coal Controller.

Exports to China.—Amongst recent additions to the firms and persons in China to whom goods may be exported from this country is the Electric Light Works, Mukden, Chanchan.

Enemy Firm Wound Up.—An order has been made by the Board of Trade for the realisation and distribution of the assets of Electro Osmose Synd. (Ltd.), Imperial House, Kingsway, London, W.C. 2 (syndicate formed to purchase patent rights for the purification of clay). Mr. J. R. Tulloch, 4B, Frederick's-place, London, E.C. 2.

Tenders Invited and Accepted.

Transformers.

ATHERTON Urban Council require tenders by Sept. 16 for the supply of two 110 kw. single-phase transformers. Particulars from the Resident Electrical Engineer.

Telegraph and Telephone Apparatus, &c.

The UNION OF SOUTH AFRICA Post and Telegraph Department requires tenders by 3 p.m. Oct. 23 for supply of copper wire, telephone apparatus (bells, blocks, boxes, coils, protectors, switchboards, &c.). Forms of tender from the Controller, Post Office Stores Room, 62, Palace of Justice, Pretoria.

Electric Lamps.

WESTMINSTER Guardians require tenders by noon Sept. 18 for supply of electric lamps, &c. Forms of tender from the Clerk, Princes row, Buckingham Palace road, London, S.W. 1.

MANCHESTER.—The following tenders have been accepted by the Corporation :—

British Thomson-Houston Co., traction motors; Andrews, Croucher & Co. and General Electric Co., carbons; London Electric Wire Co. and Smiths, copper wires, &c.; Doulton & Co. and Bullers (Ltd.), insulators.

SHEFFIELD.—The City Council has accepted the following tenders: C. A. Parsons & Co., two 25,000 kw. turbo alternators, with condensing plant (Worthington-Simpson Co.); Stirling Boilers Co., 16 boilers; A. Reyrolle & Co., six panels 3,300 volt, three-phase switchgear; Brown Bayley's Steelworks, John Brown & Co. and Cammell Laird & Co., 300 tramway tyres each (12 months' supplies).

Appointments Vacant and Filled.

A boiler-house superintendent is required by the Borough of Salford Electricity Dept. Applications to the Borough Electrical Engineer, Frederick-road, Salford, by Sept. 16. *See advertisement.*

Instructors are wanted in technical drawing and trade drawing for science and for tutorial class in the evening institutes of the London County Council. Applications to the Education Officer (T.6), Victoria Embankment, London, W.C. 2. *See an advertisement.*

A second technical assistant is required for the Newport (Mon.) Electricity & Tramways Department. Commencing salary £250 per annum. Applications to the borough electrical and tramways engineer, Mr. A. Nichols Moore, by Sept. 23. *See an advertisement.*

A junior demonstrator in physics is required at the East London College, Mile End-road, London, E. 1. Salary £200. Particulars from the Secretary.

The Council of the University College of South Wales, Monmouthshire, invite applications for the post of temporary assistant lecturer and demonstrator in physics for the Michaelmas and Lent terms of the 1918–19 Session. Salary £100, with certain additional fees. Applications to the Registrar (Mr. E. J. A. Brown), Cathays Park, Cardiff, by Sept. 16.

A lecturer in industrial administration is required for the Manchester Municipal College of Technology. Salary £600 a year for five years. Conditions, &c., from the Registrar and applications must be in by Sept. 22.

Mr. W. Forbes, assistant tramways manager, has been promoted to the position of manager of the Aberdeen municipal tramways at a salary of £450 per annum, in succession to Mr. R. S. Pilcher, who was recently appointed manager of the Edinburgh tramways.

Mr. T. W. Hibbert, of Barnsley, has been appointed station engineer at Doncaster at £230 per annum.

Coleraine Urban Council has appointed Mr. W. R. Johnstone, of Banbridge, principal of the Technical School, in succession to Mr. D. Hardman, M.Sc., who was recently appointed principal of Barrow-in-Furness Technical Institute.

Keighley Tramways and Electricity Committee has appointed Mr. B Hall, of Chatham, assistant to the borough electrical engineer and tramways manager at a commencing salary of £200 per annum.

Business Items.

Daniel Francis and Nathan Clayden (trading as Chatteris Engineering Works Co.), Chatteris, Cambs., have dissolved partnership. Debts by Chatteris Engineering Co., Ltd., which has acquired the business.

Patent Development.—The owner of patent No. 28,630/1903, relating to "Electrolytic converter for the transformation of alternating into continuous current," desires to enter into arrangements for exploiting the invention in this country. Particulars from Messrs. Allison Bros., 84-86, Chancery-lane, London, W.C. 2.

Market Exploitation.—The August number of "Business," which is issued by Greenly's Ltd., 37/8, Strand, W.C. 2, is devoted to the most effective methods of exploiting a market already existing.

Lighting Hints.—In view of the great need of coal and fuel economy, it is necessary that the best possible use should be made of the fuel and lighting allowed by the Fuel and Lighting Order, and in the recent folder on Lighting Hints issued by the British Thomson-Houston Co., Mazda House, Upper Thames-street, E.C. 4, electric supply consumers will find much useful information as to what to do and how to do it in order to comply with the Order. Small quantities, over-printed with contractors' names and addresses, will be supplied free on application.

Bankruptcies and Liquidations.

Archibald Maurice Ferguson, electrician, formerly trading at 125, Sankey-road, and 59, Allen-street, Warrington, has been adjudicated bankrupt.

The first meeting of creditors of Archibald Maurice Ferguson, electrician, formerly trading at 125, Sankey-street, Warrington, will take place on Sept. 13 at 11, Dale-street, Liverpool, and the public examination on Oct. 4 at the Court House, Palmyra-square, Warrington.

Claims against Ferdinand Winter and Gustav Herman Almenraeder, importers of vulcanite, &c., 49, Great Sutton-street, London, E.C. 1, are to be sent by Oct. 10 to the Controller, Mr. J. D. Pattullo, 65, London-wall, London, E.C. 2.

Claims against the Rotherham Electrical Engineering Co. (Ltd.), Tivoli buildings, Rotherham, are to be sent by Sept. 23 to Mr. J. C. Clegg, Official Receiver, Figtree-lane, Sheffield.

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Municipal Accounts.

Bath.—At March 31 the gross capital outlay on the electricity undertaking was £191,346, of which £77,999 is outstanding.

Revenue was £31,031 (compared with £26,508 in previous year) and working expenses were £17,638 (£14,987), leaving £13,393 (£13,472) gross profit, which was insufficient by £593 to meet outgoings on net revenue account, but the latter included £387 written off meter suspense account and £50 wages of workmen on capital work. Units generated were 2,686,130 and sold 2,071,964. Total maximum demand was 1,213 kw.

Croydon.—The accounts of the tramways department for the year ended March 31 show gross capital expenditure £286,764, of which £149,771 is outstanding.

Revenue was £112,796, working expenses were £78,626 and war allowances required £5,801. Interest, sinking fund and income tax required £17,149, leaving a surplus of £11,220. Average total revenue per car-mile was 12·3d., and average working expenses, including power, were 8·576d. Passengers carried were 22,747,240 and car-miles run 2,200,248.

Kettering.—The gross capital expenditure of the electricity department at March 31 was £94,529, and outstanding debt £59,066.

Income was £22,861 (against £19,118) and net surplus £1,138 (£615), after purchasing an electric vehicle for £1,035 and paying £288 for new boiler foundations.

King's Lynn.—The electricity department's accounts for the past year show income £12,226 (against £8,759 in previous year), working expenses were £7,406 (£5,727), gross profit was £4,820 (£3,031) and net profit £2,146 (£290).

Preston.—The accounts of the tramways department for the past year show that the gross capital outlay is £202,806, of which £129,389 is outstanding.

Revenue was £63,097 (increase £5,413) and net profit £4,158 (against £7,581 in previous year), of which £2,381 has been devoted to relief of rates.

Southport.—The accounts of the electricity department show a net deficit of £4,205 for the past year.

Income was £32,276 (compared with £25,404 in previous year), and working expenses were £23,021, leaving gross profit £9,255; but after providing for interest and sinking fund 13,703 (11,734) the net result was the deficit above mentioned. Coal cost £3,849 more and wages £739 more than in the previous year.

West Ham.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £673,948, of which £318,733 is outstanding.

Revenue was £180,834 (compared with £152,987 in previous year), and gross profit £21,598 (£18,008), and after providing for interest, sinking fund and special charges, the net result was a deficit of £32,402 (£35,425), including £4,715 (£4,613) allowance to men on active service. Costs, exclusive of capital charges were 1·428d. (1·281d.) per unit sold. Units generated were 42,856,405 (42,332,509) and sold 35,836,900 (35,298,301). Maximum load was 12,075 (11,820) kw., and load factor 33·88d. (34·09d.) per cent.

The gross capital expenditure on the tramways is £561,163, and the net outlay £557,311. Revenue was £188,851 (compared with £166,659 in previous year), working expenses were £168,826 (£149,989) and allowance to men on active service required £16,761 (£16,670), leaving balance £3,263, and, after providing for repayment of loans, sinking funds and interest, there was a net deficit of £28,177. Income per car-mile was 12·630d. (10 933d.), and working expenses 11·279d. (9·860d.).

Willesden.—The electricity department's accounts for the year ended March 31 show gross capital expenditure £248,153 (increase £8,763), of which £85,448 is outstanding.

Revenue was £51,643 (compared with £44,155 in previous year), gross profit £14,127 (£14,196), and net profit £1,200 (£1,614). Total working costs were 1·184d. (1·2d.) per unit, and total costs, including capital charges and special items 1·605d. (1·719d.) Units sold were 7,603,956 (5,990,685). Load factor was 26·65 (24·2) per cent.

Winchester.—The accounts of the electricity department for the year ended March 31 show total capital expenditure £106,833, of which £8,025 has been repaid.

Revenue was £16,559 (compared with £14,434 in previous year), and working expenses were £10,535 (£8,833), leaving gross profit £6,024 (£5,600). After providing for loan redemption, interest, &c., the net profit was £445 (£131). Maximum load was 636 (590) kw. Units generated were 1,368,070 (1,214,520) and sold 1,033,155 (910,131).

Companies' Meetings and Reports.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)—The total revenue, for 1917 was £11,410, compared with £12,793 in 1916. The balance after putting £500 to depreciation, is £2,273, compared with £2,658. After providing for debenture interest, &c., the balance is £386, which has been carried forward. The revenue decreased by £1,374, but a saving of £1,999. 19s. 7d. was effected in fuel. There was an increased expenditure on plant renewals and on mains, &c.

KALGOORLIE ELECTRIC TRAMWAYS.—Mr. O. Wethered, who presided over the annual meeting on the 5th inst., said that the conditions at Kalgoorlie had not improved and could not improve for some time. With the high cost of living, the travelling public had to practise economy. The cost of everything used in connection with the tramways had not only greatly increased in price, but it was almost impossible to get the material required. Copper wire could not be obtained in either England or America for export to Australia, but recently Japan had been supplying it. Their men's claim for increased wages had been settled by agreement, and this would add to their expenses about £1,200 per annum. The operating expenses had been cut down to the lowest point. The miners' representatives had agreed to an increase of 1d. in the workmen's tickets and to an extra 1d. on all transfers. The motor-cars were still run in competition with the tramways, and in the opinion of the directors, having regard to the obligations imposed upon the Company, they ought not to be allowed to compete at all. As the result of the alteration of fares, &c., the returns up to the end of May showed an increased profit for the first five months of the year of over £500.

SOUTHERN BRAZILIAN RAILWAYS CO. (LTD.)—The gross earnings of the tramways for the year ended Sept. 30, 1917, were £21,426 and operating expenses (at Curityba) £20,157. General expenses in Europe were £1,437, and interest £2,539, showing a loss on the tramways of £2,707. Light and power earnings were £45,709 and operating expenses £23,628, profit being £22,081. After deducting general expenses in Europe, including loss on exchange and taxes £2,658, and interest £4,232, net profit is £15,191; after transferring the tramway loss the net earnings on light and power is £12,484, and this has been dealt with as follows: Payments to unsecured creditors, £1,018; liabilities incurred in respect of accidents, £3,896; written off difference in exchange, £3,428; interest on 18,640 second series debentures of £20 each at 3s. 4d. net per debenture, plus tax, £4,142. For the preceding year the tramway loss amounted to £2,856, and net receipts from light and power after deducting this loss was £9,617.

City Notes.

BROWETT, LINDLEY & CO. (LTD.)—The directors have decided to pay the following interim dividends to June 30: 3 per cent. full half-year's dividend on the preference shares, a further 3 per cent. actual on arrears on those shares, and an interim dividend of 4 per cent. on the ordinary shares.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—An interim dividend at rate of 6 per cent. per annum (6s. per share), less tax, has been declared on the ordinary shares for the past half-year.

CITY & SOUTH LONDON RAILWAY.—The Board of Tradehas extended, by one year from Aug. 15, 1918, the time limited by the City & South London Railway Act, 1913, for the exercise of powers for payment of interest out of capital.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—An interim dividend at rate of 5 per cent. per annum (5s. per share), less tax, has been declared on the ordinary shares for the past half-year.

EASTERN TELEGRAPH CO. (LTD.)—The company announce payment on the 15th prox. of dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock for the quarter ended 30th inst., and the second quarterly interim dividend of 1½ per cent. on the ordinary stock (tax free) in respect of profits for the year ending Dec. 31, 1918. The transfer books of the ordinary stock will be closed from Oct. 5 to 14 inclusive.

GLOBE TELEGRAPH AND TRUST CO. (LTD.)—A quarterly interim dividend of 2s. per ordinary share, tax free (at the same rate as last year) is announced.

OXFORD ELECTRIC CO. (LTD.)—An interim dividend at rate of 5 per cent. per annum (2s. 6d. per share), less tax, has been declared on the ordinary shares for the past half-year.

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, September 10, 1881.]

"PASTURES NEW."—News from Cape Town says that the "Eastern Star" has been complaining that gas motors were not available because there was no gas, and recommending electric motors whose store of power can be accumulated by an inexpensive windmill or waterwork arrangement. It adds that Colonel Beaumont's air engines are likely to supersede the latter.

ELECTRIC LIGHT AT YORK.—The Brush electric light was exhibited at York this week on the occasion of the visit of the British Association. The light did not work very well, though this may reasonably be put down to the fact that at the last moment the locality of the generator had to be shifted, and the engine turned out to be of insufficient power to keep the lights going.

AMERICA TO THE FORE.—We have it on good authority that Mr. Edison's agents are offering to fit up shops in the West End of London with his incandescent lamps for six months free of all charge and unconditionally. One or two well-known West End firms have already consented to try the experiment. Yankee enterprise has given us a lesson here which should not be lost.

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CONTENTS.

Notes 427
Arrangements for the Week 429
The Character of the Thermal Storage Demand Meter. By P. M. Lincoln. Illustrated 430
On the Value of the Conductivity of Sea-Water for Currents of Frequencies as Used in Wireless Telegraphy. By Balth. van der Pol, Jun. 432
Electric Winding Engines and Mine Hoists. By H. H. Broughton. Illustrated.—*Continued* 433
The Jones Portable Automatic Trimming Conveyor. Illustrated. 436
A Method of Determining the Value of Slip. By G. Hilpert 437
Housing and Welfare 438
Reviews 439
The Calculation of Single-Phase and Three-Phase Lines. By J. R. Dick, B.Sc., M.I.E.E. Illustrated 439
The Labour Outlook. By Our Labour Correspondent 441
Electric Vehicle Crane Tractor. Illustrated 441
Arora Electric Fires. Illustrated 442
Volunteer Notices 442
Commercial Topics 442
Electricity Supply 443
Educational 445
Tenders Invited 445

Notes.

The Technical Student and the War.

We fear that the position of the technical student in regard to war service in this country is still far from satisfactory. Of course, there is no question that to win the war must be our first consideration. Other objects would have very little value if we were to suffer defeat, but it is nevertheless necessary to remember what our needs will be when peace comes and to provide for these needs as far as may be possible. In this connection the following words by Gen. William M. Black, Chief of Engineers, United States Army, are worthy of quotation :—

> Our country is going to live long after this war, and one of the things we will need after the war will be trained young men to take the place of the older who go out. So that I would think it a great mistake for the educational institutions of our country to shorten their courses or in any way cease to provide this trained product, just as I think it a great mistake for our young men to leave these courses before they are trained, excepting those who may be strictly needed.

We fully agree with these sentiments, and it is interesting to note that the policy here indicated is receiving considerable support in the United States. According to a recent announcement of the United States War Department, students of the Massachusetts Institute of Technology, and presumably of other institutions of a similar character, are to be on virtually the same footing as enlisted men. Apparently this means that failure to meet the scholastic requirements on the part of students will lead to their being removed from the school and drafted into active service. It also means that those who are at all capable in their technical studies will be allowed to continue them until qualified. This is an important decision, for it is far more difficult for a young man to return to studies which have been broken into half-way through the course than to complete the course and then to return to his life's work at a later date. Doubtless it will be agreed that the position in the United States is far less acute than it has been in this country. It may be that we have largely followed an undesirable course of necessity. But if the situation becomes easier it is to be hoped that students will be permitted to complete their course as far as possible, and also that when their instruction is complete that they will be employed on work of a technical character, so as to retain them as a technical asset to the country.

The Degree of Doctor of Philosophy.

The degree of Ph.D. has long been recognised as one of German origin, or at all events one that is largely given by German universities. It was obtainable by students who had not followed a complete course at these universities, and thus it was frequently taken by English students, and we think with beneficial results. The degree involved research, and it had the advantage of permitting a student from this country to work in the laboratories of some well-known German professor and to obtain a degree at the same time. What was often felt, however, was that the standard for this degree was not as high as was desirable. It is now interesting to note that the degree of Ph.D. has been instituted at the University of Manchester (and we believe also at one or two of the other modern universities) with the object of encouraging advanced study and research. Candidates will be required to follow an approved course of advanced research in the University for a period of not less than two years. It is further stated that the degree differs from that of D.Sc., requiring a definite course, and does not involve so high a standard of attainment as that degree. Although we think it is quite desirable that the Ph.D. degree should be instituted at Manchester and elsewhere, we rather doubt the desirability of the lower standard.

Maintenance of Lighting Installations.

In a recent number of the "Illuminating Engineer," some statistics are quoted from a Paper by Dr. D. H. Tuck, of the United States Public Health Service, on the maintenance of lighting installations. A typical case is taken in which the greater number of the lamps and reflectors were found to be cracked, defective or dirty. The efficiency of maintenance of the installation was put at only 55 per cent.; this was corroborated by tests with a photometer, which showed that removal of the defects led to the illumination being approximately doubled. The moral is drawn that proper supervision of lighting equipments is one of the best methods of securing economy; the saving is made by getting a given illumination with a smaller consumption, not merely by extinguishing lamps that may be badly needed. In principle the correctness of this view is obvious, and we agree that electric supply companies have an excellent opportunity in the present emergency to improve their relations with consumers by advising on such points. Unfortunately, the difficulties arising through shortage of staff are only too well known. But wherever conditions permit of an effort in this direction being made it would be thoroughly justified in the future.

The Suggested Exhibition at Manchester.

The British Scientific Products Exhibition held in London was so successful that a movement is on foot to hold a similar exhibition in Manchester. There is much to be said in favour

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of such a project. Manchester is such a large industrial centre that a good attendance could be ensured, and there must be many Manchester people who would have visited and benefited by the exhibition in London but for the distance. In this connection it may be interesting to point out that the number of visitors to King's College amounted to 30,000, and the cost was about 2s. 6d. per head. No Government assistance was given beyond the loan of certain exhibition cases. On the other hand, there was, of course, a great deal of honorary work involved. It is obvious that there would not have been anything like the success that was attained except by a considerable amount of work. Multitudinous committee meetings were involved, the arrangements being largely in the hands of certain energetic members, among whom we may mention Prof. R. A. GREGORY (Chairman of the Committee), Sir ROBERT HADFIELD, Col. Sir JOHN S. YOUNG and Col. W. A. J. O'MEARA. Upon the Secretary of the Faraday Society, Mr. F. S. SPIERS, fell the heavy task of detailed organisation. The net result is that it has been possible to give some instruction and education on British products to 30,000 people at a cost of 2s. 6d. per head, and we think this must be considered as a very creditable achievement.

More Power from Niagara.—According to the "General Electric Review" (U.S.A.) at least half the power available from the Niagara Falls could be effectively used without the natural beauty of the Falls being materially prejudiced. It is suggested that in view of the present coal shortage, and the large power demands of the electro-chemical industries, Congress should grant permission for this water-power to be more fully utilised.

Municipal Tramways Association.—As we announced in our last issue, the 17th annual conference of this association will take place on Thursday and Friday, the 26th and 27th inst., at Leicester. After the delivery by Ald. S. Flint (chairman of the Leicester Tramways Committee) of his presidential address, Mr. E. Hatton (engineer and manager of the Newcastle-upon-Tyne tramways) will read a Paper on "Some Notes on the Post-War Position of the Electric Power Supply," and the discussion will be opened by Mr. J. M. McElroy (general manager of the Manchester tramways).

"Steel Structures."—We have received the first issue of a quarterly publication called "Steel Structures," which is issued by the Steel Structural Section of the British Engineers' Association. It consists largely of well illustrated, though brief, descriptions of steel structures carried out by British firms, the object of the publication being to accelerate application of such methods to numerouus purposes during the difficult period of reconstruction. We trust that it will be successful in its object, though we must confess that the present moment does not seem to be opportune for the launching of new journals when there is a continual outcry as to the shortage of paper.

Afforestation in Great Britain.—In view of the pressing demands for timber since the outbreak of war and the probable shortage afterwards, some recent notes on the subject in "Nature," especially in regard to afforestation, are timely. In 1914 there were about 3,000,000 acres of woods in Britain, of which it is estimated half will disappear during the war, and the areas formerly occupied by them will ultimately be replanted. But this 1,500,000 acres is only a small part of the afforestation problem. There are some 16,750,000 acres of mountain and heath land in Great Britain, giving but a small return per acre, from 2s. 6d. down to a few pence. Of this there are at least 3 to 5 million acres which might well be planted with trees, though the problem is beset with numerous technical difficulties apart from the question of compensation for the land taken.

Formulæ for Calculating Inductance.—Scientific Paper No. 320, issued by the Bureau of Standards, Washington, furnishes a list of formulæ for the calculation of mutual and self-inductance which have appeared since the publication of the earlier Paper dealing with the same subject (Scientific Paper 169). Some of the formulæ given, notably those for eccentrically placed circles, provide a solution for cases where none has been previously available; others are extensions of formulæ already well known, or cover cases where earlier useful expressions are available. No attempt has been made to include all the recent formulæ, but in making a selection the author (Mr. F. W. Grover) has endeavoured to present only those whose form is well adapted to numerical computation, or those for which tables have been prepared which render calculations reasonably simple. Those interested may obtain a copy of this Paper by addressing a request to the Bureau.

Electric Furnace Developments in America in 1917.—Under the title of "Some Developments in the Electrical Industry during 1917," the "General Electric Review," U.S.A., remarks that the individual capacity of electric furnaces in America has altered little since 1909, but last year 20-ton furnaces were introduced and a capacity of 30 tons is probable in the near future. The rate of steel production will thus be increased and higher power consumption made possible. Thus in the case of a 6-ton furnace, the transformer capacity has been increased from 900 to 1,500 k.v.a., and even 1,800 k.v.a. The use of 150 volts may even bring the figure up to 2,250 k.v.a. Voltages up to 173 have been used. The most important recent developments in American electric furnace practice are the result of increased use of automatic control. The type of motor designed for this service has self-lubricating bearings, and ranges in size from 1 to 1½ H.P. for small equipments and 5 H.P. for 15 to 20-ton furnaces.

An Appreciation of the Late Col. Hopkinson.—To "The Times" of the 12th inst., Sir Alfred Ewing contributes a tribute to the scientific work of the late Colonel Bertram Hopkinson, C.M.G., F.R.S.

Referring to the loss which British science has suffered, Sir Alfred says: "It is indeed a tragedy in this regard that he should have been taken at the very summit of his powers, and at the moment when they were so fully engaged in serving the nation's urgent need. His genius for applied science was hereditary. He had the same faculty as gave his father an honoured place in the history of electrical engineering, the same rare combination of mastery of theory and scientific method with appreciation of practical requirements and possibilities. It was this that enabled him to be conspicuously successful as professor of applied mechanics at Cambridge; and it was this that made the value of his war work almost unique. It chanced that his own researches before the war, and those of students working under him in the Cambridge laboratory, formed in some degree a preparation for what was to come. They dealt with the processes and results of explosions, with the action of internal-combustion engines, and with the fatigue of materials under incipient overstrain. They were of high interest in themselves and in their bearing on matters of engineering practice. But to Hopkinson they were more: one may say they constituted an apprenticeship for the great work of his life, which was the work of the past four years. Of what he has accomplished, in those years for the Admiralty, and especially for the Air Force, it is not now permissible to speak. This, however, may be said, that the war gave him such an opportunity as he had never had before, and into it he threw all his inventiveness, all his initiative, his untiring energy, his power of organisation, his unrivalled capacity for getting the best out of himself and out of others. No worker rejoiced more in his work, nor accepted its call with more absolute self-renunciation. He was amazingly aloof from any consideration of personal advantage or personal convenience. The pressure of exacting claims on his attention was continuous, but it seemed never able to ruffle his serenity nor impair the soundness of his judgment. Many will mourn him as a genial and trusted friend, but only those who know something of his recent activities can have any idea of the magnitude of the nation's loss."

National Kitchens.—We have received a copy of the "Handbook of National Kitchens and Restaurants," issued by the National Kitchen Division of the Ministry of Food, from which copies may be obtained free of charge. A great deal of useful information is given in regard to size of kitchen that is desirable, choice of equipment, staff, finance, &c. Emphasis is laid upon the merits of steam for certain operations. In regard to electricity, it is stated that the last word can hardly have been said on electric cooking. If electrical energy is supplied at not more than 1d. per unit, electricity is regarded

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as a very satisfactory agent for roasting, grilling and frying. It appears that the London kitchens are run on a bonus system. The supervisor receives one-third of the profits and the remainder is divided in proportion to the wages. From the first £5 of gross profit 10 per cent. is so paid, and 5 per cent. on any further sum; but in order to protect the customer no bonus is given on any profits exceeding 33 per cent. With regard to prices, the object in view is that these should not exceed the cost of food cooked at home. The charge for working expenses should not exceed at the most one-third of the sale price, and the statement is made that when buying is skilfully done in wholesale markets it will enable a profit to be made of 25 per cent. to 33⅓ per cent., and yet for the prices to be under the domestic outlay. The book is illustrated with some plans and views of various kitchens, descriptions being also given of equipment. Lists of stock and a number of recipes are also included.

Mr. Havelock Wilson and the Batti Wallahs.—At the second of their monthly luncheons, held at the Holborn Restaurant, London, on Monday last, Mr. Havelock Wilson was given an enthusiastic reception by the members of the Batti Wallah Society. Mr. Havelock Wilson on being introduced by the chairman, Mr. Riggs, explained the policy of the commercial boycott of Germany, which the Merchant Seamen's League proposed to institute. After giving a number of instances of "U" boat barbarities on the high seas, Mr. Wilson said that the Seamen's League was entirely non-political, and that it was, therefore, independent of party. There were a quarter of a million seamen of different ratings with a smaller number of dock labourers, and these men had approved of the policy of a German commercial boycott. He felt that the question was one not for the politicians but for public opinion, and he thought that the majority of Britons were in favour of the punishment of Germany for her crimes in unrestricted submarine warfare. It was argued that the boycott could not be insisted upon if an indemnity was demanded from Germany, but Mr. Wilson's answer to that was, that Germany had been storing gold for the past 40 years and that a great deal of this was stolen from other countries. His policy was to take their gold and their ships. The lukewarm attitude of the neutral countries towards the boycott was due to the enormous sums paid in paper money by Germany and the feeling that these amounts would be difficult to recover if an unfriendly attitude on the part of the neutrals towards Germany were insisted upon. Undoubtedly the policy of the threatened boycott had a great influence in German circles, and Mr. Wilson's opinion was that if it had done nothing else it had helped considerably to shorten the war. Mr. Wilson's remarks were enthusiastically received, and at the conclusion a vote of thanks was unanimously carried. It was decided that the Batti Wallah Society would consider what steps its members could take to assist Mr. Wilson's programme.

Industrial Reconstruction Council.—The first annual general meeting of the Industrial Reconstruction Council, Incorporated, was held on Tuesday, September 17th, in the Hall of the Institute of Journalists, the Chairman, Mr. Ernest J. P. Benn, C.B.E., presiding over a large and enthusiastic gathering of members. In his résumé of the present year's work, Mr. Benn remarked on the extraordinary growth of public interest in the great problems of industrial reconstruction. Excepting the war, it was the first topic discussed in all quarters and by all classes. He ventured to hope that it was in no small measure due to the efforts of the I.R.C. that the principle underlying the Whitley Report was now so widely accepted, and that everywhere our industries were awakening to the need for closer organisation. The I.R.C. held fast to its watchword of Industrial Self-Government, and by insisting on the only sane interpretation of that phrase was, he thought, doing useful work in counteracting the dangerous revolutionary influences that were abroad. Mr. Benn gave a brief summary of the year's activities in the way of meetings, lectures, conferences and the publication and distribution of literature, and made a strong appeal to those present to secure fresh adherents to the cause, and thus further the possibilities of future development. Lieut.-Col. E. Pottinger, D.S.O., organising secretary, in presenting the financial statement, announced that the autumn work in the provinces would largely consist in the establishment of Branch Reconstruction Associations, which should keep local interest and enthusiasm constantly stimulated in each industrial centre. The following new members were elected to the Executive Committee: Sir Charles McLeod, Miss Lillian Dawson (Fabian Society, Women's Group), Mr. George Selby (Cloth Hat and Cap manufacturer), Mr. John Baker (Iron and Steel Trades' Confederation), Mr. T. Owen Jacobsen, M.P., Miss M. F. Peake (Welfare Superviser), Mr. E. W. Mundy (Labour Co-partnership Association), and Lieut. H. V. Roe, R.A.F.

A conference on Trade Boards will be held under the auspices of the Industrial Reconstruction Council on Tuesday, Sept. 24 at 6 p.m., in the Hall of the Institute of Journalists, 2 and 4, Tudor-street, E.C. 4. The subject will be introduced by Mr. J. J. Mallon, of the Anti-Sweating League, after which the discussion will be open. No tickets are necessary.

Obituary.

W. SAMUEL INSULL.—On Saturday last the death occurred at Brook Green, Hammersmith, of Mr. W. Samuel Insull, father of Mr. Samuel Insull, President of the Commonwealth Edison Co. of Chicago. Mr. Insull was in his 87th year.

WAR CASUALTIES.—We are informed by the India Rubber Co. that the following casualties have occurred amongst former members of the company's staff:—

Major F. A. Robinson, M.C. (Tank Corps), of the electric light department, has been wounded; Driver J. P. Crosley (R.F.A.) and Pte. H. F. Payne (E. Yorks Regt.), of the general office staff, have also been wounded, the former seriously. Pte. W. F. Day (M.G.C.), of the electric light department, died on Aug. 13, after being gassed.

Lieut. E. Morton, who has died of wounds received in action, was formerly an electrician with Whitehaven Corporation and the Mersey Railway Co.

Personal.

Dr. H. S. Hele-Shaw and Senator Guglielmo Marconi, G.C.V.O., have been elected honorary fellows of the Society of Engineers.

Mr. A. Canham has been appointed Trades Commissioner for the Union of South Africa in this country, in succession to Mr. C. du P. Chiappini.

Lieut. Mozley, R.E. (son of Mr. Henry Mozley, manager of the Burnley tramways), has been promoted to captain.

The many friends of Mr. W. E. Hammond, traffic manager of the Metropolitan Electric Tramways, and vice-chairman of the Metropolitan Association of Electric Tramways Managers, will be pleased to learn that his son, L./Bombr. H. W. Hammond (who joined the R.G.A. in October, 1916, and was sent to Hong Kong, where he has been acting as Master Gunners' Assistant), has been seconded to the Kowloon Canton Railway Co. for temporary appointment as traffic inspector on the British section of the line.

L./Bombr. Hammond joined the staff of the Metropolitan Electric Tramways in September, 1904. He was transferred in March, 1913, to the British Electrical Federation, and three years later again transferred to the London Electric Railways, both appointments being in the claims departments.

Arrangements for the Week.

THURSDAY, Sept. 26th.

MUNICIPAL TRAMWAYS ASSOCIATION.

10 a.m. and *1 p.m.* At the Town Hall, Leicester. Seventeenth Annual Meeting. Presidential Address by Ald. S. Flint. Paper to be read entitled "Some Notes and Considerations on the Post-War Position of Electric Power Supply" by Mr. E. Hutton.

FRIDAY, Sept. 27th

MUNICIPAL TRAMWAYS ASSOCIATION.

10 a.m. At the Town Hall, Leicester. Further business to be resumed.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. 1. Paper on "The Most Important Piece of Machinery in the World," by Mr. P Marshall.

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The Character of the Thermal Storage Demand Meter.*

By P. M. LINCOLN.

Summary.—A description of the principle and construction of the thermal storage demand meter is given. Such a meter indicates "logarithmic average" rather than "arithmetic average" of power consumption hitherto indicated by practically all demand meters. Examples are given demonstrating that the thermal storage meter alone recognises the true heating effect which determines size of equipment and, therefore, cost that should be assessed against the customer.

A thermal storage wattmeter measures the "logarithmic average," whereas the arithmetical average is the quantity measured by practically all other types of demand wattmeters. The "maximum demand" rate is an attempt to assess upon the consumer his proper share of the annual cost of the equipment necessary for giving service.

It is the "maximum demand" and not the kilowatt hours of consumption that determines the amount of equipment that must be installed to carry a given customer's load It is to determine this "maximum demand" that demand meters are used.

It may be well to give a brief description of the thermal storage wattmeter as now being built.†

In Fig. 1, *A* is a circuit feeding a load *B*. *C* is a small transformer incorporated within the meter with its primary across the circuit *A*. In series with the secondary of this transformer are two equal resistances R_1 and R_2. The current set up in these resistances is proportional to the voltage of the circuit *A*. The load current

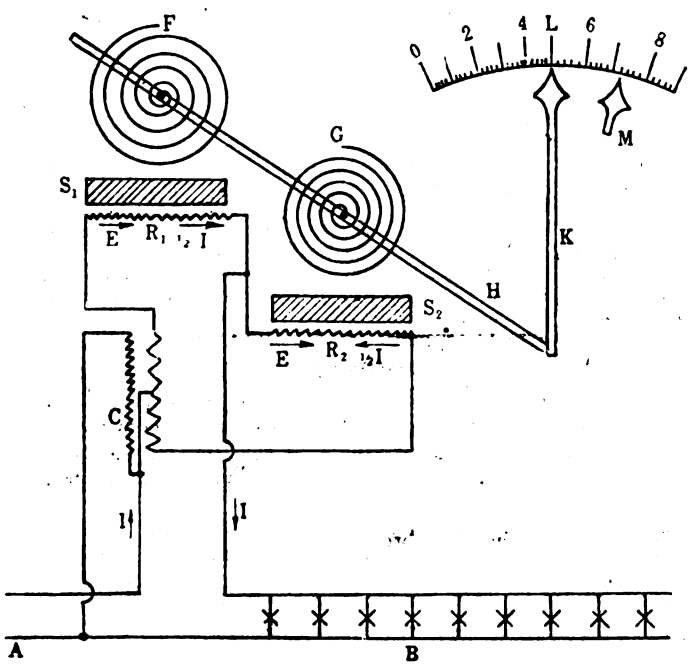

FIG. 1.

also circulates through these resistances as shown in Fig 1, being taken into the middle of the secondary of the small transformer and taken out at the connection between resistances R_1 and R_2. These two currents are additive in one of these resistances and subtractive in the other. The difference in heating effect of the two resultant currents is proportional to the watts of the load *B*. If we represent the current that passes through the resistance R_1 and R_2 by *E*, and the load current therein by *I*, the resultant current in one resistance is $E+I$ and in the other $E-I$. The losses are proportional to the squares of these currents and the *difference* in these losses to the product *EI*, independent of power factor and wave form. *F* and *G* are spiral springs made from bimetallic strips attached rigidly to their casings at the outer ends and to a common shaft *H* at their inner ends. These springs tend to coil up on an increase in temperature, but are wound in opposite directions. Hence no movement of the shaft *H* will take place unless there is a *difference* in temperature between *F* and *G*, corresponding to the difference in the losses in resistances R_1 and R_2. S_1 and S_2 represent diagrammatically the thermal storage of the cases in which the bimetallic springs *F* and *G* are enclosed. Due to this thermal storage, the wattmeter does not respond instantly to a change in load, but indicates the logarithmic average load over the time period immediately preceding the instant of observation. *K* is a pointer attached to shaft *H* and travelling over the scale *L*. *M* is a loose pointer which shows the highest excursion of pointer *K* since last reset.

A thermal storage meter thus indicates the "logarithmic average" of the power consumption during the particular time period immediately preceding the instant of observation. The indications will

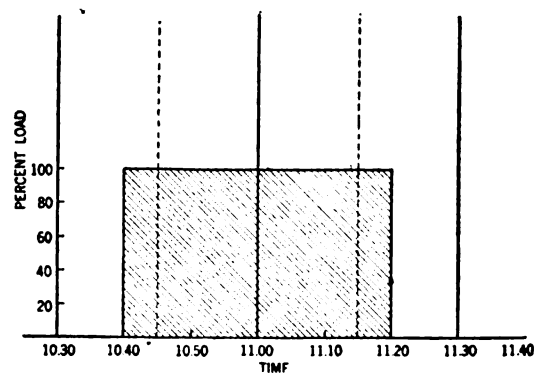

FIG. 2.

not be due to the watts passing at that instant, but will be the resultant of all the wattage flow that has passed, each instant of past flow having a value influenced in respect to its time proximity by a logarithmic law. This resultant is not an average in the commonly accepted sense of that word (*i.e.*, assuming that each instant of time over which the average is taken has equal weight). In the resultant obtained by a heat storage meter, each instant of time has not an equal weight, but the influence of each instant decreases with its remoteness in point of time, and the degree by which the watts during any instant influences the total indication is proportional to e^{-Kt}, where *K* is an adjustable constant, and *t* is the time measured backward from the instant of observation. The resultant thus obtained by means of thermal storage is termed the "logarithmic average."

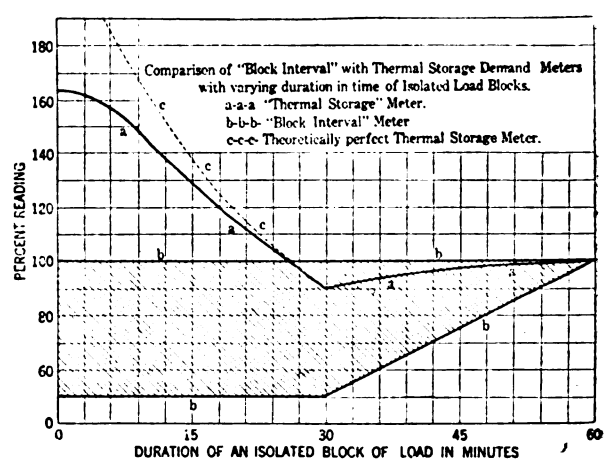

FIG. 3.

Hitherto, practically all demand meters have indicated in terms of the arithmetical average. This type of meter is known as the "block interval" meter. One of its inherent faults is that it may split an isolated peak of load and therefore become indefinite in its indications. Assume that Fig. 2 shows the reason for this. If an isolated block of load comes on at 10.40 a.m. and lasts until 11.30 a.m. such as is involved in pumping out a small dry dock. Suppose, further, that we are using a "block interval" meter with a 30 minute

* Abstract of a Paper presented before the American Institute of Electrical Engineers.

† The complete theory of the thermal storage wattmeter is given in the author's Paper before the American Institute of Electrical Engineers, entitled "Rates and Rate Making." ("Transactions" A.I.E.E., Vol. 34, 1915, pp. 2175-2214.)

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time period to measure the maximum demand of this load. If this meter integrated the load first from 10 to 10.30 and then from 10.30 to 11.30, the maximum quantity indicated during any one period would be much less than if the meter periods began and ended on the even quarter hours. This indefiniteness of indication begins when the duration of the block of load is less than 60 minutes, and when its duration is less than 30 minutes this "coefficient of indefiniteness" becomes 50 per cent.

A more serious fault of the "block interval" meter is that for isolated blocks of load it does not measure the true value of its heating effect on the equipment that serves the load and therefore does measure the true value of the duty on that equipment. No method has been suggested by which the "block interval" meter may overcome this fault

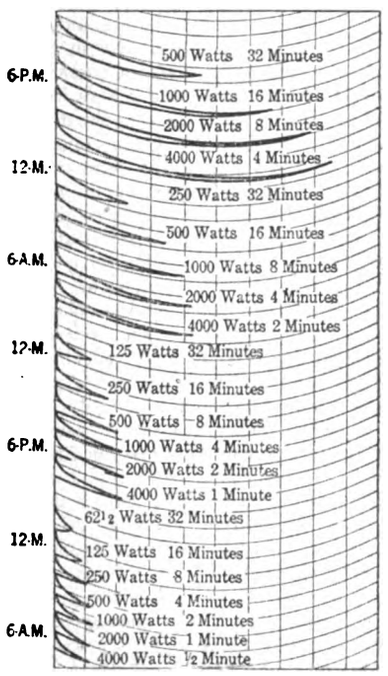

FIG. 4.

So long as the loads are steady over long periods of time the arithmetical (block interval) and the logarithmic (thermal storage) averages are the same. It is only when the duration in time of a block of load begins to come down to the time period of the meter that there is an appreciable difference between the two types.

A comparison between the two types of meter is shown in Fig. 3. The cross hatched area indicates the "area of indefiniteness" of a "block interval" meter of 30 minutes duration, the indications of the "block interval" meter may fall anywhere within this area On the other hand, the thermal storage meter is perfectly definite in its indication. Each time a given load of given time duration is applied to this type of meter, it gives the same indication. This indication, however, differs from that of a "block interval" meter. Even with the greatest overload imaginable the amount of equipment to carry 60,000 kw. for 1 minute is more than that to carry 2,000 kw. for 30 minutes. The "block interval" meter recognises no difference whatever between these conditions, since the arithmetical average of the two loads when taken over a 30 minute period is exactly the same. The thermal storage meter, however, discriminates automatically against the short-time high-peak load and gives a result which follows the same kind of a law as does the heating of the equipment that furnishes the power. Now it is the *heating effect* that fixes the size of the equipment, and, therefore, the cost that should be assessed against the customer. It follows, therefore, that the indications of the thermal storage meter are more logical for rate making purposes than are those of the arithmetical average or "block interval" meter.

In the original Paper the author gives the results of a series of test runs made with a graphic meter of the thermal storage type. The time period was 30 minutes; that is, the application of a steady load would bring the meter indication to 90 per cent. of final at the end of 30 min., 99 per cent. at the end of 60 min., 99·9 per cent. at the end of 90 min., &c. Fig. 4 shows the result of four series of tests. In the first series shown at the right-hand bottom of Fig. 4, 2,000 watt-minutes were applied to the meter, each test of the series starting at zero. In the first test of the first series the whole 2,000 watt-minutes were put in in ½ minute; *i.e.*, power applied at the rate of 4,000 watts (four times normal load) for ½ minute. In the second test of the series, viz., 2,000 watts for one minute was applied. The third block was 1,000 watts for 2 minutes; then follow 500 watts for four minutes, 250 watts for eight minutes, 125 watts for 16 minutes and 62·5 watts for 32 minutes. A "block interval" 30 minute meter would have given the same results (barring the "indefiniteness" mentioned in a preceding paragraph), except, of course, the last test of the series. There are few who will contend that the customer who insists on taking his entire half hour's requirements in a half-minute should not pay a larger demand rate than the one who spreads it out evenly throughout the half-hour.

The second series of tests, shown was the same as the first except that the amount of power was doubled, 4,000 watt-minutes being applied instead of 2,000. Similarly, in the third and fourth series of tests, 8,000 and 16,000 watt-minutes were applied respectively Comparing the results of the individual tests of a given series with those deduced from purely theoretical considerations, we find that the quantity indicated by the actual meter when subjected to isolated short-time blocks of load is not as great as the true logarithmic average. In Fig. 3, for instance, the curve *aaa* and the area *bbb* compare the actual thermal meter with the equivalent "block interval" meter. If the thermal meter had followed a true logarithmic law the comparison would have been shown by the dotted curve *ccc*, instead of the solid curve *aaa*—a point to be discussed shortly.

Table I.

Duration of cycle minutes.	Per cent. of time of power on.	Meter indications.		
		Logarithmic.	Block interval.	
			Maximum.	Minimum.
2	0·25	250	250	250
2	0·50	500	500	500
2	0·75	770	750	750
4	0·25	260	267	250
4	0·50	510	533	500
4	0·75	775	767	750
10	0·25	285	250	250
10	0·50	550	500	500
10	0·75	800	750	750
20	0·25	360	333	250
20	0·50	640	667	500
20	0·75	855	833	750
30	0·25	425	250	250
30	0·50	725	500	500
30	0·75	890	750	750
60	0·25	640	500	250
60	0·50	960	1000	500
60	0·75	980	1000	750

Tabulating all the results given in the original Paper, the author arrives at the comparison between the two types given in Table I.

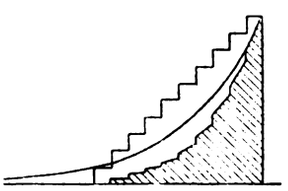

FIG. 5.

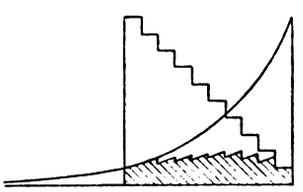

FIG. 6.

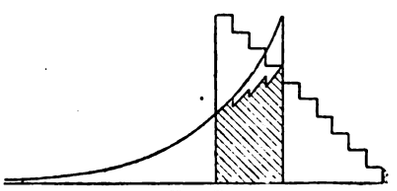

FIG. 7.

The author then proceeds to analyse the action of the thermal demand meter and show the reasons for its departure from indicating a true logarithmic average for isolated short-time loads. For short-time applications of load the actual meter is not theoretically perfect. The principal cause for this departure is the fact that diffusion of heat throughout the mass of a meter element is not instantaneous. It takes nearly five minutes after the load is thrown off before the pointer reaches its maximum position, because the heat must first pass the from resistances to the casings enclosing the springs, then the air inside the casings is heated and this, in turn, heats the bimetallic springs. This process takes time, and the effect causes

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the actual meter to read lower than the theoretical. This is the "safe" position. If any device used in determining a customer's bill favours the company supplying the service, it can be successfully attacked by the customer. If the contrary is true, it cannot.

An objection has been raised to the thermal storage meter in that it reads higher on an increasing load than it does on a decreasing load, the kilowatt-hours and the time of application being the same in both cases. A comparison of the actual thermal meter, the theoretically perfect logarithmic average meter and the arithmetical average meter for these various load applications is given in the following table. (Percentage is variation from perfect logarithmic meter.)

Time interval. Minutes.	Nature of load.	Actual meter.	Theoretically perfect meter.	Block interval meter.	
				Maximum	Minimum.
1	Increasing	295 (10·2%)	328	187 (43%)	93 (71·5%)
1	Decreasing	275 (1·8%)	280	187 (33·3%)	93 (66·7%)
2	Increasing	480 (9·4%)	529	373 (29·5%)	187 (64·7%)
2	Decreasing	425 (0%)	425	373 (12·3%)	187 (56%)
5	Increasing	760 (4%)	792	750 (5·2%)	450 (43·2%)
5	Decreasing	630 (0·2%)	631	750 (9·6%)	450 (28·8%)

The reason for the difference in indication between increasing and decreasing loads is readily seen by reference to Figs. 5, 6 and 7. The reading of a theoretically perfect meter on a load increasing by 10 per cent. steps, would be proportional to the cross-hatched area in Fig. 5. Fig. 6 shows the same method of analysis applied to a decreasing load. The cross-hatched area in this figure is obviously less than that in Fig. 5. However, the instant chosen is not the instant of maximum indication, which, with a decreasing load occurs before the entire block of load has passed through the meter. The instant shown in Fig. 7 gives a considerably larger cross-hatched area. With a decreasing load the maximum indication arrives before the whole load has been put in, *i.e.*, with an increasing load, each increment of load finds the meter already heated by the preceding load and the maximum load is applied to the hottest meter element, but with a decreasing load the reverse applies and the maximum temperature arrived at is not as great as with an increasing load. This action is quite defensible since exactly the same action takes place in the equipment that serves the load. An increasing load heats up transformers, cables, generators, &c., more than does a decreasing load, although the kilowatt-hours and the time of application are exactly the same in each case

The question may be raised as to the proper time period to use in the measurement of maximum demand. At present, the practice of various public service companies varies in this respect. One minute is the minimum time duration that the author is aware of and one hour is the maximum. Between these limits a large number of time periods have been proposed and used. So long as it is recognised that equipment cost is the element that dictates the maximum demand portion of a customer's bill the use of time periods of less than about 30 minutes cannot be justified. In many cases short-time periods for maximum demand have been adopted for the purpose of penalising the customer with a high short-time peak. The thermal demand meter does this automatically and, therefore, there is not the same reason for using short periods. For steady loads it does not matter whether the demand is on a one minute or a one hour basis, the result is the same. The chief conclusions arrived at in the Paper may be summarised as follows :—

1. The cost of electric service is dependent in part upon the cost of the equipment necessary to provide that service.

2. The cost of the necessary equipment to a given customer depends upon his maximum demand and not on his kilowatt-hours of consumption.

3. The thermal storage demand meter gives a perfectly definite indication independent of the character of the load applied while the "block interval" demand meter becomes highly indefinite on short-time peak-load applications.

4. For short-time peak-load applications the thermal storage demand meter follows a law of the same nature as the heating effect of the load application upon the service equipment, while the "block interval" meter does not.

5. For steady loads the thermal storage and "block interval" demand meters give identical results.

6. The thermal storage demand meter gives a much higher indication for a very short-time peak-load application than does the "block interval" demand meter, thereby making unnecessary the adoption of short demand periods designed to penalise such high peak loads

On the Value of the Conductivity of Sea-Water for Currents of Frequencies as Used in Wireless Telegraphy.*

By BALTH. van der POL, Jun.

The materials of the earth's crust, over and through which the electromagnetic waves sent out by a wireless telegraphy station travel, have an important influence on the variations of the wave amplitude with distance from the sending station.

When a plane bounding surface exists between the air and the earth, the magnitudes of the conductivity of most materials of which the earth's crust consists are such that a decrease of wave amplitude with distance, due to absorption, can in general be expected. But when the boundary surface, in closer approximation to the actual circumstances, is supposed to be a sphere, consisting of sea-water, and if the value of the conductivity of the latter as found under direct or slowly alternating currents is used in the calculations, it appears that a *greater* wave amplitude for the same sender can be expected than would be obtained if the sphere were made up of an infinitely good conducting material, though the difference is small.

The greater part of wireless traffic being conducted over sea, an exact determination of the value of the conductivity of sea-water for alternating currents of high frequencies may be of importance. The researches of Sir J. J. Thomson on the conductivity of electrolytes under very rapidly alternating currents of frequencies up to 10^8 would lead one to expect the conductivity of sea-water to be constant within the range of frequencies between 0 and 10^6. Prof. J. A. Fleming and Mr. G. B Dyke, on the other hand, found the conductivity of various materials as glass, celluloid, paraffin-wax, mica, paper, slate and sulphur to increase with the frequency. Thus the conductivity of ebonite under 4,600 cycles per second was 6·4 times greater than under 920 cycles. For gutta-percha under a frequency as low as 800 a conductivity was obtained already 100,000 times greater than the value usually given for direct currents in the handbooks, while at higher frequencies this ratio still increased. Prof. Fleming, therefore, suggested to me to determine the conductivity of sea-water under frequencies as used in wireless telegraphy, and to compare it with the value found under steady or slowly alternating currents.

A simple calculation shows, assuming the conductivity of sea-water has its normal value $\sigma \sim 5 \cdot 10^{-11}$, that up to the frequency 10^6 the dielectric displacement current in sea-water (the dielectric constant being assumed $\epsilon = 81$) can be neglected in comparison with the conduction current, the ratio of the two being $\epsilon p / 4\pi\sigma c^2$, where p is the angular frequency and c the velocity of light. For the material under consideration this ratio amounts to

$$\frac{81 \cdot 10^6}{4\pi \cdot 5 \cdot 10^{-11} \cdot 9 \cdot 10^{20}} = 1{\cdot}4 \cdot 10^{-4};$$

so in order to measure the conductivity of sea-water a method can be applied in which the latter is treated as only having a resistivity.

To use a bridge method did not seem advisable for high frequencies, as serious errors introduced by the inductive effects of the arms had to be avoided. The author therefore employed a substitution method, which is described in detail in the original Paper; it is also shown that adequate accuracy can be obtained with this apparatus.

These values (for samples of sea-water obtained from Hastings) show that the conductivity of sea-water for frequencies used in wireless telegraphy is equal to the value for steady currents to within less than half a per cent. A calculation of the true direct current conductivity from the resistance and the dimensions of the tube yielded the value 0·0377 Ω^{-1} per centimetre cube at 12·5°C., corresponding to $\sigma = 3{\cdot}77 \cdot 10^{-11}$ electromagnetic unit.

As the conductivity varies very much with the temperature and the origin of the sample, a value of σ between 1 and $5 \cdot 10^{-11}$ is, therefore, appropriate to form the numerical basis for the theory of propagation of electromagnetic waves over the surface of the sea.

Machine Tools in Switzerland.—The machine tool industry in Switzerland appears to have made great strides since the outbreak of war. As compared with 1913, the exports have been phenomenal, France taking 40 times as much as in that year, and Italy about 30 times, while even Germany's demand increased by 300 per cent. The types of machines exported comprise engine and turret lathes, thread milling machines, tool-grinding machines of various kinds and drills.

* Abstract of a communication to the "Philosophical Magazine."

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Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

(*Continued from page* 356.)

Summary.—This article is devoted to the mechanics of the conical-drum winder. An expression is deduced for the ratio of diameters which will give a practically constant static torque throughout the wind, and the effect of altering this ratio is illustrated. The resultant static torque of a conical-drum winder is determined by two methods, one of which is arithmetical and the other graphical. The figures used in the graphical method can be used by the reader as an example.

Conical Drums.

The compensation afforded by the tail-rope can be obtained by means of conical drums, the rope being wound from the small end to the large end of the cone. Provided that the ratio of the two diameters is correct the resultant static torque throughout the wind is practically constant.

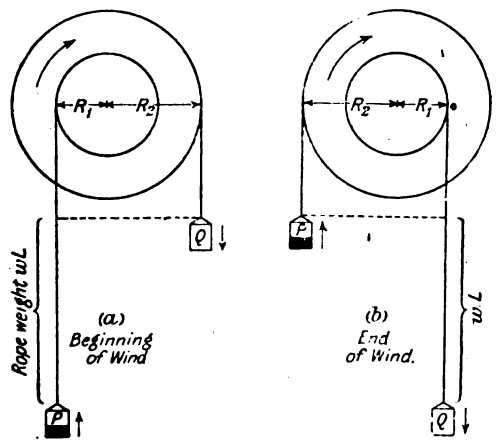

Fig. 21.—Conical Drum or Reel Winder.

To determine the correct ratio, let

P = pull due to loaded skip *plus* friction of same, lb.,
Q = pull due to unloaded skip *minus* friction of same, lb.,
L = depth of shaft, ft.,
R_1 = smallest working radius of drum, ft.,
and R_2 = largest working radius of drum, ft.

Then, from Fig. 21 (*a*) it is seen that the

$$\text{Initial moment} = (P+wL)R_1 - QR_2,$$

and from Fig. 21 (*b*) that the

$$\text{Final moment} = PR_2 - (Q+wL)R_1.$$

Therefore, $(P+wL)R_1 - QR_2 = PR_2 - (Q+wL)R_1$,

from which

$$R_2 = R_1(P+Q+2wL) \div (P+Q). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (33)$$

Example 4.—To determine the end diameters of a conical drum for a balanced winder intended for the following duty :—

Load	10,000 lb.
Skip	6,000 lb.
Rope	1¾ in. dia., 3 lb. per ft.
Depth of shaft	3,000 ft.
Friction	10 per cent. of load depending from rope.

Using the same notation as above

$$P = 10{,}000 + 6{,}000 + 0{\cdot}10(10{,}000 + 6{,}000)$$
$$= 17{,}600 \text{ lb.},$$
$$Q = 6{,}000 - 0{\cdot}10 \times 6{,}000$$
$$= 5{,}400 \text{ lb.},$$

and weight of rope $= 3 \times 3{,}000 = 9{,}000$ lb.

Adopting a minimum working diameter of 80 times the diameter of the rope results in R_1 being 4·6 ft.

Inserting these values into equation (33), we get

$$R_2 = 4{\cdot}6(17{,}600 + 5{,}400 + 18{,}000) \div (17{,}600 + 5{,}400)$$
$$= 8{\cdot}2 \text{ ft.},$$

and $R_2 \div R_1 = 8{\cdot}2 \div 4{\cdot}6 = 1{\cdot}79$.

Neglecting slight distortion the resultant static torque throughout the wind is plotted in Fig. 22 (*a*). If instead of a ratio of $R_2 \div R_1 = 1{\cdot}79$, a higher value be used, the torque increases towards the end of the wind as shown in Fig. 22 (*b*), and the rope is said to be over-compensated. A lower ratio results in a decrease of torque as the wind progresses, or in under-compensation, Fig. 22 (*c*).

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Resultant Static Torque.—The determination of the torque diagram for this type of drum is less straightforward than that for the cylindrical drums already dealt with. Following the practice of the steam-winder makers the diagrams will be drawn upon a base line representing the turns made by the drum, and in the first instance an arithmetical method will be used. Let

W = weight of material hoisted, lb.
W_c = weight of each cage, lb.
W_t = weight of tubs, or trucks, per cage, lb.
W_s = weight of each skip, lb. (if the material is hoisted in a skip).
w = weight of rope, lb. per ft.
L = vertical depth of shaft, ft.
R_1 = smallest working radius of drum, ft.
R_2 = largest working radius of drum, ft.

Furthermore, the allowance to be made for friction and windage is assumed to be known.

The number of revolutions N made by the drums during the wind is equal to the depth of the shaft divided by the mean circumference of the drum, or

$$N = L \div \pi(R_1 + R_2).$$

This number, to a suitable scale, serves as a base BE for the torque diagram, Fig. 23.

At any instant the torque due to the loaded skip (or cage) and that due to the unloaded skip (or cage) is proportional to the drum radius at the said instant. Since this radius increases uniformly on the loaded side, and decreases uniformly on the unloaded side, the torque lines for the skips or cages are readily obtained.

Taking the loaded, or "ascending" side, the pull P lb. due to the loaded cage *plus* friction of same is

$$(W + W_c + W_t)(1+f),$$

where f is the allowance for friction. If the allowance be 10 per cent., f will be 0·10. At the beginning of the wind the torque is $P \times R_1 = \{(W + W_c + W_t)(1+f)\} R_1$ lb. ft., and at the end of the wind the torque is $P \times R_2 = \{(W + W_c + W_t)(1+f)\} R_2$ lb. ft. These values are marked off to a convenient scale at B and E respectively, as shown in Fig. 23, and the straight line ab represents the torque at every instant due to the ascending—or loaded—cage. If the load is hoisted in a skip, W_s must be used instead of $W_c + W_t$.

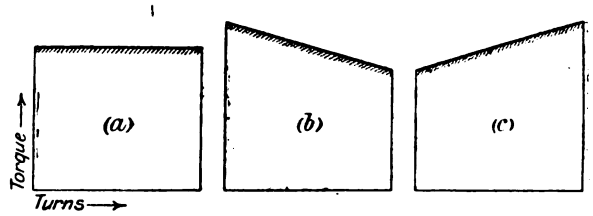

Fig. 22.—Static Torque Diagrams for Various Conical Drum Winders.

Similarly for the descending side, the torque values are $Q \times R_2$ and $Q \times R_1$ lb. ft. at the beginning and end of the wind respectively, Q being the pull on the rope due to the unloaded skip *minus* the friction, or $Q = (W_c + W_t)(1-f)$. These values are marked off below the base line to show that the moments are of opposite kind to those on the ascending side, and the straight line, cd, connecting them gives the torque at every instant due to the descending cage or skip.

The resultant torque, due to the ascending and descending cages, is found by combining ab and cd, and is represented by ef in the diagram.

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The two ropes are dealt with separately. At the beginning of the wind, on the ascending side, the rope torque is $w \times L \times R_1$ lb. ft., and at the end of the wind it is O. Intermediate points on the curve can be found without difficulty by the method previously described.* Thus, after n turns the drum radius is r and a length, l ft., of rope has been wound on the drums leaving a length $(L-l)$ ft., of weight $w(L-l)$ lb., depending from the drum; hence, at this instant, the torque is $w(L-l) \times r$ lb. ft. Several points are determined in this manner and a fair curve gE is drawn through them.

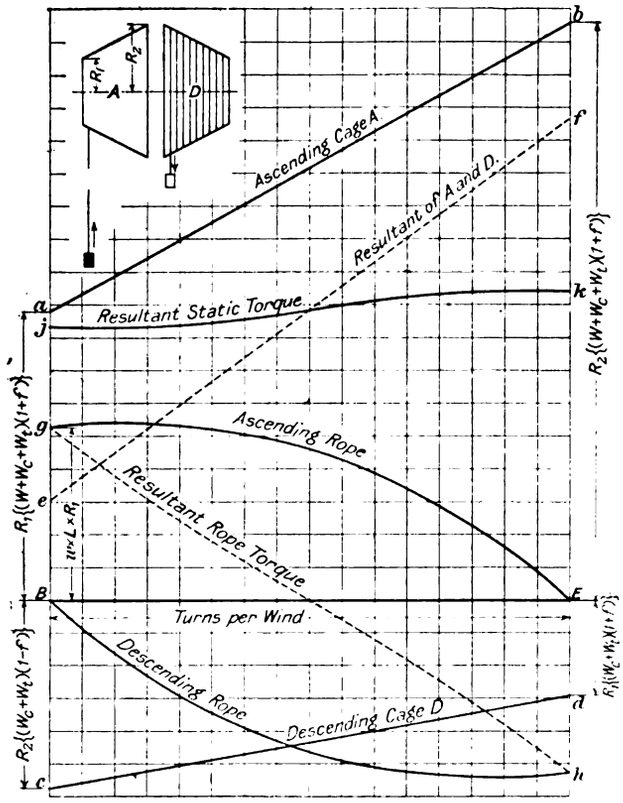

FIG. 23.—RESULTANT STATIC TORQUE OF BALANCED CONICAL-DRUM WINDER.

On the descending side the rope starts on the large radius of the drum with zero torque and finishes on the small radius with a torque equal to $w \times L \times R_1$ lb. ft. The curve Bh is obtained directly from that for the ascending rope by transferring the origin from B to E, and working from right to left, marking off all the moments below the base line as shown in Fig. 23.

The resultant rope torque, gh, found by combining gE and Bh, differs but slightly from a straight line.

By combining the curves ef and gh the resultant static torque curve, jk, for balanced winding is obtained. The slight departure from the straight line of the resultant rope torque results in a similar curvature of the resultant static torque, but in most cases the curvature may be neglected, as shown in Fig. 22, without appreciable error.

Although less straightforward than the direct computation of the torque, the method just described enables one quickly to prepare the diagrams for unbalanced operation. Thus, by combining the curves ab and gE, Fig. 23, for the ascending (loaded) cage and rope the static torque at every instant during the hoisting part of the cycle is obtained. This is represented by the curve AB in Fig. 24. Similarly by combining the curves cd and Bh the static torque CD, Fig. 24, during the lowering part of the cycle is found.

Acceleration and Retardation.—During the starting period an additional moment is required for accelerating the masses, and to bring the masses to rest a negative moment has to be applied.

* THE ELECTRICIAN, Aug 16 and 23.

Assuming a uniform rate of angular acceleration, the torque necessary for accelerating the loaded skip, rope and drum on the ascending side is

$$M_a = \Sigma \frac{W}{g} \cdot r_g^2 \times \omega_a,$$

where ΣW is the sum of all the weights to be set in motion on the ascending side reduced to a common radius of gyration r_g; ω_a is the angular acceleration in radians per second per second $= 2\pi s_1 \div t_1$, s being the maximum speed of the drum in revolutions per second, and t_1 the accelerating period in seconds.

The moment required for accelerating the skip, rope and drum on the descending side is obtained in a similar manner.

During the period of constant angular speed there is a gradual increase in the speed of the ascending skip, and a corresponding decrease in the speed of the descending skip. The accelerating and retarding moments due to this speed variation are small and, in the majority of cases, may be neglected.

CONICAL DRUMS (*Continued*).—GRAPHICAL METHOD.

Before passing on to drums of other types it is thought to be advisable to examine, at greater length, the conical drum, because certain other drums, namely, the cylindro-conical and spiro-cylindrical, are merely combinations of cone and cylinder; or cone, spiral and cone. At the same time it is desirable to examine in detail the inertia of conical-drum winders.

As the calculation of the cardinal points of the torque diagram for a conical-drum winder is a tedious process, we shall have recourse to graphical or semi-graphical methods.

Of the graphical methods that have been proposed, the best, as far as the author is aware, is that described in 1902 by Mr. Hans C. Behr in a Paper on "Winding Engines for Great Depths," which was read before the Institution of Mining and Metallurgy. This Paper deals exhaustively and authoritatively with the mechanics of the winder, and is generally regarded as a contribution of the highest importance. Through the courtesy of the Council of the Institution the author is able to give the following description of Mr. Behr's graphical method of determining the static torque of a conical-drum winder.

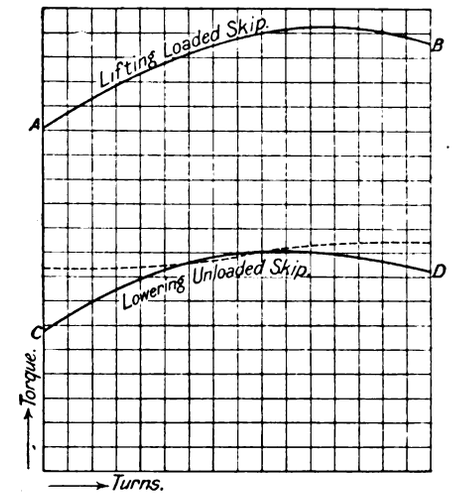

FIG. 24.—STATIC TORQUE DIAGRAM FOR UNBALANCED WINDING.
(The Resultant Statical Torque for Balanced Winding, Fig. 23, is represented by a dotted line.)

Example 5.—Determine the resultant static torque of a conical-drum winder working (*a*) balanced and (*b*) unbalanced having given:

Net load	=	6,000 lb.
Skip	=	4,000 lb.
Depth	=	3,000 ft. (vertical).
Rope	=	2·2 lb. per ft.

Drum.—Conical, 8 ft. to 16 ft. diameter.

Friction may be neglected.

Also determine the inertia of the loads and ropes depending from the drums; of the ropes coiled on the drums and of the pithead sheaves.

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Static Torque.—Draw a line, $a_1 a_2$, Fig. 25, to represent, to any convenient scale, the 80 revolutions required to wind up 3,000 ft. of rope.* At a_1 and a_2 erect perpendiculars $a_1 c_1 b_2$, and $a_2 c_2 b_1$, making $a_1 b_2 = a_2 b_1$ = the maximum drum radius 8 ft., to a suitable scale, and $a_1 c_1 = a_2 c_2$ = the minimum drum radius, 4 ft. Join $c_1 b_1$ and $c_2 b_2$. The length of rope wound on the drum being equal to the product of the number of turns and the length of the mean turn is thus proportional to the area $a_1 c_1 b_1 a_2$.

Now extend the line $b_1 c_1$ until it cuts the prolongation of $a_1 a_2$ at o_1. The latter point is the apex of a cone that completes the drum cone, while the surface of the completing cone is proportional to the area $o_1 a_1 c_1$. This area, therefore, will also be proportional to the length of rope wound on the completing cone at the same pitch as on the actual drum, and the

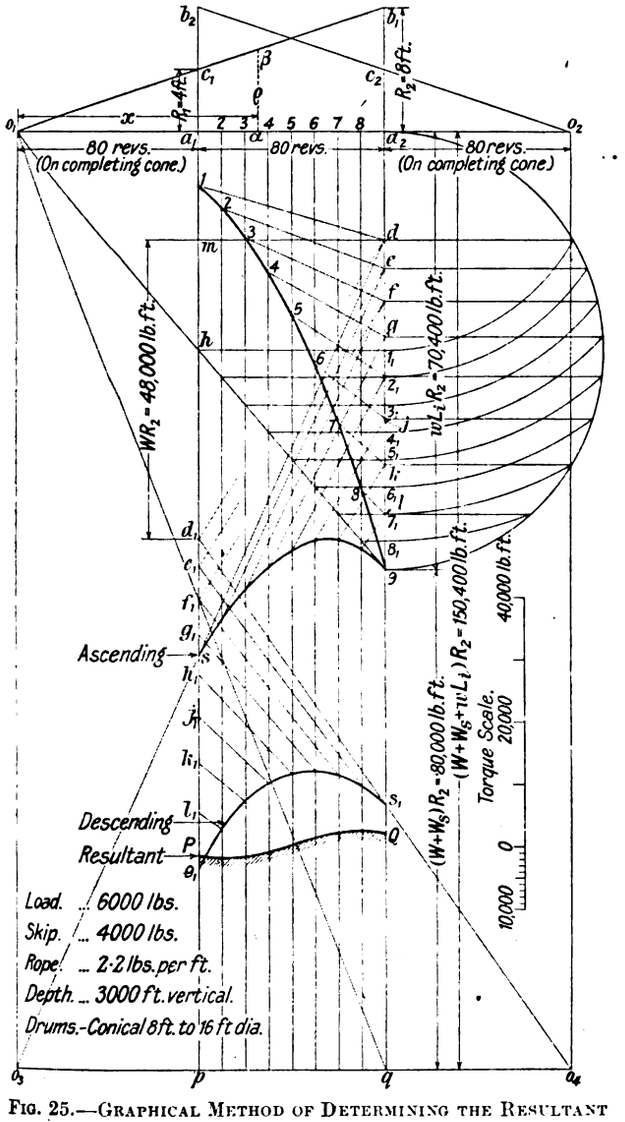

FIG. 25.—GRAPHICAL METHOD OF DETERMINING THE RESULTANT STATIC TORQUE OF A CONICAL-DRUM WINDER.

distance oa_1 is a measure of the number of coils of rope wound on the completing cone. If ρ represents any radius of the drum, ρ will be proportional to x, and the total length of rope wound on the drum and completing cone will be proportional to the area $o_1 a\beta$, which is proportional to ρ^2. The length of rope required to cover the completing cone at the same pitch as the drum is 1,000 ft. Adding this to the length of rope actually wound on the drum we get $L_1 = 1{,}000 + 3{,}000 = 4{,}000$ ft. as the length, L_i, of what Mr. Behr terms the *ideal* rope, and it is this ideal rope weighing $4{,}000 \times 2{\cdot}2 = 8.800$ lb. which is used in the calculations in order to be able to employ the graphical construction from the apex, o_1, of the completing cone.

* Revolutions of drum per wind = Depth of wind ÷ mean diameter of drum = 3,000 ÷ 12π = 80 approximately.

If we suppose the weight of the load plus that of the ideal rope to remain constant, and only the radius of the drum from which the load is suspended to vary, then the moment of this entire load would vary according to an inclined straight line $o_1 q$, passing through the apex of the cone at o_1. The moment at a_2 will then be represented by $(W + W_s + wL_i)R_2 = 150{,}400$ lb. ft.

But the moments along $o_1 q$ must be diminished by the moment of the rope wound on the drums, plus that covering the completing cone. The weight of rope wound on the cone up to any point was found above to be proportional to ρ^2. The moments to be deducted must, therefore, be proportional to $\rho^2 \times \rho = \rho^3$, and the end-points of the ordinates representing these moments must lie along a cubical parabola. The end moment $a_2 9$, at the point where the rope is all wound up, is equal to $wLiR_2 = 70{,}400$ lb. ft., and is the easiest point from which to work.

To construct the cubical parabola, draw the line $o_1 9$, and from its intersection h with the vertical $a_1 P$, draw the horizontal $h1_1$. Divide the distance $a_1 a_2$ into any number of parts, draw in the verticals through the points 1, 2, 3 ... 8, and divide the distance $1_1 9$ into the same number of parts proportional to those composing $a_1 a_2$. On $a_2 9$ as a diameter, draw a semicircle. Then with a_2 as centre, draw arcs cutting the semicircle from the divisions 1_1, 2_1, 3_1 ... 8_1 on the line $a_2 9$. Through the points where the arcs cut the semicircle, draw lines perpendicular to $a_2 9$, cutting the latter in the points d, e, f ... l. From these points draw vectors to o_1. The intersections of the vectors $o_1 d$, $o_1 e$, $o_1 f$, &c., with the verticals through the points a_1, 2, 3, &c., on $a_1 a_2$, give points on the cubical parabola, *1*, *2*, *3* ... *9*. The intercepts between this curve and the line $o_1 q$ give the moments for the loaded skip and rope. Those between the curve and the line $o_1 9$ give the moments for the rope depending from the drum.

The oblique position of the diagrams thus found is, however, inconvenient for use, and it will be better to lay down the ordinates from the horizontal $o_3 o_4$ as a new base, giving the curve $s9$ marked "Ascending" in Fig. 25. If preferred, the latter curve may be laid down directly without deriving it from the curve *1*, *2*, *3* ... *9*, by drawing vectors from d, e, f ... l to o_3 instead of o_1. The triangles formed by the vectors, like, for example, $o_1 eq$ and $o_3 eq$, are drawn on the same base, eq, and therefore have equal corresponding intercepts parallel to the common base of the triangles.

In a similar manner the diagram for the unloaded side on the other drum may be drawn by means of vectors from the pole o_4 to points $d_1, e_1, f_1 \ldots l_1$, on the opposite vertical $a_1 p$. These points must, however, be brought nearer than d, e, f, &c., to the base $o_3 o_4$ by the distance $md_1 = WR_2 = 48{,}000$ lb. ft., this being the maximum moment of the load in the skip, by which amount that on the empty side is less than the corresponding one on the loaded side. The vectors $o_4 d_1$, $o_4 e_1$, &c., then give the torque curve, $9_1 s_1$, marked "Descending" in Fig. 25, for the unloaded side.

The intercepts between the two torque curves marked off from $o_3 o_4$ as a base give the curve of static moments PQ for balanced running.

(To be continued.)

Water-power on the Rhine.—Under the title, "The Freedom of the Rhine," a Swiss correspondent has been contributing an interesting account to the "Engineer" of the proposals being made in Germany for the full development of navigation on the Rhine. We observe that, among other projects, it is desired to erect electricity works to utilise the falls to be caused by artificial dams erected across the Rhine between Strassburg and Basle. It is estimated that 5,000,000 kw.-hours per annum could thus be obtained. It would, however, take about 10 years to construct the works, and meantime navigation on this section of the Rhine would be paralysed. Switzerland, therefore, naturally views with disfavour a prospect likely to interfere materially, and possibly permanently, with her outlet to the sea via Holland.

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The Jones Portable Automatic Trimming Conveyor.

The process of "coaling ship," which consists not only in getting the coal on board but in conveying it to and filling the various bunkers, termed trimming, is always an operation requiring a large amount of hand labour. Part of the operation consists in transferring the coal from barges or other craft, or from shore to the reverse. Many mechanical devices are used, but for filling and trimming the bunkers by mechanical means little has been done at present

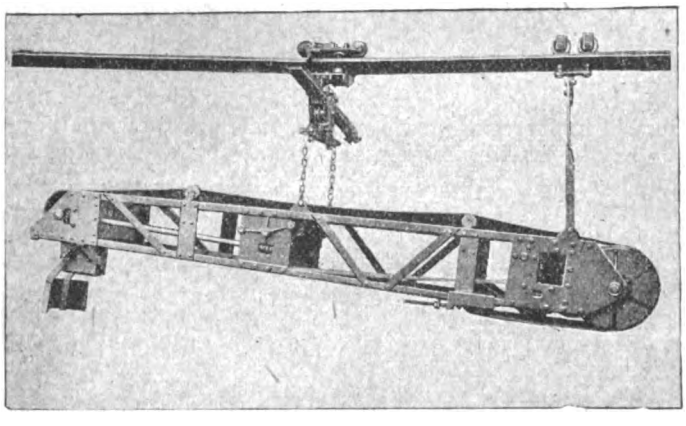

FIG. 1.

The conveyors are each driven by an electric motor situated inside, and forming part of the end driving drum or terminal. The necessary lateral and longitudinal movements of the trimming conveyor are operated by mechanism from the driving motor, and both are automatic. The lateral movement is continuous, and the longitudinal movement is dependent upon the action of an ingenious device attached to the front of the conveyor, and consisting of a hanging plate or shield, which is caused to move by the action of the coal piling up, thereby making an electric contact, which sets in motion a drum and winds back the train of conveyors.

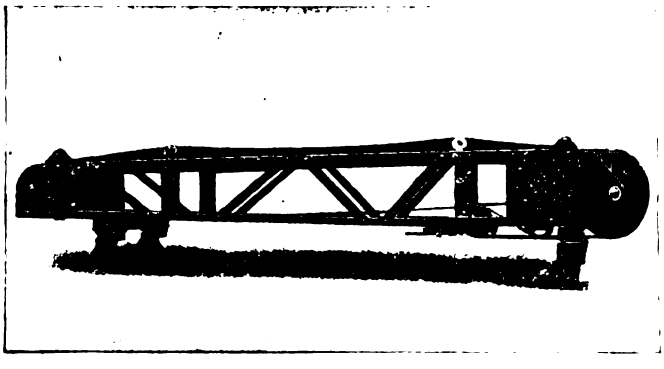

FIG. 2.

The portable automatic trimming conveyor herein described has been designed with the purpose of handling the coal with the minimum of labour, trimming it into all the bunkering spaces provided in mail and cargo steamers, reducing the cost and displacing the hand labour required in the present bunkering system.

Fig. 3 illustrates the arrangement of the plant, which consists generally of a series of short self-contained conveyors, usually

When the end or tail conveyor has been backed beyond the delivery shoot, and is no longer required, it can be removed and fixed in another position. Coaling can then commence in another bunker, or several trains can be fitted up from a central delivery shoot, and the whole of the coaling proceed at the same time.

When both sides of the ship must simultaneously be coaled conveyors can be laid across the decks or slung from gantries or

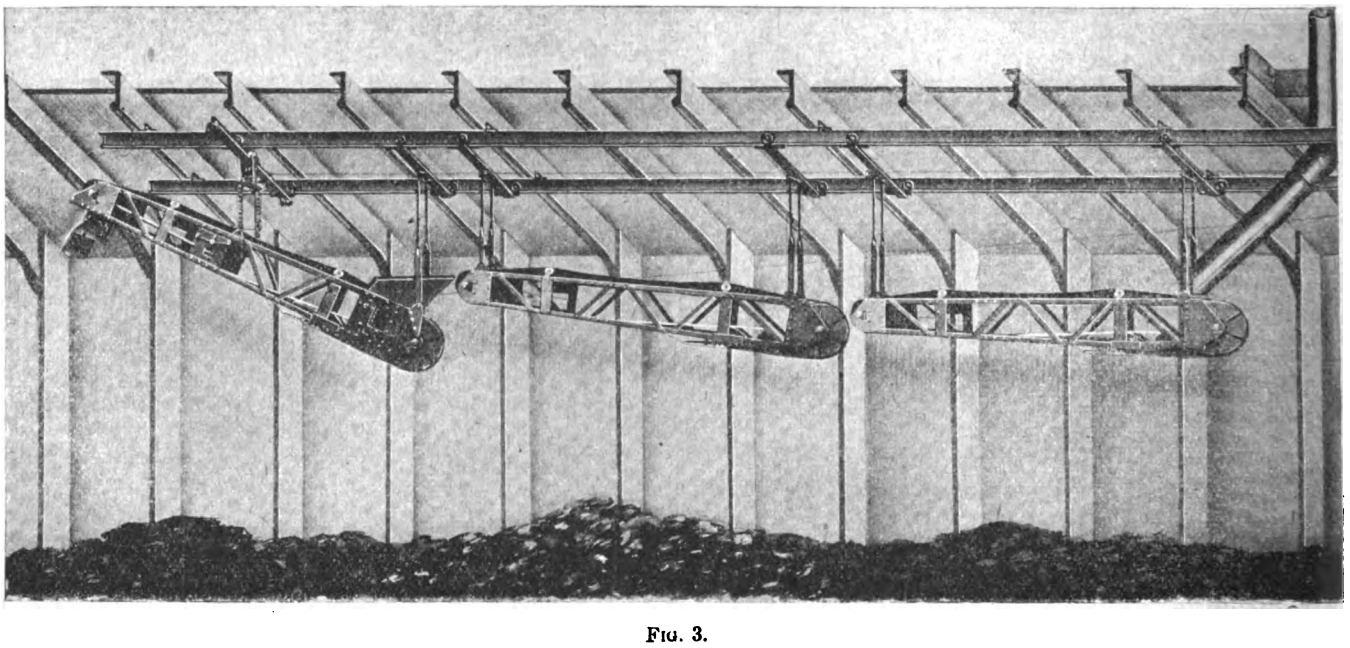

FIG. 3.

three in number, but depending upon the length of bunker, suspended from a pair of rails attached to the centre of the deck beams inside the bunker upon which the conveyors are free to travel longitudinally. The coal is delivered at one end of the series of conveyors by means of a shoot from the deck above, and is discharged at the other end by the trimming or front conveyor. This conveyor is provided with a lateral movement, so that the coal may be distributed over the whole width of the bunker, and is inclined sufficiently to throw the coal high enough to fill the bunker up to the top.

cranes to the delivery hatch. In fact, they can be adapted in any direction where material has to be shovelled, wheeled or carried.

Fig. 1 illustrates the trimming conveyor only.

Fig. 2 illustrates a portable conveyor of the same general design as the trimming conveyor, mounted on swivelling castors for moving about the ship's deck, wharf, warehouses or any other place where material has to be moved. These conveyors are also self-contained, and can be made in any desired length, and any number can be fitted up end to end, making a continuous train, possibly several hundred feet in length

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The special feature of this conveying plant is the electric driving drum, of which the complete machine is illustrated in Fig. 4. This driving drum consists of an electric motor of suitable horse-power

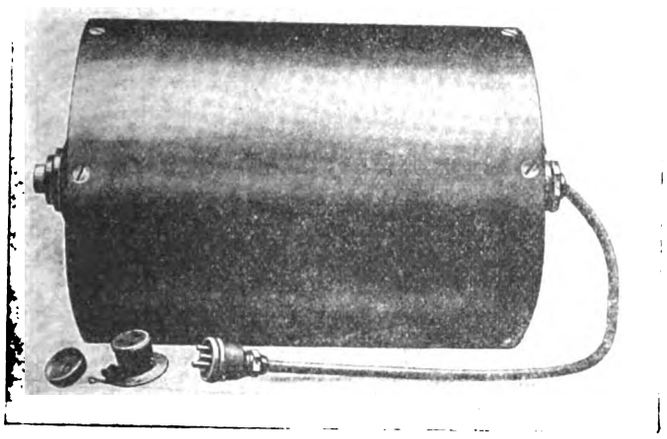

FIG. 4.

which can be wound for any commercial voltage for either direct or alternating current.

The whole of the outer drum which forms the belt pulley revolves and receives its power from an internal machine cut gear wheel,

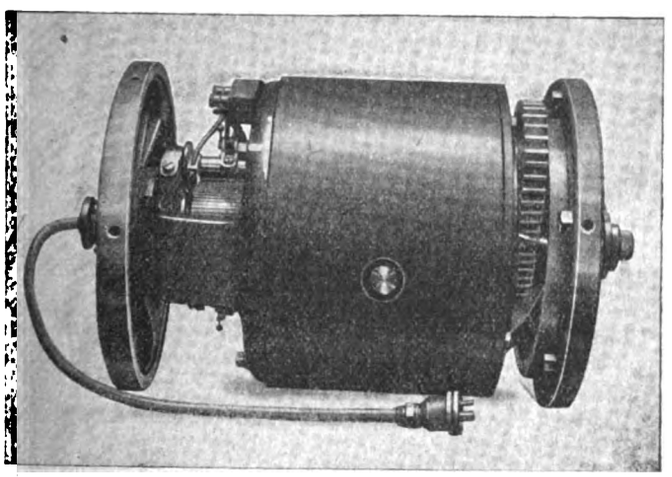

FIG. 5.

fixed to one of the end brackets that carry it; these brackets run on standard roller bearings. This internal gear-wheel is connected by suitable spur and pinion, with a pinion fixed on one end

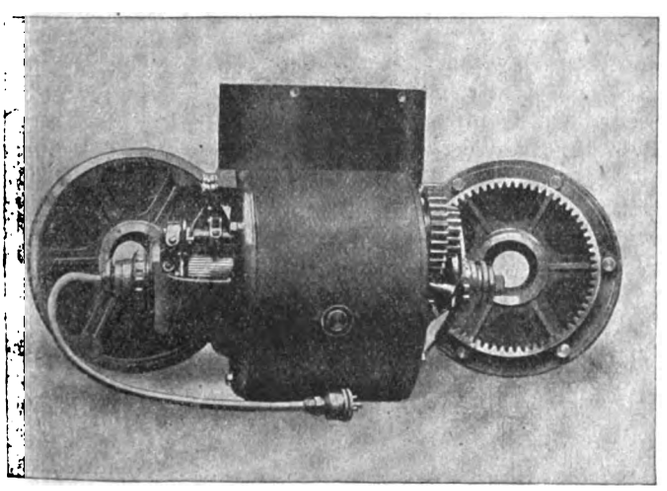

FIG. 6.

of the sleeve, on which is also mounted the armature of the motor. This armature and driving pinion revolve on a hollow shaft, to which is keyed the yoke and fields of the motor.

The hollow shaft serves the double purpose of providing at one end a reservoir for the lubricant for the armature sleeve and gearing, and at the other a channel and protection for the cable connections. Both end brackets of the drum are solid, so that the machine becomes a totally enclosed motor protected from dust and damp, enabling it to be used under any weather conditions or in any situation.

Fig. 5 shows the driving drum with the pulley removed, the end brackets in position with the intermediate pinion, and the method of making the cable connections. Fig. 6 illustrates the parts of the driving drum, showing the motor complete with both brackets and pulley removed, and making clear the whole design and construction of the machine.

The special self-contained motor and driving drum is adaptable for a great many purposes, such as elevators working in exposed positions, conveyors both above ground and underground in connection with coal mines, &c., portable stackers, loaders and pilers, slat conveyors in connection with the mechanical handling of materials. It can also be used for haulage purposes for driving winches, capstans, &c., replacing steam-driven machines working in exposed positions.

The sole licencees and manufacturers of this special labour-saving machinery are Messrs. J. Martin Blair, 3-7, Southampton-street, Strand, W.: and the motors are built for this firm by the Collins Electrical (Ltd.), 115, Clerkenwell-road, E.C.

A Method of Determining the Value of Slip*

By G. HILPERT.

The following method of determining the slip is so simple that it is quite possibly already known. However, on account of its value and simplicity it is worthy of mention, seeing that it requires no unusual apparatus, and can also be applied to squirrel cage motors. The method does not tire the eye of the observer, and takes neither from the motor or the network any measurable amount of energy. Let us suppose a disc to be mounted on the pulley of the motor, and in it let there be a number of radial slits corresponding to the number of the poles. Through these slits observations are made on a frequency meter of the reed-vibrating type; then the reeds vibrate at a speed depending on the slip of the motor. Let the vibrations be counted over a measured period of time; then the slip can be calculated exactly as in the method which employs polarised apparatus like a galvanometer. It is best to direct attention to the reed which has the greatest vibration. If the swinging of the other reeds disturbs the observer, these can be shielded by some sort of a cover. The only instruments that are required are a frequency meter and a watch.

Some points may be mentioned about the disc, its construction and arrangement. Card or sheet metal can be used; this depends on whether the disc is in frequent use. For high speeds, paper is sufficient, as it is kept taut by centrifugal force. If the disc is painted with a matt black varnish, the vibrations of the white reeds are easy to observe. The slits should be slightly larger than the biggest swing of the reeds; possibly 15 mm. or 20 mm. is sufficient. The diameter of the disc depends on the method of fixing and also on the frequency meter. If a pulley is available the disc is best made of wood, bored out to the proper diameter. If the experiments are made on a motor, which drives through a belt, then the following plan can be recommended. Three or four small segments of sheet metal are prepared, which can be fixed in any radial position by screws, which fit in the slits. The segments are separated to such an extent that they lie on the inner side of the disc; the screws are then tightened, as soon as the disc has been centrally mounted. A third plan is to provide the disc with a three-edged tip, such as is used on speed-counters, the whole thing being capable of rotating on a hand-grip. But this is an uncertain plan, even if the centre of the pulley is roughened with a chisel. If it is difficult to bring the eye into position for observing, an inclined mirror can, of course, be used. The method is specially suitable for small motors, since the air-friction of the disc is very small. The current required is very small, and amounts to about 30 milliamperes for the frequency meter. The arc lamp, which is used in stroboscopic methods, is not needed, and as it frequently takes more current than the motor itself, this is a great saving.

* Abstract of an article in the "Elektrotechnische Zeitschrift."

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Housing and Welfare.

A pamphlet has recently been issued by the Ministry of Reconstruction on "Housing in England and Wales." The subject undoubtedly forms one of our many reconstruction problems, and therefore it is well to have an official statement on the position. The magnitude of the task before this country is indicated by the fact that at present there is a shortage in England and Wales alone amounting to between 300,000 and 400,000 houses, and this figure is quite apart from any further shortage which may be created by the closing down of slum districts. Moreover, it is well to remember that this figure depends upon our definition of over-crowding, and the official definition of this state of affairs is undoubtedly low. It is to the effect that people are regarded as overcrowded only if they are living more than two in a room, including living rooms. Thus, if a cottage consists of two bedrooms and a living room, it is only regarded as over-crowded if there are more than six persons living in it. This is certainly a sufficiently low standard, and yet, according to the Report of the Census of 1911, no fewer than one-tenth of the population were living under over-crowded conditions. This state of affairs can only be regarded as a blot on a civilised community, and it is curious that it should have persisted for so long. And yet this is not for lack of remedies. As a matter of fact, local authorities have had wide powers to deal with the situation by various Acts of Parliament for a number of years past. They have the power to purchase property, to alter existing houses and to build new houses, and it would certainly be thought that the local authority controlling the affairs of any town would be the authority to which such a subject would appeal most readily, and which would take immediate steps to eliminate the evil. Moreover, if the local authority fails to exercise its powers, any four inhabitant householders in the district may complain to the Local Government Board, whereupon, after a public inquiry, the Local Government Board may order it to do so. Yet the number of houses that have been built by local authorities is only a small proportion of the total required. It amounted to 4,408 in 1915 and to a smaller number in 1914. Many local authorities, in spite of pressure from the Local Government Board, have failed to make any use whatever of their powers, and many have made quite inadequate use of them.

The state of affairs has, of course, been aggravated by the war. This aspect of the question was discussed in detail in a recently published work by Mr. J. E. HUTTON.* In his preface the author remarks that he has no "axe to grind," and that he puts forward the little volume in the earnest hope that it may meet an undoubted want in an acceptable and unvarnished guise. Certainly the volume is acceptable, and it carries the stamp of authority with it, as it deals with the arrangements that have been found necessary and desirable by Messrs. Vickers, Limited, which is the largest commercial undertaking in the country and employs over 100,000 persons. Obviously the work entailed has been on a large scale, and this may be divided into two classes—temporary and permanent. As an example of the former, it may be mentioned that in Kent some 200 houses and institutions have been acquired. Some particulars are given of the cost and of the charges that are made to the tenants. The charge at first amounted to 18s. 6d. per week for a single man, and included board and lodging complete, this charge being subsequently raised to £1. 4s. in 1917. It was recognised that such charges necessarily entailed a loss, but it was evidently felt that the welfare of the employees was worth paying for.

Permanent housing is illustrated by a small town called Vickerstown, which is a garden city built for the use of the employees of Messrs. Vickers at Barrow, the total cost being £150,000. Where schemes are not so ambitious, the author recommends that the aid of the Rural Housing Organisation Society should be invoked. By so doing, and by registering under the Industrial and Provident Societies Act, with a restriction of interest on capital of not more than 5 per cent., two-thirds of the required capital can be obtained on mortgage from the Public Works Loan Commissioners. This method was followed at Crayford, where 589 cottages were erected on 60 acres of land, the accommodation generally provided consisting of a living room, parlour, scullery, three bedrooms and bath room, with fixed water supply in every case. We are glad to note the inclusion of the bath, which is, unfortunately, so often absent in this class of property, and yet it is surely most desirable for those who are employed in hard manual labour.

Undoubtedly, one reason why housing on these lines has not made more rapid progress is the financial aspect. The cost of these cottages amounted to £350 each. Under pre-war conditions they would, of course, be cheaper, but even at £250 it is not easy to show a good financial balance sheet. Such a cottage would let at, say, 8s. 6d. to 10s. 6d. per week, and would therefore bring in a gross revenue of, say, £22 to £27 per annum. Out of this sum, however, must come the whole cost of painting and all repairs, so that when complete costs are taken into account it is not a simple matter to show even a 5 per cent. return on the outlay.

In the schemes described by Mr. HUTTON the cottages are erected on a basis of 10 to 12 to the acre; that, of course, is ideal, but in towns this becomes practically impossible. It appears to us that there would be a considerable gain by erecting higher buildings in many parts of the poorer quarters of London, say in the form of flats, which would at the same time permit larger open spaces and gardens.

Housing, however, is only one of the problems which Mr. HUTTON has had before him. There has also been the problem of catering. Many interesting facts are given in regard to this important matter, everything being provided for the employees at a fixed charge, and, judging by the details that are given, the value obtained for the money is extremely good.

Housing may be regarded as merely one branch of welfare work, which Mr. HUTTON prefers to describe as "physiological management." Details are also given of the lines followed by Messrs. VICKERS in welfare work, pure and simple. In the opinion of the author it is essential that the person in charge of such work should be a member of the management. The welfare department should deal with the engagement and dismissal of employees, except in regard to technical qualifications, and also with sanitation, ventilation, heating and many other problems with which our readers are familiar. Mr. HUTTON makes the interesting suggestion that output curves should be plotted for each person engaged on piece work. This is not with

* "Welfare and Housing: A Practical Record of War-Time Management." (London: Longmans, Green & Co.) Pp. viii. + 192. 5s. net.

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a view to maintaining output; but if there is a falling off in output this is shown at once by the curves and is generally due to lack of health in some direction or another. By taking this in hand without delay a breakdown can be avoided. Some useful hints are also given of what are termed efficiency appliances; in other words, the adaptation of tools so that they suit the operator who is to work with them.

In conclusion, we may say that Mr. HUTTON's book is full of practical information, and we commend its perusal to all who have to consider these problems in relation to works, whether large or small.

Reviews.

The Year Book of Wireless Telegraphy and Telephony (1918). (London: The Wireless Press, Ltd.) Pp. cxiii.+1,154 6s. net.

The edition of the "Year Book of Wireless Telegraphy and Telephony" for the present year is again a testimony to "the incurable habit of progress" recorded in previous issues. It has been found necessary to increase the number of pages by over 230. The section devoted to Laws and Regulations, as might perhaps be anticipated, is responsible for a considerable proportion of the greater bulk, now occupying 463 pages, as compared with 273 in 1917. Special acknowledgment is made of the courteous co-operation of the chief officials presiding over Government departments in various countries, under which wireless telegraphy is organised, in compiling these data.

The Record of Developments for 1917 contains some interesting items, though naturally technical progress can at present be scarcely mentioned. The summary of Valve Patents published in 1917, however, which forms a new feature, will prove very useful. It is interesting to note that in June last year wireless telegraphy "came of age," just 21 years having elapsed since the first patent, taken out on June 2, 1896, which formed the basis of the Marconi system. During the past year 10 eminent experts in wireless telegraphy have passed away; among these are Mr. W. du Bois Duddell and Captain Camille Tissot, of whom biographical notes are appended.

Among the specially contributed articles we note those by Dr. J. A. Fleming on "Waves in Water, Air, Earth and Aether"; by Mr. B. van der Pol, junr., on "Energy Transmission in Wireless Telegraphy"; and by Mr. D. Sarnoff on "Wireless Telegraphy in the U.S.A." Dr. N. W. McLachlan deals with "The Magnetic Behaviour of Iron in Alternating Fields of Radio Frequency," and Mr. A. R. Burrows contributes an interesting sketch of Wireless Possibilities.

The useful Data section by Dr. Erskine Murray remains as revised, and is to be enlarged and reprinted as a separate volume. A feature of the present edition of the Year Book is the addition to the series of plates included to illustrate new forms of wireless appliances or instruments (such as those used by the late Mr. Duddell) of historic interest.

There are again many moving instances recorded of the heroism of wireless operators at sea. May the next issue of the Year Book find us nearer the resumption of normal wireless operations in the service of peace.

Aviation Pocket Book for 1918. By R. BORLASE MATTHEWS. (London: Crosby Lockwood & Son.) Pp. xvi.+362. 6s. net.

This useful pocket book is appreciably larger than the 1917 edition, the number of pages being now 362 as compared with 300 a year ago. The new features include some pages devoted to the way in which the manufacture of aeroplanes may be accelerated by the more extended use of jigs and similar devices. Five pages are now allotted to the quite important subject of parachutes. This innovation will be welcomed, as the literature on this subject is distinctly scanty and scattered. Another section which has been increased is that dealing with meteorological conditions and data. These additions undoubtedly enhance the value of an already useful volume.

Welfare and Housing: A Practical Record of Wartime Management. By J. E. HUTTON. (London: Longmans, Green & Co.) Pp. 192. 5s. net.

We refer to this book in our Leading Article.

The Calculation of Single-Phase and Three-Phase Lines.*

By J. R. DICK, B.Sc., M.I.E.E.

A method frequently employed is that of drawing to scale a vector diagram of the known quantities involved, and from this the unknown factors can be determined. Great accuracy is not a feature of the method, even when the draughtsmanship is done with care, as the quantities vary through wide ranges, and the selection of a scale suitable for all of them is somewhat difficult. Again, facilities for accurate drawing may not be available, when the calculations have to be made, and thus it is well to be familiar with the algebraic formulæ, which are quite simple to apply with the help of a sheet of four-figure logarithms and a one-page table of cosines. The formulæ can also be used for determining, with greater accuracy than the graphical method, the phasal angles of all the quantities.

1. *Single-phase feeder, non-inductive, supplying an inductive load.* In this case the various vector quantities are related to each other as shown in the diagram Fig. 1.

The line AC represents the current vector; AB is drawn making an angle φ_1 with AC and represents the voltage V_1 at the supply end. The angle φ_1 is such that cos φ_1 is the power factor of the power supplied. If C_0 is the current in the circuit, and r the total resistance of the circuit the ohmic drop $C_0 r$ is represented by BD drawn parallel to the current vector AC, with which it is naturally in phase, r being a purely arithmetical quantity. As the line is supposed to have no sensible induction there is no allowance to be made for inductive drop, and by joining A to D we obtain the voltage V_2 at the far, or load, end of the line. The power factor there is given by the cosine of the angle DAC or φ_2.

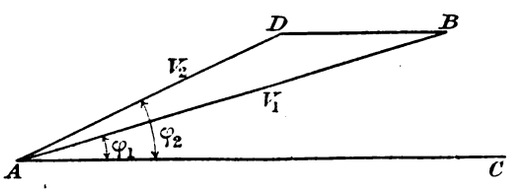

FIG. 1.

For clearness the line BD in Fig. 1 is made too large compared with AB or AD, but if all the quantities were drawn strictly to scale the difficulty of measuring V_2 would be at once recognised.

* From the forthcoming new edition of "Electric Mains and Distributing Systems" (Dick and Fernie).

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The true voltage drop is the arithmetical difference between AB and AD or $V_1—V_2$. The problem is usually to find the supply end voltage and the drop, when we know the load P at the far end of the line, its power factor $\cos\varphi_2$ and the actual pressure V_2 which has to be maintained there.

From the ordinary trigonometrical rule we have the following relation between AD or V_2, AB or V_1, and DB or C_0r.

$$V_1^2 = V_2^2 + (C_0r)^2 + 2V_2C_0r\cos\varphi_2.$$

If the load were non-inductive P would be $CV_2 = C_0\cos\varphi_2 V_2$. Thus $C_0 = \frac{C}{\cos\varphi_2}$, and by substitution, and a trigonometrical transformation we obtain

$$V_1 = \sqrt{(V_2 + Cr)^2 + (Cr\tan\varphi_2)^2}.$$

Under non-inductive conditions $V_1 = V_2 + Cr = \sqrt{(V_2 + Cr)^2}$; with induction present it is slightly greater, but the effect of $(\tan\varphi_2)^2$ in the formula is so small as to be usually negligible

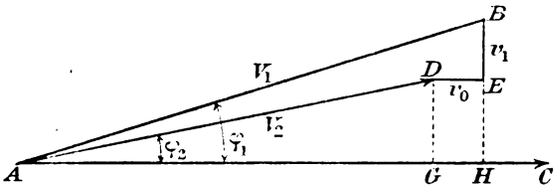

FIG 24

Thus the difference between V_1 and V_2, or the true voltage drop, may be taken as the same in both cases. Hence, for a given voltage drop, in working out the cross-section of a non-inductive alternating-current feeder, of length $2l$ (forward and return), supplying a current C_0 with a power factor $\cos\varphi$, we have only to replace C in the formulæ by $C_0\cos\varphi$.

The drop v in any circuit of resistance r, carrying a current C, is $v = Cr$, and if the section is s and the length $2l$, we have $r = 2l/\rho s$, where ρ is the resistivity constant for copper. Thus $v = 2Cl/\rho s$, and $s = 2Cl/\rho v$. Replacing C by $C_0\cos\varphi$ we obtain for the conditions stated $s = 2C_0l\cos\varphi/\rho v$.

Correspondingly, for a uniformly loaded two-wire distributor, with each conductor of length l, the formula

$$s = Cl^2/\rho v \text{ becomes } s = C_0l^2\cos\varphi/\rho v.$$

2. *Inductive Loads on Mains with Inductance and Capacity.*

The data for problems involving these factors are usually (1) A given load P, (2) A standard pressure V_2 at the load end, (3) A fixed percentage power loss p in the line. The cross-section is first determined from the permitted line loss, and the voltage drop is then calculated as follows :—

The power supplied $P = V_2C_0\cos\varphi_2$, and as P, V_2 and $\cos\varphi_2$, the power factor of the load, are all known, C_0 is at once found. The power loss is $pP = w = C_0^2r$, where r is the ohmic resistance of the circuit of length $2l$; and as $r = \frac{2l}{\rho s}$, we have $w = \frac{2C_0^2l}{\rho s}$ and $s = \frac{2C_0^2l}{\rho w}$.

In addition to the ohmic drop, we have with overhead lines, and to a less extent with underground cables, the effect of their inductance to consider. The effect of capacity is included later. The ohmic drop is $v_0 = C_0r$ volts; the inductive drop, also in volts, is given by the expression $2\pi nLC_0$, where L is the coefficient of self-induction of the circuit in henries.

The diagram in Fig. 2 is constructed by taking, as before, AC as the direction of the current vector C_0, and AD, representing to scale V_2 and making with AC the angle φ_2. The ohmic drop $v_0 = C_0r$ being necessarily in phase with C_0 is represented by DE, to scale, parallel to AC.

The inductive drop v_1, or BE in the diagram, has its length equal to $2\pi nLC_0$. It is at right angles to DE, as it has a relative phase displacement of a quarter period. Joining A to B gives the magnitude of the supply end pressure V_1 and its phase relation to the current. The cosine of the angel φ_1 which it makes with AC is the power factor at the supply end. From the diagram

$$AB = \sqrt{AH^2 + BH^2}$$
$$= \sqrt{(AG + DE)^2 + (DG + BE)^2},$$

or $$V_1 = \sqrt{(V_2\cos\varphi_2 + C_0r)^2 + (V_2\sin\varphi_2 + 2\pi nLC_0)^2}.$$

All these quantities are known and thus V_1 can be calculated; and we then find the true line drop $V_1—V_2$. The power factor at the supply end is

$$\cos\varphi_1 = \frac{AH}{AB} = \frac{V_2\cos\varphi_2 + C_0r}{V_1}.$$

The power put into the line is $P_1 = V_1C_0\cos\varphi_1$ or by adding the line losses to the load it can be alternatively expressed as $P_1 = V_2C_0\cos\varphi_2 + rC_0^2$.

The coefficient of self-induction *per mile of single conductor* of a paper insulated multicore cable is obtained from the formula $\left\{0{\cdot}085 + 0{\cdot}74\log\left(\frac{d}{r}\right)\right\}10^{-3}$ henries, where d is the distance between centres of the conductors and r is the radius of each conductor.

A similar formula holds for overhead lines, but it is somewhat beyond our immediate purpose to show how these expressions are derived.

When the distance from the point of supply to the load is l miles and L per mile is known the value of

$$v_1 = 2\pi nL \times 2l \times C_0$$

as the total length of conductor, forward and return is $2l$. In the same way, in reckoning r in the formula for v_0, we must use $2l$ miles as the total length.

When capacity exists in the line the charging current through it leads to some modifications in the formulæ.

If K is the capacity in microfarads of the transmission cable either twin or concentric, considered as a condenser, the charging current is $C_k = 2\pi nVK \cdot 10^{-6}$ amperes.

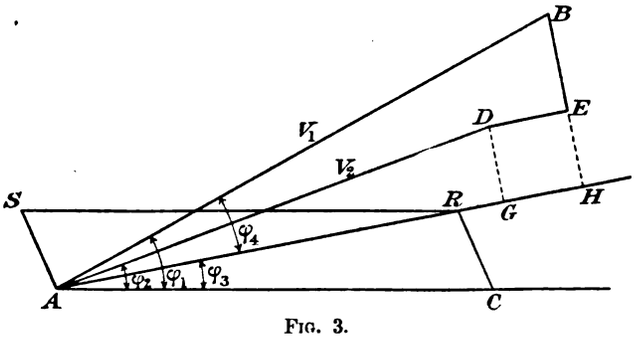

FIG. 3.

The voltage V varies from the supply to the load end, but the total drop being generally less than 10 per cent. it is accurate enough to take the value V_2 as applying to the whole line, when calculating C_k. The diagram in Fig. 2 is modified as shown in Fig. 3. The line AC now represents the load current C_0 in magnitude as well as phase. In order to compound with it the capacity current, AS is drawn equal to the value of C_k and at right angles to the voltage vector AD, as these two vector quantities are very approximately in quadrature. By completing the parallelogram we obtain its diagonal AR, which represents the resultant current, at the supply end, in magnitude and direction. It can be at once calculated, since

$$AR^2 = AC^2 + AS^2 — 2AC \cdot AS\cos ACR,$$

or resultant current $C_r = \sqrt{C_0^2 + C_k^2 — 2C_0 \cdot C_k\cos(90° — \varphi_2)}$.

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To take a fairly accurate account of the capacity we have now to replace C_0 by C_r in the formulæ for finding V_1 and the other quantities required.

It will be at once noticed from Fig. 3 that the current at the supply end is less than before due to the capacity of the line, and that the power factor has been improved, as φ_4 its phase angle is less than the original φ_1, without capacity in the circuit. The benefit of capacity of a moderate amount is clearly recognisable in this method of calculating its effect. Ohm's Law for an alternating-current circuit shows the beneficial influence of capacity in another way. When inductance and capacity are *in series*,

$$V = C\sqrt{r^2 + \left(2\pi nL - \frac{1}{2\pi nK}\right)^2},$$

and it is clear at once that when $\frac{1}{2\pi nK}$ approximates to $2\pi nL$ the quantity under the root sign will tend to become r^2, and we get $V = C_r$, which represents non-inductive conditions. When capacity and an inductive load are *in parallel*, as in alternating current lines and networks, its beneficial effect is not so simple to indicate algebraically, but the vectorial addition of the capacity current in the method we have used above illustrates the general effect quite clearly.

(To be concluded.)

The Labour Outlook.

(BY OUR LABOUR CORRESPONDENT.)

There are two lines of doggerel which once summarised some of the aspirations of labour.

"Eight hours' work and eight hours' play,
Eight hours' sleep and eight bob a day."

The demand for an eight hour day is one of old standing; but the low wages which have prevailed in the past have made increased remuneration the prime consideration. As, however, the standard of life has been raised, the demand for an eight hour day has become more insistent, until now it appears as though it will be one of the main planks of trade union policy for after the war.

It is interesting to observe that there were no less than four resolutions on the eight hour day or the 48 hour week, down for discussion at the recent Trade Union Congress, submitted by four unions catering for different types of workers. One came from the General Workers Union, another from the Bakers, a third from the Vehicle Workers and the fourth from the Cotton Weavers. A further resolution in the name of the Boiler Makers and Shipbuilders asked for a 44 hour week and the limitation of overtime.

Curiously enough almost the same day there was published a Report from the Ministry of Reconstruction (Cd. 9,107, 3d.) which may be heartily commended to all who are interested in industrial conditions. This Report recommends the establishment of a maximum legal working day of eight hours and less than that where the work carried on is heavy and exhausting.

The eight hour day is in operation in some places in steel works, and the introduction of the eight hour day by the great engineering firm of Mather & Platt is well known. The miners enjoy a statutory working day of eight hours and are the only class of adult male workers whose hours of labour are determined by law.

There is legal protection for women and young persons of both sexes in factories, workshops and shops. In textile factories the hours are limited to 55½ per week, and in non-textile factories to 60, with certain provisions for limited overtime. Women and young persons employed at mines above ground may work 54 hours per week; and shop assistants have a maximum legal working week of 74 hours. For the workers in offices, and in transport work there is no legal protection of hours.

Investigations in industrial fatigue have proved, what workpeople knew from experience, that long hours are wasteful and that they do not pay. Everyone knows cases where hours of labour have been reduced and output has not suffered. Lord Leverhulme has gone so far as to suggest a six hour day. But his proposals find little support in Labour circles, because his intention appears to be to work three or four shifts, and night work is an abomination in the eyes of the workers, and with much justification.

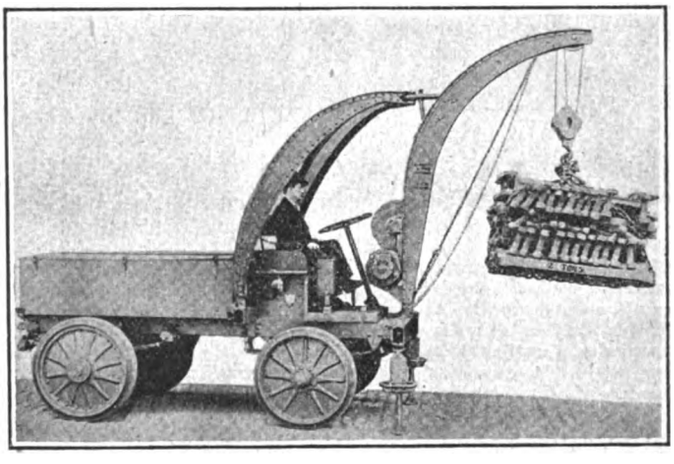
There is now a strong and growing opinion in the labour movement in favour of the 44 hour week, which would mean an eight hour day of two four hour spells and four hours on Saturdays. Workpeople have heard of the eight hour day in the United States. They have witnessed the enormous increase in the productivity of industry. They are becoming more and more determined to take part in the social and political life of their localities. For a full generation there has been no appreciable reduction of the working day. The trade unions have now nailed to the mast the flag of a reasonable working day. What is happening is that they are now evolving a policy containing the primary demands which labour intends to make before the post-war industrial system becomes crystallised. One of the chief items is the eight hour day, a demand which many progressive employers are willing to accept

The end may be reached either by trade union agreements which would not cover all classes of workers, or by legislation. Though the new spirit in trade unionism prefers direct action to secure its objects, the prevailing feeling is in favour of State intervention. Whether the Government will take the bold line remains to be seen; but if no action is taken, unnecessary industrial trouble is certain.

Electric Vehicle Crane Tractor.

A Chicago manufacturer of electric vehicles recently placed on the market, in response to a demand from terminals and manufacturing plants, a tractor (as shown in the accompanying illustration) equipped with a 2-ton capacity crane, also operated by electric motors, and supplied with current from the same storage battery used to propel the electric vehicle.

The demand for this mobile electric tractor crane was created principally through war conditions, and the consequent handling by such plants of many heavy materials in large units. This electric crane tractor, although it has not as high a lifting capacity as many locomotive



ELECTRIC VEHICLE CRANE.

and overhead cranes, has, however, the advantage of being more flexible in its radius of action.

Recently one of these electric crane tractors was observed unloading a freight car at a well-known terminal. It was handling large crates of army kitchen equipment weighing approximately 3,700 lb. After lifting the cases off the freight car it backed away, and, running across the pier under its own power, deposited its load. While this is a somewhat larger load than the electric crane tractor was figured to carry while in motion—the manufacturers would prefer loads to be limited to 2,000 lb. or 3,000 lb. in such instances—the ordinary stationary crane having only a maximum capacity of 4,000 lb., the electric crane tractor performed its duty easily. The boom of the electric crane tractor swings 180 deg., so that after material is lifted it can be deposited easily on the ground or on a trailer for transportation elsewhere.

It can be readily realised that speed in handling materials is vital under present conditions. Locomotive or overhead cranes are not always available at just the place where it is necessary to handle material at a given time, and, even if available, they cannot always be transported quickly from one point to another, as can an electric crane tractor of this type.

This electric crane tractor is also equipped with a spring drawbar coupler at the rear of the frame. It is possible, therefore, to load trailers by means of the electric crane and then haul these trailers electrically to another point and unload them. As a tractor it can haul a gross trailing load of 15 tons. Electric tractors of this type have been used in many instances to "spot" loaded freight cars, either pulling or pushing them.

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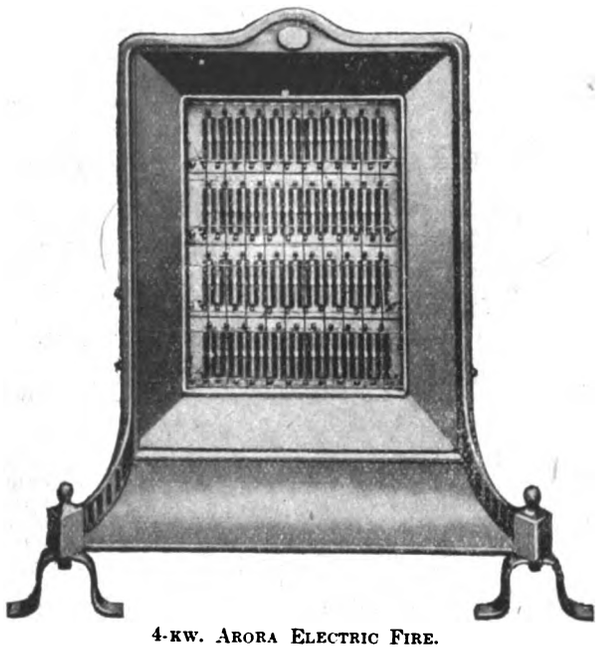
Arora Electric Fires.

In May, 1915, the Arora Company of Loughborough, Leicestershire, started operations with works having a foundry and engineering shop already in working order, and the progress made by the company was described in THE ELECTRICIAN of Feb. 25, 1916. We are informed that since that date the demand for the company's electric fires has necessitated large extensions to the erecting shop for Arora fires, and it now occupies about five times the original floor space.

In a leaflet recently issued by the company particulars are given of two new Arora fires, a 4-kw. fire and a one-bar fire. The larger fire is manufactured to the same general design as the two- and three-bar fires, having been standardised with 1,000 watt bars instead of the 750 watts elements, and it is controlled by three 10-ampere switches. This fire is



4-KW. ARORA ELECTRIC FIRE.

23½ in. high and 23 in. wide, the weight being 35 lb. The fire-box forms a standardised part, and is interchangeable, and as it is held by two nuts only it can be quickly attached to front castings of various finishes. The one-bar (No. 10) fire is arranged with one 750 watt bar and is formed of two strong castings. Its measurements are 10¾ in. × 4½ in. × 3 in. and weighs 7 lb. The leaflet also gives the prices and particulars of other fires manufactured by the company.

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on ceipt of published price, plus postage.]

"Present Day Applications of Psychology, with Special Reference to Industry, Education and Nervous Breakdown," by Mr. C. S. Myers, F.R.S. (London: Methuen & Co.) Pp. 47. 1s. net.

"Social and Industrial Reform," by Sir Charles W. Macara, Bart. (Manchester: Sherratt & Hughes.) Pp. 207. 5s. net.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain of the Week.—Capt. W. Darley Bentley.

Next for Duty.—Capt. E. G. Fleming.

Sunday, Sept. 22.—Annual Musketry Course at Pirbright. Parade Waterloo Station 8.45 a.m. Drill order with rifles. Midday and tea rations to be carrried.

Monday. Sept. 23 to Saturday, Sept. 28.—Drills as usual.

Sunday, Sept. 29.—Commandant's Parade Waterloo Station 8.45 a.m. for work at Esher. Dress: Drill order without rifles. Midday and tea rations to be carried.

Commercial Topics.

Banking Facilities and After War Problems.

During the week Sir Edward Holden (chairman of the London, City & Midland Bank) and Sir Herbert Hambling (chairman of the London Provincial & South Western Bank) delivered important speeches on the recent bank amalgamations, the relations between German banks and industrial undertakings, German competition after the war, the necessity of increased exports, &c.

Sir EDWARD HOLDEN explained the reason for the series of bank amalgamations during the last nine months. Bankers were confronted with the problem of restoring the industries of the country after the war to the condition which they previously occupied. The concerns which had been converted from peace production into munition factories would have to be reconverted to their original condition. In the case of a number of those branches of industry which had continued in their pre-war occupation, such as those producing for home consumption and for export, the plant and machinery had been allowed to run down, and it would be necessary to renovate them and bring them up to date, and even to a better condition than before the war. Large sums of money would have to be found for the purchase of raw material and for improving the trade position generally. It was estimated that no less than 300 millions sterling would be required for those purposes, and credit would in some way have to be created for that amount. Large and powerful banks were indispensable for the purpose. The second reason why those amalgamations had taken place was that every effort should be made to retain London as the financial centre of the world. One of our principal competitors in the future would be Germany, and just as the Germans made great preparations for the war by increasing their armies and supplying themselves with large amounts of gold and munitions of war, so they were at present making their preparations for after-war trade. Having given statistics of the deposits with the three leading German banks and with the principal British banks, Sir Edward Holden gave a sketch of banking development since 1800, and supplied statistics as to exports, &c. He said there had never been a parallel to the present position in the world. If this country was to restore and gradually improve her financial and industrial position, it could only be done by increasing her exports to a larger amount than they had ever been before. We should live in a world of keen competition for export trade. We should only be in a position to win in the struggle and to increase our trade if our banks were not less big and powerful than those of our trade rivals. Sir Edward Holden dealt at some length with the means of creating credit for our trade after the war, &c.

At the meeting of the London, Provincial & South-Western Bank, Sir H. Hambling dealt with the necessity for providing adequate additional banking facilities after the war. The salient features of the post-war economic position would be that the interest on the National Debt would be enormous, that wages would be high, that interest received on foreign investments would be much less than formerly, and that the fictitious prosperity created by Government orders would cease. To meet the interest of the National Debt, pay those wages, provide a set-off for the loss of interest, and to substitute a genuine for a fictitious prosperity involved a great increase in production and in exports; hence the vital necessity for providing manufacturers with facilities equal to, or better than, those enjoyed by their competitors in the world's markets. If the war factories could be promptly converted to peaceful production on a maximum basis, the post-war economic problem would largely be solved. The essentials to that end included adequate financial facilities for home and foreign trade, adequate supplies of raw materials, and adequate information as to the conditions abroad affecting the supply of raw materials and the demand for our manufactures, together with the sympathetic action of the Government. It was necessary that the banks should be far more fully advised from points all over the world as to the state of markets both for raw materials and manufactured articles, because they could not with safety provide the larger facilities required unless they themselves possessed independent and direct information.

* * * *

Electrical Legislation in British East Africa.

A Bill which deals in a comprehensive manner with electric power supply is now awaiting its final reading in the Legislative Council of the British East Africa Protectorate. The measure is designed to foster and promote bulk supply methods and ensure standardisation.

Public and local authorities must adopt the standards and specifications of the British Engineering Standards Association. The standard system for the Protectorate will be three-phase at 50 periods, excepting for special purposes, and excepting the supplies to authorised distributors and for special purposes, the pressures of supply will be 415 and 240 volts. All apparatus to be used in connection with a standard system by a licensee, must comply with these standards, and that which may be used by others on a standard system must be marked when usual or necessary as to its capacity or value, in terms of British standards. Practically every form of energy which industrialists in the Protectorate will require must be obtained from or by the conversion of electrical energy generated by water power, internal combustion engines, or oil-fired boilers. Consequently, a demand for apparatus is developing which should not be neglected by British manufacturers.

The Government electrical engineer (Mr. James McBlain) will be pleased to receive catalogues and other information (with prices where possible) relating to hydraulic, internal, combustion and steam types of prime movers, electric generators and motors, transformers, E.H.P.

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transmission line materials, split phase and other control and switching apparatus, indicating and recording meters, testing and measuring apparatus, &c.; also relating to apparatus for any industrial application of electrical energy, including farm and electro-culture equipment, electrolysers, ozonisers, automobiles, batteries, and battery charging, coffee drying and roasting, steam raising, mashing and distilling, casting and welding, cement burning, domestic heating and cooking, and X-ray and electro-medical equipment, &c. Enquiries from those interested are solicited, and should be addressed to the Government Electrical Engineer, Nairobi, British East Africa.

* * * *

Hydro-Electric Power in Tasmania.

In a recent speech the Governor (Sir Francis Newdegate, K.C.M.G.) made reference to the progress made with the State hydro-electric works, ship building, &c.

The Governor stated that the State hydro-electric scheme had made further progress. Increased power had been supplied to the Electrolytic Zinc Co., whose operations were steadily increasing and were likely to assume large proportions, and also to the Hydro-Electric Co. for the manufacture of excellent carbide from Tasmanian raw material. Proposals were being prepared for the development of further water-power sources after the war.

Two steel ships of 5,500 tons each would be constructed in Tasmania immediately. The building of wooden ships had revived, and there was a marked increase in the demand for timbers. Mining had considerably improved.

Electricity Supply.

General.

Aberdeen.—The employees of the electricity department have accepted the offer of 5s. per week, bringing their advance up to 22s.

Arklow.—The L.G. Board has informed the Urban Council that it cannot receive the proposed deputation in connection with the electric lighting scheme until the plans have been prepared and a local inquiry has been held.

Blackburn.—The Electricity Committee recommend that a grant of £500 be made to Mr. P. P. Wheelwright, borough electrical engineer, in recognition of the extra duties devolving upon him owing to the war.

Bristol.—In moving the adoption of the annual accounts of the electric supply department, which were abstracted in a recent issue of THE ELECTRICIAN, the chairman of the Electrical Committee (Ald. G. Pearson) said that there had been an increase in the cost of production in some respects.

Wages had increased, and the cost of coal had also gone up, but taking everything into consideration, he thought they had passed through the year satisfactorily. Referring to the report of the Board of Trade Electric Power Supply Committee, he believed the Committee had made a straightforward attempt to deal with a thorny subject, but the matter should be watched carefully. The crucial question was the point at which it ceased to be economical to send current over long cables.

The report and accounts were adopted after some discussion.

Bury St. Edmunds.—Owing to the growing demand for electric current in the Northgate locality, extensions of mains, &c., are proposed at a cost of £2,500.

In order to give a supply of current to the Great Eastern Railway Co. for power and other purposes, the electrical engineer (Mr. S. E. Day) has been instructed to apply to the Ministry of Munitions for a permit to obtain the necessary cable and other electrical fittings.

Limavady.—Owing to the closing of the gas works the town hall was without a lighting system from April until last week, when electric lighting was employed. The streets are also to be lighted electrically.

Rotherham.—The Guardians have appointed a committee to report upon the question of adopting electric power for the laundry.

Sheffield.—At the meeting of the Corporation last week the annual accounts of the electric supply department were approved.

The chairman of the Electric Supply Committee (Councillor WARLOW) called attention to some of the leading points in the accounts. He said the average price was 0·88d. per unit, or less than that in Manchester, Birmingham or Glasgow. From the point of view of units sold, Sheffield was now the second largest undertaking in the country, Manchester being the only one above it; but the recent progress of Sheffield had been much greater than that of Manchester. Whereas the sales in the Lancashire city had grown since 1914 from 118 million units to 195¼ million, Sheffield had advanced in the same period from 26½ to 172½ million. He dwelt on the financial stability of the undertaking, and showed how, if it were regarded as an ordinary company, it could afford to pay a dividend of 10 per cent. for the year and still have a credit balance of £3,216.

In regard to the proposed advance in the price of current, he said the increase was recommended only with the greatest reluctance owing to the increased cost of coal and the recent advances in wages. Together those items would involve an extra expenditure of £49,000, and it was estimated that the advanced price would bring in an increase of income of £34,000. Sheffield had done magnificently during the war in supplying the munition firms with current. In conclusion, he paid a tribute to the work of the general manager (Mr. S. E. Fedden) and his staff during a very trying period.

Though there was some opposition to the proposed increase of charges, the Committee's recommendation was adopted.

Swansea.—The Corporation has been asked to supply Messrs. Richard Thomas & Co. with current by an overhead electric cable to Cwmfelin works.

Walsall.—The L.G. Board has sanctioned the borrowing of £6,304 for the electric supply undertaking.

Worcester.—The Council has decided to purchase an additional 10 in. circulating water pump, with motor, &c., for improving the supply of water to the Hylton-road works.

Electric Traction.

Extension of Time.—The Board of Trade has extended by one year the times limited for carrying out provisions of the following Acts and Orders: Birmingham Corporation Light Railway Orders, 1912 and 1913 (completion of works and purchase of lands); Brighton Corporation Act, 1913 (completion of overhead equipment for railless trolley cars); Bristol Tramways Act, 1915 (purchase of lands and completion of tramways).

Leeds.—The Corporation has decided to substitute the span-wire system for the tramway centre poles in Briggate.

Sunderland.—The salary of the general manager of the Corporation tramways (Mr. A. R. Dayson) has been increased from £600 to £700 per annum.

Imperial Notes.

Electrical Employers' Association of New South Wales.—In the annual report submitted at the recent annual meeting it is stated that power houses, mines and industries have been unable to obtain machinery required for extensions.

However, a stimulus had been given to the local manufacturer of switchgear, starters, &c. The uniform set of conditions for wiring contracts were completed in the early part of the year. The Government departments had been approached with a view to the adoption of the conditions for Government work. The conditions of contract for the supply of materials to the Federal and State Government departments, Municipal Councils, &c., were also now complete, and would be submitted to the new Executive.

The officers of the Association for the present year are: President, Mr. A. D. Stevenson (British General Electric Co., re-elected); vice-presidents, Messrs. R. B. Hungerford (Western Electric Co.), R. Burgin (Ramsay, Sharp & Co.); executive committee, Messrs. J. E. Donoghue, J. D. Handley, A. Maughan, F. T. S. O'Donnell and A. Waddell.

Johannesburg.—The Municipal Council will expend £10,000 on the purchase of a temporary steam generating plant.

Patents and Designs in South Africa.—The privileges granted by sec. 80 (4 and 5) and sec. 41 (2 and 3) of the South African Patents, Designs and Trade Marks Act, 1916, to countries affording similar privileges to South Africa have been extended to the United Kingdom

The sections provide that the registration of a design in a country outside South Africa shall not be a bar to the registration by the same person of the same design in the Union, and that the grant of a patent in a country outside South Africa shall not be a bar to the grant to the same person of a patent for the same invention in South Africa, subject to certain conditions.

Tasmanian Industrial Progress.—It is reported that the G.M.C. Syndicate proposes to establish works for the manufacture of white lead in Tasmania.

At the start it is proposed to make 700 tons of white lead per month. The machinery and plant are on the way, and it is hoped to have the first furnace blown in before the end of the year. The syndicate's representative (Mr. Gitsham) states that with the cheap electric power, and the cheap, suitable galena available in Tasmania, his directors believed it was possible to supply the markets of the world from the Tasmanian works; but when once the larger scheme was entered upon it would be necessary to draw supplies of ore from Broken Hill (N.S.W.) and Queensland, as well as Tasmania. It is explained that as the charge for electrical energy in Great Britain had been increased from a halfpenny to a penny per unit, and as it was impossible to purchase galena (owing to the Government having commandeered all supplies), while there was a general difficulty prevailing in procuring all kinds of necessary materials, the Tasmanian scheme appeared to be the only means of proceeding with the Company's business during the war. The syndicate has entered into a contract with the Tasmanian Government to supply 400 H.P. for a start at a farthing per unit, with an additional 1,600 H.P. later on at a lower rate. The first price, it was estimated, would halve the cost of the finished product. Galena, too, was always purchasable in Tasmania at about £5 per ton below the current prices in England, and was particularly suitable for the purpose. In addition to the 2,000 H.P., which the Tasmanian Government was committed to supply, the Company will require an option over a further 10,000 H.P. as soon as it can be obtained.

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Foreign Notes.

American Nitrate Plants.—It is announced that the second nitrate plant of the United States Government is nearing completion.

The plant is being erected near Sheffield (Ala.), and the site occupies 2,209 acres. The work was begun in January and it is expected that two units of the $30,000,000 plant will be in operation by October at the latest. Its capacity is 133,000 tons of nitrates for gunpowder, or 220,000 tons of fertiliser concentrates. Though hydro-electric plant will be ultimately installed, the present plant, which is there has been built a steam power plant, has a capacity of 120,000 H.P. The first plant is also a steam plant, with 6,000 H.P., while transmission lines from the plant of the Alabama Co., transmit over a distance of 90 miles 30,000 H.P. By October an additional unit of the latter plant will have been completed, making a grand total of 186,000 H.P.

Electrical Exports of U.S.A.—In May the value of the exports of electrical merchandise from the U.S.A. was $5,013,379, compared with $4,590,275 in May, 1917, and bringing the total for the first five months of the current year up to $22,837,665. In most branches there were substantial increases, but insulated wire and cables, arc, carbon and metal filaments lamp show a decline of 45 to 10 per cent.

Electric Extraction of Salt from Sea Water.—"Engineering" reports that a company has been formed in Norway with a capital of 20,000,000 kr., for the exploitation on a large scale of Prof. Helland Hansen's method for extracting salt from sea water.

It is stated that the undertaking is being backed up by several men of exceptional standing. It will in all probability be found expedient to erect several works along the coast, as more electric energy becomes available. The comparatively large capital is necessary on account of the large plant needed, pumping stations, &c., absorbing the bulk of the power; the production of the salt itself only requires a small amount of energy. Stavanger has been mentioned as a likely place for the first factory, and the Glaamfjord for the second.

Greece.—There should be a fairly good demand for electrical plant and apparatus in Greece after the war, for, in addition to existing electric supply works, several new schemes are projected.

Hitherto the greater part of the electrical machinery and supplies has come from Germany, but as this source of supply is now closed, British manufacturers should pay attention to this market. The Department of Telegraphs and Telephones contemplated large extensions before the war, and particulars of these might be obtained. The market is certainly worth cultivation, and the visit of the Greek commercial delegates should assist British manufacturers in getting a firmer footing.

Swedish Electrochemical Industry.—Prof. W. Palmaers gives the following particulars of the work now being done at Trolhättan:—

In 1910 a 2,000 kw. experimental furnace was installed for the electric production of pig iron. The plant was bought by A.-B. Trollhattans Elektriska Masugn, which has now started another furnace of 3,200 kw. The production amounts to about 4 tons of pig iron per kilowatt per year, and the consumption of charcoal is 0·35 per ton of iron against 0·9 ton in an ordinary furnace. For steel manufacture A.-B. Stridsberg & Biorck use two Rennerfelt furnaces at Trollhattan. The production of ferro-alloys has increased immensely during the war. In Sweden in 1917 45,000 kw. were used to produce ferro-alloys, about 1·2 tons ferro-silicon of 50 per cent. being obtained per kilowatt per year. Wargöns Aktiebolag employ 14,500 kw. from Trollhattan in the production of ferro-silicon, silicious ferro-manganese and ferro-manganese. A.-B. Ferrolegeringar use 8,000 to 10,000 kw. in the manufacture of ferro-chrome, ferro-manganese and ferro-molybdenum. At E. Olausson's Smelting Works (at Trollhattan) 1,000 kw. are used to produce ferro-silicon. In 1916 the A. Karlson Metall och Maskinaktiebolag commenced the production of ferro-silicon, ferro-manganese and cast pig iron with 2,300 kw. A.-B. Mangane Silicium are building plant of 1,000 kw. for the production of silico-manganese from Dasland rhodonite. For the electrolytic refini g of zinc and lead A.-B. Electrokoppar takes from Trollhattan about 500 kw., partly for its works at Partille for electrolytic copper refining, and V. Dan Bergmans Works 160 kw. for producing magnesium. In 1916 Stockholms Superfosfatfabriks A.-B. started the electrolytic production of perchlorate of ammonium. Elektrolytiska A.-B. Trollhattan take 1,000 kw. to produce chlorate of potassium at Stallbacka, and a large carbide factory taking 5,000 kw. is run at the same place by Stockholms Superfosfatfabriks A.-B. Important experiments have been undertaken at Trollhattan in the production of manures and nitric acid. A.-B. Electrosalpeter has recently contracted for a 12,000 kw. plant for producing highly concentrated nitric acid for the manufacture of explosives according to the Birkeland-Eyde method. A.-B. Difosfat has a 130 kw. experimental plant where diphosphate is manufactured from slag containing apatite. Another factory to use 2,000 kw. for the production of alkali cyanides from ores containing potassium is being built at Stallbacka by A.-B. Trollhatte Cyanid Verk. A.-B. för Kemisk och Elektrokemisk Produktion in 1916 started a factory for the production of phosphorus. For the electro-chemical industry at Trollhattan since 1910 16 factories have been built and four are under construction. The electrical energy continually in use during 1917 was 57,000 kw. About three-quarters of the power from Trollhättan is used for electro-chemical production. By the end of 1918 the power station at Trollhättan is calculated to yield 105,000 kw. and after regulating the waterflow from Lake Vanern this is expected to be raised to 270,000 kw. In 1917 there were 75 works (against 36 in 1916) using 126,000 kw. (78,000 kw.)

Miscellaneous.

A British Manufacturers Corporation.—At a meeting of representatives of manufacturing interests at Manchester on Tuesday it was decided to form a British manufacturers corporation to secure a large extension of British export trade after the war and to organise well-equipped agencies in foreign countries.

Three hundred firms have given their adhesion to the scheme, and it is believed that fully 1,000 can be counted upon to join the association when established. The annual subscription of members would be £200. Each agency will be under the control of an agent in charge, who will have the assistance of technical advisers and an adequate staff. The proposals were outlined to the meeting by Sir Charles Mandleberg and unanimously approved.

Engineers' Club.—A special general meeting of members will be held on the 15th prox. at 4.30 p.m. to consider and pass, if approved, the new draft rules of the club submitted by the Committee.

These rules can be inspected in the smoke room of the club, Albert-square, Manchester, and members can obtain copies on application to the hon. secretary. Notices of amendment to the proposed rules must be given in writing to the hon. secretary (Mr. H. Richardson) before 4.30 p.m. on Oct. 8.

Greek Commercial Delegates' Tour.—The tour of Greek commercial delegates, which has been organised by the Federation of British Industries, commenced on Sunday last.

The party, who are staying at the Ritz Hotel, were entertained to dinner on Monday by the Government. Earlier in the day a visit was made to the Osram Robertson Lamp Works at Hammersmith, and the visitors were afterwards entertained to luncheon by Mr. Hugo Hirst. On Tuesday luncheon at the Mansion House was followed by the Federation dinner in the evening. The president of the Feder. tion (Sir Richard Vassar-Smith) was in the chair, and among those present were Sir Vincent Caillard, Sir Robert Hadfield, Sir Wilfred Stokes, Sir Algernon Firth and Sir T. O. Callender. In welcoming the guests the President said Great Britain might pride herself upon the fact that, in extending her trade with a foreign country she had never been guilty of ulterior motives, and had never wished to impose her domination upon any other country. He believed that the guests knew that in Great Britain they would obtain co-operation on absolutely equal terms. They looked forward to a time, after the conclusion of peace, when the merchandise of Great Britain would flow freely again to the overseas markets.

On Wednesday the works of Callender's Cable & Construction Co. (Ltd.), at Erith, were visited.

Yesterday (Thursday) the delegates proceeded to Birmingham, where they will remain until Sept. 23, and Sept. 24 and 25 will be spent at Nottingham and Lincoln. After a brief stay at Derby on September 26 the delegates will go to Liverpool, where the works of the United Alkali Co. (Widnes) and Lever Bros. (Port Sunlight) will be visited on Sept. 27 and 28. On Sept. 30 and Oct. 1 a visit will be paid to Manchester (British Westinghouse Works, Crossley Motors and Ashton Bros. & Co.). On Oct. 2 and 3 several Sheffield steel and engineering works will be inspected, after which Bradford (Oct. 4), Harrogate (Oct. 5 and 6) and Leeds (Oct. 7 and 8) will be visited. On Oct. 9, 10 and 11 the delegates go to Glasgow (N. British Locomotive Works Co., Carron Co., Beardmores, Stewarts & Lloyds, Ltd.). After a visit to the Grand Fleet, Edinburgh will be reached on Oct. 14, while on Oct. 15 and 16 Newcastle and Middlesbrough (Armstrong Whitworths, Hawthorn Leslie's, Cargo Fleet Iron Co., Cochrane & Co., Dorman, Long & Co.) will be covered. On Oct. 18 and 19 S. Wales and Swansea will be visited, and the provincial tour will be concluded by visits on Oct. 20, 21 and 22 to Bristol and Bath. On Oct. 23 the delegates will return to London, where a Federation luncheon will be served, and the Association of Great Britain and Greece (Industry and Economics) will be formed.

The Federation officials attached to the tour are Sir Chas. Dundas of Dundas, Mr. E. L. Hill, M.I.Mech.E., M.I.E.E., and Mr. H. W. Babington-Browne.

The following are the names of the delegates: H. E. Mons. Michalocopoulos, Minister of Agriculture; M. A. Skintzopoulos, Industrial Inspector of the Greek Ministry of National Economy; M. B. Zamanos, Member of Parliament and founder of the Vodena Cement Works; M. L. Oeconomides, chemical manufacturer; M. J. Damala, finance and banking; M. A. Taitis, cotton spinner; M. C. Malikopoulos, importer of textiles; M. E. Caralopoulos, iron, steel, machinery and development schemes; and M. M. Kazazes, importer of agricultural machinery.

Household Coal Control.—An order by the Board of Trade empowers local fuel overseers to commandeer trucks of coal that may arrive at stations consigned to private consumers and to use the coal in the public interest.

King's Fund for the Disabled.—Good progress is being made with this fund for disabled officers and men, to which the King contributed the magnificent sum of £78,000.

The fund was recently inaugurated to assist disabled officers and men of the Navy, Army and Air Force to become useful members of the community again.

The trustees of the fund, of whom Mr. John Hodge, Minister of Pensions, is chairman, appeal to our readers for subscriptions which will help to find a new place in civil life for officers and men of His Majesty's Forces disabled in the war, and for the widows and children of officers and men who have given their lives for us.

Outside the State pension scale there is a great human field which the

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King's Fund can cover. At present the trustees are receiving 600 applications a week; 2,500 cases have been dealt with. Where the officer or man has been trained by the Ministry of Pensions, or where there is a business given up for war service, which he can restart, an adequate grant can be made. It is hoped to raise a sum of £3,000,000. Apart from some munificent private donations, the Lord Mayors, Provosts, Mayors and chairman of Councils have taken the matter up, and are raising subscriptions to enable discharged men to start such businesses as they are most capable to conduct.

The expenses of administration do not come out of the contributions.

Relations of Employers and Employed.—In these days of strikes, which suggest a lack of co-operation between employer and employee, it is of interest to receive a copy of a resolution passed by the staff and workmen of Brittain's Electric Motor Co. on the occasion of their recent annual outing:—

The staff and employees tender to Mr. Brittain their best thanks for his generous donation, for the good wishes he expressed in his letter for the outing we had to-day, and also wish him a very prosperous coming business year, and assure him of our very hearty co-operation at the works to make it so.

We should like to hear of more of this kind of thing, but doubtless we shall do when the Whitley Report becomes better known and its spirit is acted up to by both parties.

Educational.

King's College (London).—In the faculty of engineering there are complete courses of study, extending over three or four years, in civil, mechanical and electrical engineering, for the engineering degrees of the University of London and for the diploma and certificate of the College. The four years' course also provides opportunities for practical training in works, and there are five well equipped laboratories for practical work and research. The next term begins on Oct. 2. Particulars may be obtained from the Dean of the Faculty, or the secretary, King's College, Strand, London, W.C. 2.

Manchester College of Technology.—The prospectus of the courses for the 1918-19 session is now available.

The head of the electrical engineering department is Prof. Miles Walker, M.A., B.Sc., M.I.E.E., and the mechanical engineering department is under the charge of Prof. G. Gerald Stoney, M.A.I., M.Inst.C.E., while each is assisted by a large staff of lecturers and instructors, and there are well-equipped laboratores for practical work. The course of study for a degree (B.Sc.Tech.) or a certificate of proficiency extends over three years. A new degree of doctor of philosophy has been instituted in order to encourage advanced study and research.

Royal Technical College, Glasgow.—The session 1918-19 begins on Sept. 24.

The diploma of the college is granted in the departments of civil, mechanical and electrical engineering, mining, naval architecture, chemistry, metallurgy, building, &c. The college is affiliated to the University of Glasgow, and degrees of the university in engineering and applied chemistry are open to its students. A full course of instruction in wireless telegraphy is also provided. Prospectuses (free) from Director.

Battersea Polytechnic.—The courses at this polytechnic prepare for the B.Sc. (Eng.) of the University of London and for the Polytechnic Diploma.

The day courses commence on Sept. 24 and the evening courses on Sept. 30. The latter cover c.c. and a.c. engineering, electrical design, electric traction generation, distribution, &c. Calendars may be obtained from the secretary, Battersea Polytechnic, London, S.W. 11.

Tenders Invited.

Electric Fittings, &c.

Tenders are required by Sept. 28 for the supply of electric fittings, &c., for the Midlothian and Peebles District Asylum, ROSSLYNLEE. Forms of tender from the Clerk, 19, Heriot-row, Edinburgh.

SOUTH SHIELDS Guardians require tenders by 10 a.m. Sept. 23 for six months' supply of electrical fittings, &c. Forms of tender from the Clerk.

KENSINGTON (London) Guardians require tenders by 26th inst. for six months' supply of electric fittings, lamps, &c. Forms of tender from the Clerk, Marloes-road, London, W. 8.

MANCHESTER Guardians require tenders by noon Sept. 23 for one, three or six months' supply of electric lamps, &c. Forms of tender from the Clerk, Union Offices, All Saints, Manchester.

Electrical Stores.

STOCKTON-ON-TEES Corporation require tenders by 20th inst. for materials and stores for the electricity department. Forms of tender from the Electrical Engineer.

Telegraph and Telephone Apparatus, &c.

The UNION OF SOUTH AFRICA Post and Telegraph Department requires tenders by 3 p.m. Oct. 23 for supply of copper wire, telephone apparatus (bells, blocks, boxes, coils, protectors, switchboards, &c.). Forms of tender from the Controller, Post Office Stores Room, 62, Palace of Justice, Pretoria.

Appointments Vacant and Filled.

A second technical assistant is required for the Newport (Mon.) Electricity & Tramways Department. Commencing salary £250 per annum. Applications to the borough electrical and tramways engineer, Mr. A. Nichols Moore, by Sept. 23.

The National Boiler & General Insurance Co. (Ltd.), St. Mary's Parsonage, Manchester, require additional electrical inspectors. Applications to chief engineer, Mr. Edward G. Hiller. *See advertisement.*

A temporary assistant lecturer and demonstrator in physics is required for the University College of South Wales and Monmouthshire. Salary £100 for the two terms, with certain fees. Applications to the Registrar by Sept. 30. *See an advertisement.*

Applications are invited for the post of general manager of the Bradford tramways. Salary £800 per annum. Applications to Town Clerk by Sept. 24.

A principal and secretary is required for the Newry Municipal Technical School. Commencing salary £275, plus bonus. Applications to the Chairman, Technical Instruction Committee, Courtney Hill House, Newry, by Sept. 23.

A lecturer in industrial administration is required for the Manchester Municipal College of Technology. Salary £600 a year for five years. Conditions, &c., from the Registrar and applications must be in by Sept. 22.

Mr. H. E. Mortimer, of Croydon, has been appointed assistant mains engineer to Marylebone (London) electricity department.

Business Items.

Mr. Leslie Miller has removed to larger manufacturing premises at 70, Sanderstead-road, South Croydon. Telephone: Croydon 2117.

As announced recently, the Stanton Ironworks Co. (Ltd.) has absorbed the Holwell Iron Co.

This absorption will result in Mr. J. N. Derbyshire and Mr. F. Carbutt (directors of the Holwell Company) joining the Stanton board, Mr. T. Sarson, general manager of the Holwell Company, will become general assistant to the Managing Director of the Stanton Company with a seat on the Board as assistant managing director, and Mr. F. Chambers, foundry general manager of the Stanton Company, will also join the Board in charge of the foundries of the two businesses. Mr. C. R. Crompton is chairman, and Mr. E. J. Fox managing director of the Stanton Company, whilst Mr. E. Carter will be secretary.

Plant for Sale.—Tynmouth Corporation advertises for sale a booster-balancer. Offers to the borough electrical engineer, Mr. C. Turnbull, Electricity Works, Tynmouth.

Incandescent Electric Lamps.—We have received from the British Thomson-Houston Co. a new edition of their very excellent little handbook on standard incandescent electric lamps.

This is called Handbook No. 1A, and is a revised and fuller edition of their first lamp handbook No. 1. The universal appreciation of and the widespread demand for the first lamp handbook issued has caused the company to issue this second edition, giving the latest revised Association sales rules, terms and conditions. Opportunity has been taken to make the new edition more complete in respect to the definitions and terms used in the electric lamp trade and lighting industry. We note also an interesting and informing article on the "Lumen," the new unit of light rating for electric lamps, and its method of application in solving illumination problems. This article is written in popular style and is clear and convincing as to the merits of the lumen as an all-round unit of light rating.

There is also a very complete list of photometric units, standards and definitions, setting forth the new units of illuminating engineering, and clearly defining and describing each. These new units of illuminating engineering should be familiar to all electrical engineers and contractors, as they are sure to become definite units of the lighting industry. The handbook is issued for the use of the electrical trade and electrical engineers, and copies can be obtained from the Lamp and Wiring Supplies Department, Mazda House, 77, Upper Thames-street, London, E.C.4.

Fuel Registers.—Messrs. Ben Johnson & Co. (Ltd.), Micklegate, York, have sent us a specimen copy of their Consumer's Fuel Register, which they have just published.

The register will enable a complete record of the gas, electricity, coal or other fuel consumed to be recorded week by week in each quarter. The Register, which is printed on stout paper, and can be hung on the wall, is also being issued to gas and electricity companies, and should prove useful in enabling a complete and correct register of fuel to be kept.

Liquidations.

The liquidator (Mr. H. de Vaux Brougham), of Steel's Electric & Engineering Co. (Ltd.), 206, East India Dock-road, Poplar, London, E., has been released.

Claims against the British Telegraph Instrument Co. (Ltd.) are to be sent to the liquidator, Mr. J. H. Webb, 177, Clapham-road, London, S.W. 9, by Oct. 7.

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Municipal Accounts.

Aberdeen.—The accounts of the electricity department for the year to July 31 show net surplus £10,580.

Revenue was £103,316 (compared with £76,994 in previous year); working and special expenses were £58,502, including generation £40,145 (compared with £31,017), distribution £1,314 (£709) and management £2,501 (£2,432). Coal cost £7,337 more than in previous year. Sinking fund required £19,624 and interest £13,839. Units generated were 20,276,880 (an increase of over 3,000,000) and sold or used 19,777,320. £10,022 has been placed to reserve. Capital expenditure is £525,614.

Coventry.—The gross capital outlay on the tramways at March 31 was £241,337 (£239,745), of which £23,220 has been repaid. The total amount of the sinking fund is £33,033.

Last year's revenue was £71,802 (£61,447), working expenses were £46,717 (£38,980), interest required £9,706 (£8,636) and sinking fund £6,138 (£5,988), net profit being £8,010 (£7,279). Average total revenue per car-mile was 17·222d. (14·239d.), and working expenses, including power, were 11·205d. (9·033d.) Passengers carried were 15,437,378 (13,766,182) and car miles run 1,000,621 (1,035,683).

Greenock.—The accounts of the electricity department were recently submitted to the Council.

Total capital expenditure was £ 63,418, of which £111,319 has been repaid, while the reserve amounts to £46,497. Revenue for the past year was £117,588 (compared with £96,843 in previous year) and after providing for working expenses, capital charges, &c., the net credit balance is £7,561. Units generated were 29,386,791 (against 25,576,509) and sold 24,678,149 (21,149,458). Total maximum demand was 9,351 (7,783) kw.

Salford.—The net profit of the electricity undertaking for the past year was £13,309 (compared with £21,353 in previous year).

Revenue was £173,999 (against £156,955), and gross profit £67,698 £70,924). A sum of £8,500 has been devoted to relief of rates.

Sheffield.—The electric supply department's accounts for the year ended March 25 show that the gross capital outlay is £2,416,685 (increase £316,413), of which £703,942 has been repaid or in sinking fund.

Revenue was £639,667 (compared with £450,087 in previous year), and working expenses were £372,490 (£244,371). Interest required £63,780 (£55,266) and repayment of principal £70,329 (£61,519), leaving net profit £133,066 (£88,930). The renewals and special expenditure or reserve and depreciation fund amounts to £338,644. Costs per unit sold were 0·51d. (0·46d.) exclusive, and 0·70d. (0·68d.) inclusive of capital charges. Units generated were 199,522,937 (144,250,535) and sold 172,451,007 (126,476,858). Maximum demand was 57,338 k.v.a. (46,493 k.v.a.). The capacity of the plant is 68,225 kw. (59,725 kw.). Motors connected aggregate 97,841 H.P. (79,551 H.P.).: the total number of consumers is 7,722, an increase of 166, and total connections are equal to 133,149 kw. (113,873 kw.), and there are applications in hand for 26,855 kw.

The report of the Electric Supply Committee states that considerable progress has been made with the emergency power station. The department was responsible for the installation of 6,356 H.P. of motors out of a total of 18,291 H.P. connected during the year.

City Notes.

ANGLIAN ENGINEERING CO. (LTD.)—The annual general meeting was held at Stowmarket on Sept. 7, Mr. L. Tibbenham presiding. It was unanimously resolved, after allowing for depreciation, reserve for bad debts, and directors' fees, to pay a dividend of 6 per cent. to all shareholders. A vote of thanks was passed to the chairman for the successful working of the company, this being the first dividend paid since its formation in 1898.

BRITISH ALUMINIUM CO. (LTD.)—The directors recommend a dividend at rate of 8 per cent. per annum (less tax) on the ordinary and at rate of 6 per cent. per annum (less tax) on the preference share capital for the six months to June 30.

BRITISH INSULATED & HELSBY CABLES (LTD.)—An interim dividend of 3¾ per cent. (9d. per share), less tax, has been declared on the ordinary shares.

BROMLEY (KENT) ELECTRIC LIGHT & POWER CO. (LTD.)—An interim dividend at rate of 4 per cent. per annum (2s. per share), less tax, has been declared on the ordinary shares for the past half-year.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The directors have declared a second quarterly interim dividend of 3s. per share, payable (tax free) on the 15th prox. in respect of the profits for the year ending Dec. 31, 1918. The share register will be closed from Oct. 7 to 14 inclusive.

FALK, STADELMANN & CO. (LTD.)—The last annual return (to Oct. 23, 1917) shows that 88,560 ordinary, 66,200 B and 238,180 preference shares had been issued out of the nominal capital of £410,600 in 90,000 ordinary, 68,000 B and 252,000 preference shares of £1 each. £239,610 had been paid in cash on 47,810 ordinary, 10,200 B and 181,600 preference, and £153,330 was credited as paid on the remainder. There were no debentures. In the list of shareholders the company appeared as holder of 28,080 ordinary and 50,367 preference of its own shares, all but 1,000 preference of these being shares formerly held by Bernhard Thurnauer, of Nurnberg, and the other 1,000 preference being those formerly held by Mrs. Pauline Israel, of Hochberg. All these shares were vested in the Public Trustee and transferred to the company. At the date of the return the directors were Max Falk (now a British subject, formerly of Wurtemberg), Louis Thurnauer (a British subject of Bavarian origin), Victor Falk (now a British subject, formerly of Wurtemberg), and A. R. McClelland and I. F. Blackburn (both British by birth). A. R. McClelland is the manager and I. F. Blackburn is the secretary. Early in 1917 the company adopted amendments to its articles of association, in the usual form approved by the Board of Trade, for excluding foreign control.

MACKAY COMPANIES.—A dividend of 1½ per cent. ($1½ per share), less tax, has been declated on the common stock for the quarter, payable Oct. 1.

MADRAS ELECTRIC TRAMWAYS (1904) (LTD.)—In respect of profits for year to Dec. 31, 1918, interim dividends of 6 per cent. per annum on the preference and 8 per cent. per annum on the ordinary shares have been declared.

REES ROTURBO MFG. CO. (LTD.)—Subject to final audit, the available balance at Sept. 30, 1917, is £66,730. After adding £18,000 to depreciation reserve and placing £25,000 to general reserve, it is proposed to pay dividends on the preference shares for the two years and two months to Dec. 31, 1911, at 5 per cent., absorbing £6,587, and to carry forward £17,143. The directors deny the rumour that they are negotiating for the sale of the business or works at Wolverhampton.

RICHARDSONS, WESTGARTH & CO. (LTD.)—At the meeting last week the motion to adopt the report and balance-sheet was rejected. Mr. S. T. Coulson argued that the balance-sheet justified his attitude, and several shareholders protested against so large a sum as £168,000 being placed to depreciation.

SHAWINIGAN WATER & POWER CO. (LTD.)—A quarterly dividend of 1¾ per cent. per annum has been declared for the quarter ended September.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—The directors have declared an interim dividend on the ordinary shares of 5 per cent., free of tax up to 5s. in the pound.

VICKERS (LTD.)—Mr. Albert Vickers, who has been associated with the company for 64 years, has resigned his position as chairman of the board, and Mr. Douglas Vickers has been elected to succeed him. Mr. Albert Vickers will remain associated with the company in a consultative capacity.

WESTERN UNION TELEGRAPH CO. (LTD.)—A quarterly dividend of 1¾ per cent. has been declared.

The Round Table.

By "kVA."

EVENT OF THE WEEK.—The profits of the National Kitchens (which have badly got up the noses of the unpatriotic restaurateurs)!

* * * *

Thus a writer in the "Financial Times":—

"The major part of Great Britain's coast possesses cliffs. By constructing a reservoir on the crest of every cliff above 100 ft. fed by a "main" from the sea, and erecting a number of small windmills to pump the sea-water into the reservoir it can be kept full, giving a steady 90-ft. pressure to a turbine driven dynamo. Our coast is famous for its air currents, let us use them and save millions of pounds annually at a comparatively small initial outlay and upkeep. Here is a chance for capital to help England and make profit."

Or, as they would say at the front, "That's the stuff to gie 'em!"

* * * *

Replying to a correspondent, I think I may safely say that though the Igranic coil winding machines produce pancake coils they can be used on other days than Shrove Tuesday!

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, September 17, 1881.]

THOUGHTFULNESS.—It is reported that the steamer "Faraday," now laying the mid section of the new Atlantic cable, having had several articles of gear washed overboard, the captain telegraphed home via the cable that no uneasiness need be felt if such articles were picked up.

THE TRANSMISSION OF POWER.—A prize of 1,000 marks (equal to about £50) is offered by the Electrotechnischer Verein, of Berlin, for the best essay on the transmission of power by electrical and mechanical means. Essays must be sent in before the 1st October, 1882. Further particulars as to the conditions of the competition, &c., can be obtained from Herr Julius Springer, Electrotechnischer Verein, Berlin.

ELECTRICITY AND COAL.—Speaking at a banquet given to some members of the British Association at Whitby the other day, Sir George Elliot, Bart., M.P., referred to the probable exhaustion of our coal supply, and to electricity as the probable motive power of the future. He thought, also, that we might look forward to applying the fore of water as a substitute for coal, in combination with electricity, compressed air and hydraulic appliances.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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CONTENTS.

Notes 447
Arrangements for the Week 449
Temperature Indicator for Transformer Winding. By V. M. Montsinger and A. T. Childs. Illustrated 450
Experimental Examination of the Arc in Gases Under Pressure. By W. Mathiesen. Illustrated 451
Electric Winding Engines and Mine Hoists. By H. H. Broughton. Illustrated.—*Continued* 453
Whitley Committee's Final Report 455
South African Industrial Progress 455
New Works of Benjamin Electric, Ltd. Illustrated 456
The Labour Outlook. By Our Labour Correspondent 457
Electric Power in British East Africa 458
The Calculation of Single-Phase and Three-Phase Lines. By J. R. Dick, B.Sc., M.I.E.E. Illustrated.—*Concluded* 459
Correspondence 461
Reconstruction in France and Belgium 461
A Watertight Lantern. Illustrated 461
Patent Record 462
Volunteer Notices 462
Commercial Topics 462
Electricity Supply 463
Educational 466

Notes.

The Ethics and Psychology of Strikes.

Our readers will remember that a Committee was appointed recently under the chairmanship of Mr. Justice McCardie to inquire into the causes of the Coventry strike, which was primarily caused by the embargo on skilled labour. It appears from the evidence that the embargo scheme was necessary in the national interest, and we do not think there was ever a reasonable doubt on this point. There were, however, two things which were wrong. The first mistake was the christening of the regulation with an absurdly imposing name; and the second was the putting into force of the regulation before it was properly explained. To the detached reader these will seem to be trivial causes. The name is not such that should arouse very great misgivings, though it savours of the pompous language occasionally used by State officials. The object could have been described in simple language. But seeing that such trivial causes give rise to a strike it becomes clear that the men engaged on munitions are in a state of nervous tension. Whether this is due to overwork or to the natural tendency to lose a balanced view in time of war, we do not know. Considering that the movement in favour of restriction of hours has been very marked since the abolition of Sunday work, and the holding of inquiries into industrial unrest, it seems that overwork should not be the cause. Whatever the reason, it appears to us that the Government would do well to inquire a little further. There is, however, a paragraph in the Report which gives some clue as to the origin of disputes of this kind. The Committee state :—

> Although the majority of those who stopped work are in every way anxious to maintain the output of munitions there is evidence that a small section of the community, not confined to the ranks of labour, is hostile to the constitution and the procedure of trade union organisation in this country and desires to take advantage of the causes of irritation to bring about, if possible, a stoppage of work for other reasons than the redress of immediate grievances.

This conclusion displays a lack of responsibility in the rank and file which is very regrettable. It has been noticeable on several occasions, as, for example, during the strike at Barrow. There is a lack of independent thought and action on the part of the responsible men, as distinct from a minority of the rank and file who are irresponsible.

The Railway Strike.

Another illustration of this attitude has unfortunately arisen during the present week. The railwaymen appealed for a further rise of 10s. per week and have been granted a rise of 5s. It appears that their total rise in wages during the war has amounted to 120 per cent., whereas the cost of living has risen to the extent of 110 per cent. The present award carries with it machinery for automatically raising the wages if the cost of living rises still more. The award has been accepted by the responsible officials and also accepted by the rank and file, though in many cases under protest, except for 10 men at some small centre in South Wales. Yet the action of those 10 men has been sufficient to lead to a strike which may have very serious results. We fear the idea is gaining ground that those in indispensable services can demand any wages they like, and at the same time there is the erroneous view that the cost of food can be reduced by a stroke of the pen. One of the great objects of trade unions is to render collective bargaining possible. Such bargaining, however, is rendered quite impossible if the awards given in arbitration are to be binding only on the employers and may be thrown over at once by the employed. There would be a great popular outcry (and quite rightly) if an award at any time were refused by the employers and followed by a lock-out. We have every sympathy with the legitimate claims of labour, but it must be remembered that labour is only one part of the public, and the demands on the part of labour cannot be carried through successfully if public sympathy is lost by the demands being of an unreasonable nature. Excessive prices obtained through the critical needs of the nation are profiteering, be they by capitalists or by labour; and in so far as they are permitted the general public (and notably the workers) will be the poorer when the days of peace return and we have to face normal, instead of highly artificial, conditions once more. As we go to press we learn that the strike is collapsing, owing to the strong action of the Government. We are relieved that such action has been taken, for any other course would have meant nothing less than mob rule.

A Reader's Complaint.

In these days of paper shortage and restrictions on space it is more than usually difficult to cater for all readers of The Electrician. Probably the tastes of our readers are more varied than those of any other journal. Some are interested in heavy engineering, others in lighter branches and some in questions of measurement; then, again, there is the commercial side, of no less importance, and when all these aspects are suitably treated there is still pure science, which must not be neglected, and even abstruse speculation. There is the standing difficulty that some readers are rather specialised in their views and are, therefore, only interested in one particular line, and to these it may seem that space in any other direction is not usefully employed. There may be some

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readers, for example, who feel that the space we have devoted to Mr. A. C. CREHORE'S Paper on "Some Applications of Electromagnetic Theory to Matter" has not been well utilised. In this connection we have been interested to receive a letter from Mr. J. SAYERS, which appears in our Correspondence columns. This letter is not only a testimonial to the value of the Paper, but even takes us to task for not dealing with it more liberally. The point of view of Mr. SAYERS is that practical electrical engineers do not get time in which to study such subjects and consequently it is important that they should at times have an opportunity of reading a comprehensive article summing up and explaining the position of an abstruse subject. Mr. SAYERS goes so far as to say that he would have liked other articles to have been altogether omitted from THE ELECTRICIAN so as to permit of Mr. CREHORE'S Paper being published in one complete instalment, thus allowing it to be read with the greatest ease. We are glad to find that our own judgment on such matters is to a large extent supported by an engineer of Mr. SAYERS' practical experience. It is very seldom in these days that we are able to give an article of any great length without abbreviation. The fact that we gave Mr. CREHORE'S Paper practically in full is evidence that we considered it to be of more than usual value. On the other hand, we cannot lose sight of the fact that there are readers of all kinds for whom we have to cater, and it is for this reason that we found it necessary to give this Paper in several instalments. We fully agree that it is highly desirable to keep in as close touch as our leisure will permit with advances in theoretical physics, more particularly when they are of a fundamental character. The structure of the molecule may, for the moment, seem to be of small consequence to some of us. The fact remains, however, that the better our knowledge of molecular structure the more likely it is that we shall be able to make progress in the utilisation of matter along new lines. He would be a rash man who would say in these days that the speculations of the pure scientist would lead to nothing of commercial value. The subject of radio-activity is a case in point, and shows the desirability of occasionally putting on one side the life's task so that some idea can be gained of the broad landscape, and even of the distant horizon, around us. We must do what we can to follow these developments, and, as far as THE ELECTRICIAN is concerned, they will be presented from time to time. For the moment we live in an age of compromise, which renders good service difficult, but we look forward to the day when there will once again be greater freedom.

The Efficient Use of Fuel in the Future.

WHILE so much attention is being given to what may be termed improvised fuel-economies in order to meet the present emergency, it is of interest to turn to the much wider problem of more efficient utilisation of fuel resources in the future. Most of the measures that can be suggested under this head are too far-reaching to be considered at present, but some data given by Mr. E. W. RICE in one of a series of articles on the subject in the "General Electric Review" (U.S.A.) give a very vivid idea of the waste that has taken place in the past, and is, indeed, still proceeding. Among other facts, he points out that frequently 40 per cent. or more of the coal in a mine can never reach the market. Present procedure often results in the flooding or caving in of mines from which only the better grades of coal have been taken. Thus, in the United States, the wastage for the year 1917 might be assessed at 300,000,000 tons. Similarly the Bureau of Mines estimates the continuous waste of petroleum through leaky tanks and other opportunities for evaporation, at 10 per cent. of the total production and 60 per cent. of the estimated war needs. In the case of natural gas the waste in the past has been almost beyond computation. Vast quantities have been lost through the indifference of those searching primarily for petroleum, and ignoring the gas from the wells, and through inability to cope with the high pressures when reservoirs were tapped. Even these losses, however, are small compared with the appalling loss from burning wells. Hundreds of millions of cubic feet have thus been destroyed daily. As late as 1913 in the Oklahoma field alone the yearly waste amounted to 100,000,000,000 cubic ft. Finally, the wastefulness of the present methods of using forest products is a by-word. In lumbering operations it is estimated that one-quarter of the timber cut, and at the mills at least another quarter of the original forest output, is sacrificed; by the time the finished product is available fully 60 per cent. of the original growth has been ruined for commercial use. These facts afford convincing evidence of the improvident way in which natural resources are being utilised. One of the lessons of the war, and the period of scarcity which may be expected to succeed it, will surely be the application of science to this field, and the development of more efficient methods.

National Association of Supervising Electricians.—Mr. J. S. Highfield will deliver his presidential Address on October 1.

National Union of Scientific Workers.—The first general meeting of the Union, which will determine its constitution and place it on a permanent basis, will be held in London in the last week of October. The secretary of the Union is Mr. Norman Campbell, North Lodge, Queen's-road, Teddington.

Electric Welding for Shipbuilding.—The secretary of "Lloyd's Register of Shipping" states that with regard to the use of electric welding for ship construction, the Committee of Lloyd's Register, who have already approved of one system of electric welding, are prepared to consider applications from any electric welding companies to have their processes recognised by the Society, and to have their names inserted in a list of companies whose processes have been approved, as fulfilling the Society's conditions.

London School of Economics.—On Monday, Oct. 28, at 8 p.m., Dr. A. D. Denning will begin a course of three lectures on "Scientific Factory Management." A course of five public lectures is also to be given on Wednesdays, Oct. 9, 16, 23 and 30 and Nov. 6, on "Cost Accounts and Efficiency Methods." The first will be given by Mr. M. Webster Jenkinson on "Costing as Applied to National Factories," and the last lecture will be given by Mr. A. G. Seaman, managing director of the British Westinghouse Co.

The Electric Lamp Industry in France.—In a recent communication to the "Bulletin" of the Société Internationale des Electriciens, Mr. A. Larnaude remarks that the present capacity of French glow-lamp factories amounts to 15-20 millions of lamps per annum, but this figure might be doubled in the near future. The tonnage required for the transport of materials needed in this industry is small, and one ton of the ore will provide sufficient material for 3,000,000 lamps. An important element in the manufacture of gas-filled lamps has been the production of argon required for the smaller types. This gas is now being made in considerable quantity by the process of Mr. Claude.

Electric Welding of Cast Iron.—Under the present heavy demands upon the locomotive equipment of American railways, it is remarked in the "Engineer," great saving of time and cost are effected in repair work by using electric arc welding to repair cracks and fractures in large castings which otherwise would have to be scrapped and renewed. Thus, cylinder castings which cost, say, £200, and the renewal of which might cause long delay, may now be patched by welding at a cost of £10 to £20, and the work can be done in a few days. The

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fracture is widened out to a V section by a pneumatic chisel, the steel studs are screwed into the sides, and the space is then filled up with new metal by the metal electrode process, the new metal being extended as a pad over the outside of the cylinder wall. Where pieces are broken out, a piece of wrought iron of the same thickness as the flange can be cut to fit and fill the gap, and then welded in place. In a case of fracture in the valve ports, which could not be reached from the outside, a piece was cut out of the steam chest wall by an oxy-acetylene torch to give access for electric welding. When this work had been completed a wrought iron plate was cut to fit the hole, and welded into place in the wall of the steam chest.

Coal-Saving and the Electrification of Railways in Switzerland.—Switzerland, in common with most countries, is suffering severely through the shortage of coal. It is estimated that in normal circumstances about 300,000 metric tons are consumed monthly. At present, however, only about 160,000 tons are received from Germany, and of this practically only 86,000 tons are available for general use. Some help has been obtained from the extended use of peat and wood, and the development of anthracite workings in the Valais, but a vast shortage remains. An article in the "Revue Suisse d'Exportation" therefore asks whether the time is not ripe to consider the electrification of the Swiss railways, and the substitution of hydraulic power, converted to electricity, in place of coal. At present only about half the potential water-power of the country (estimated at 2,000,000 H.P.) is used. Already electrical power is used on certain sections of railway, and it will shortly be employed in the Simplon and St. Gothard tunnels. It is calculated that if complete electrification were resorted to the aggregate saving from all sources, might be as much as 80,000 tons per month.

The "Industrial League Journal."—It is not often in these times that one has to record the appearance of a new journal (and when we do we generally find there is ground for criticism), but it will be generally agreed that the "Industrial League Journal," the first copy of which we have just received, has a special reason for its existence. The Journal, as the organ of the Industrial League, is concerned with the promotion of better relations between masters and men in industry—a need, the urgency of which is being strikingly illustrated by current events. The Journal contains an introductory article by the Rt. Hon. G. H. Roberts, M.P., Minister of Labour, and Mr. H. G. Williams discusses the possibilities of increased industrial production. The constitution and aims of the League are set forth in the editorial notes. There is also an account of a recent conference on "Workshop Committees." We notice that the Executive Committee of the League contains representatives of several influential trade unions as well as prominent manufacturers and business men, and we need hardly point out the necessity of securing adequate support from Labour for the success of a scheme of this kind. The Journal is published from the offices of the Industrial League, at 56, Victoria-street, London, whence fuller information of its aims and objects can be obtained. A strong appeal, which we gladly endorse, is made for further support, so that the work of the League may be extended.

Industrial Reconstruction Council.—Last Tuesday a conference was held by the Industrial Reconstruction Council on "Trade Boards," when the chair was taken by Dr. W. Garnett, and the subject was introduced by Mr. J. J. Mallon, secretary of the Anti-Sweating League and a member of the Whitley Committee.

Mr. MALLON remarked that the idea of Trade Boards could be traced back to a page of J. S. Mill's book on "Political Economy," in which he showed that an industry in which the workers were insufficiently paid was a source of weakness rather than of strength to a country. The Trade Boards Act was passed in 1909 to deal with cases of exceptionally low wages, as it was realised that the views expressed by Mill were correct. Two methods of fixing wages were possible. Either they could be fixed by some outside authority, or they could be fixed by the industry concerned. The latter was the better plan, as it would be very difficult to enforce a wage that was not supported by public opinion in the particular trade. In the Trade Boards Act this matter was left to negotiation, and in the opinion of the lecturer the method so adopted was good. Such boards were set up in industries which were only poorly organised, and a neutral chairman was appointed by the Government in each case. This chairman did not attempt to decide what wages should be given, but he took evidence on both sides, and thus enabled an agreement to be reached. The Trade Boards as originally set up had no power to fix hours or conditions of work. On the other hand, they sent inspectors to all factories, and this action led to improved efficiency through the suggestions the inspectors were often able to make. Further, the holding of these inquiries led to organisation, and thus rendered Industrial Councils possible. As an instance of what had been accomplished, the lecturer mentioned Cradley Heath. The original deplorable conditions were well known to the public, and it had been generally agreed that such conditions should not exist; but the difficulty was that no one employer could act alone, and there was no organisation of employers to act jointly. The effect of the Trade Board was to bring the employers together, and they so altered the rates that the net earnings per woman were increased immediately from 4s. to 10s. 6d. per week, and further increases were made subsequently. It was found that the industry did not suffer; on the other hand, the people of Cradley Heath became relatively prosperous. According to the new Act, Trade Boards have power to regulate the training of young people. They can fix rates for overtime, and they can see that the workers get a minimum income as distinct from minimum wages (that is, deductions are not made except for absence from factories). Further, the Boards can make recommendations to Government Departments.

The first of an important series of lectures arranged by the Industrial Reconstruction Council will be held in the Saddlers' Hall, Cheapside, E.C. 2, on Wednesday, Oct. 2. The chair will be taken at 4.30 by the Rt. Hon. G. N. Barnes M.P. and, an address on Commerce and Industry after the War will be given by the Rt. Hon. Sir Albert Stanley, M.P., President of the Board of Trade. Applications for tickets should be made to the Secretary, I.R.C., 2 & 4, Tudor-street, E.C. 4.

Obituary.

A. S. ESSLEMONT, C.B.E.—The death is announced of Mr. A. S. Esslemont, C.B.E., late Controller of the Optical Munitions, Glassware and Potash Production Department of the Ministry of Munitions. On the creation of the Ministry of Munitions in 1915 Mr. Esslemont offered his services as a volunteer.

ALD. G. HOWARTH.—The death is announced of Ald. Geo. Howarth who was chairman of the Manchester Electricity Committee for some years, and a member of the Committee from 1901 until 1910.

DEATH ON ACTIVE SERVICE.—We regret to learn that Flight-Cadet J. E. Denton (R.A.F.), the eldest son of Mr. E. Denton, borough electrical engineer of Pudsey, has been killed as the result of a flying accident.

Personal.

In our issue of Aug. 23 we announced that the Distinguished Flying Cross had been awarded to Capt. W. Wedgwood Benn, D.S.O.

In the official announcement issued by the Air Ministry, Capt. Benn is described as a gallant observer of exceptional ability, and in the official record of the service for which the award was made it is stated that, after setting out on a bombing raid, the scout machines assigned to act as an escort became separated, and it then became necessary for the bombing planes to proceed on their task without support. Capt. Benn's machine took the lead, followed by three other bombers, and succeeded in dropping his bombs (direct hits) on an enemy aerodrome. On the return journey the bombing machines were attacked by several enemy scouts, which were eventually driven away. Recently this officer organised and carried out a special flight by night over the enemy's lines, in most difficult circumstances, with conspicuous success. He has at all times set a splendid example of courage.

Arrangements for the Week.

FRIDAY, Sept. 27th (to-day)

MUNICIPAL TRAMWAYS ASSOCIATION.

10 a.m. At the Town Hall, Leicester. Conclusion of annual meeting.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W.1. Paper on "The Most Important Piece of Machinery in the World," by Mr. P. Marshall.

TUESDAY, Oct. 1st.

JUNIOR INSTITUTION OF ENGINEERS, NORTH-EASTERN SECTION.

7.15 p.m. At the Mining Institute, Neville-street, Newcastle. Annual General Meeting.

FRIDAY, Oct. 4th.

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers. Annual Thomas Hawksley Lecture. "The Experimental Study of the Mechanical Properties of Materials," by Dr. W. C. Unwin, F.R.S.

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Temperature Indicator for Transformer Winding.*

By V. M. MONTSINGER and A. T. CHILDS.

Until it became usual to operate transformers continuously at maximum capacity, it was not important to know the internal temperature of the windings. The observation of the maximum oil temperature was generally sufficient, because the danger point was only approached for a short interval. Until within the last two or three years apparatus transformers were operated for the greater part of the time with a 40°C. rise, although during short-time overload periods a temperature rise of either 55°C. or 60°C. was allowed, the 55 deg. rise applying to all transformers excepting those for railway work. This method of rating railway transformers is still used and recognised by the A.I.E.E.

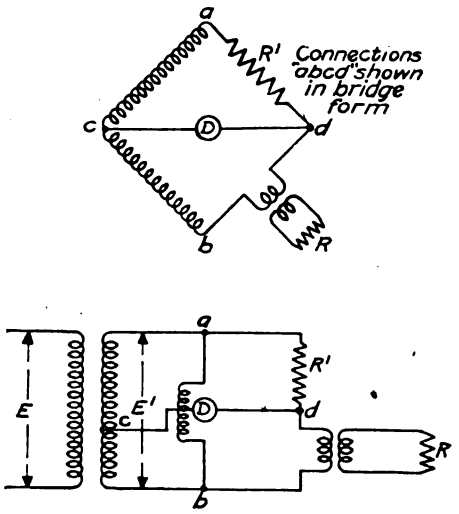

FIG. 1.—SIMPLIFIED CONNECTIONS OF ALTERNATING-CURRENT TEMPERATURE INDICATOR.

With the present method of rating transformers, namely, to operate continuously with a 55°C. rise, a few degrees variation from the allowable rise in temperature will have a marked effect on the life of the transformer. Hence, determination of the internal temperature not only protects against overheating, but may permit greater output with safety. An increase of approximately 1 per cent. in the kilovolt-amperes capacity of self-cooled transformers can usually be obtained for each degree that the ambient temperature is below 40°C., without exceeding the normal hot-spot limit. The same approximate rate of increase in capacity applies to water-cooled transformers for each degree that the temperature of the ingoing water is below 25°C. Due, however, to variations in the design charcteristics of transformers, such as the ratio of iron loss to copper loss, or the ratio of maximum to average temperature, it is unsafe to take advantage of the cooler ambient temperature unless there is a dependable means for determining the maximum temperature of the windings. On the other hand, if the temperature of the ingoing cooling water is 15°C., the amount of water can usually be reduced, without exceeding a safe hot-spot temperature, to one-half the amount that would be required if the temperature were 25°C.

The following are the most important advantages in knowing the internal temperature of a transformer during operation.

1. The insurance against damage from overheating. This should prolong the life of the transformer.

2. The ability to increase the output or capacity of the transformer.

(*a*) When the ambient temperature is below normal.

(*b*) When short-time overloads are required.

(*c*) When the difference between the hot-spot and the average temperature is negligible.

3. The possibility of conserving the cooling water for water-cooled transformers.

(*a*) When the temperature of the ingoing water is below 25°C.

(*b*) When the load is below normal.

In devising a method of observing the hot-spot temperature of transformers, it is necessary to bear in mind the difficulty of placing a thermometer, thermo-couple, or resistance unit close enough to the winding to determine the temperature of the copper without subjecting the operator to the danger of these potentials. If a resistance unit be sufficiently insulated from the transformer windings the difference in temperature between it and the windings would be too great. If the internal temperature of the transformer windings is to be accurately observed with safety, the resistance unit must be embedded in the windings and insulated from the temperature-indicating instrument. This prevents the use of direct current for energising the resistance unit. Alternating current, therefore, must be used.

One method is to place a non-inductive resistance unit between turns of the transformer windings, and to force a current through it from the secondary winding of an insulating transformer, whose primary winding is excited from any source of constant potential. The current will then change as the resistance (or temperature) of the unit changes. An ammeter in the circuit could be calibrated to read directly in degrees. The scheme, however, requires perfect voltage regulation, which may be prohibitively expensive.

Another proposed scheme is to create, outside the transformer windings, an artificial hot-spot which shall have the same temperature as the actual hot-spot. The artificial hot-spot is heated with current from the secondary winding of a current transformer whose primary winding is connected in series with the load current. The temperature of the artificial hot-spot is therefore a function of the load current, and a thermo-couple or resistance unit may be safely embedded in it.

The successful operation of the foregoing scheme necessitates that two conditions be fulfilled. First, the artificial hot-spot must be designed to be the same as that of the transformer under constant conditions ; second, the artificial hot-spot must duplicate the actual hot-spot temperature for all rapid variations in load. The first condition can be approached fairly closely, but it is practically impossible to meet the second. There are other schemes which have been proposed, but the preceding seem to be the most common.

The primary requisites for the successful operation of any temperature-indicating instrument are that the instrument must be safe, simple in operation, and must indicate continuously, correctly and permanently the maximum internal temperature of the windings. The General Electric Co. have developed a temperature indicator for transformers which meets the requirements. It is suitable for any type of winding operating at any voltage up to approximately 27,000 volts, which can no doubt be increased as more experience is gained.

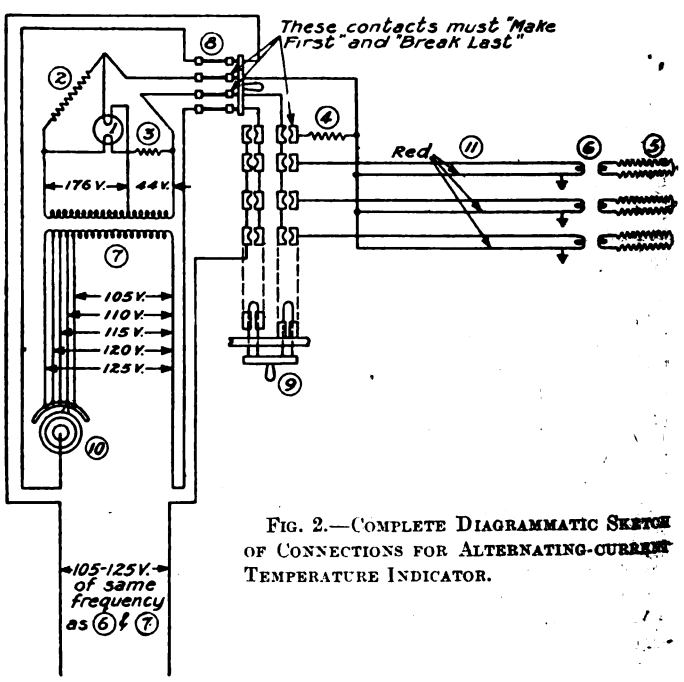

FIG. 2.—COMPLETE DIAGRAMMATIC SKETCH OF CONNECTIONS FOR ALTERNATING-CURRENT TEMPERATURE INDICATOR.

The scheme employs what is essentially a four-arm bridge. Two arms of the bridge, Fig. 1, are formed by the secondary winding of a potential transformer ; the third arm by a constant resistance, *R'* ; and the fourth arm by the primary winding of a transformer whose secondary winding is connected to a non-inductive copper resistance, *R*, which is embedded in the winding of the transformer whose temperature is to be measured.

* Abstract of an article in the " General Electric Review " (U.S.A.).

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An alternating E.M.F. *E* is applied to the primary winding of the potential transformer; and a second E.M.F., *E'*, is induced between the points *a* and *b*. Between these two points are three circuits, two of which, *acb* and *adb*, form the bridge, and the third, *ab*, is the fixed coil circuit of a separately excited dynamometer, *D*. As the temperature of the transformer changes, the resistance of the copper unit changes, thereby affecting the balance of the bridge. The dynamometer, with its movable coil connected across the points *dc*, denotes in degrees Centigrade the amount that the bridge is out of balance. It has been found necessary to add certain features for protection and convenience in switching, &c. A complete wiring diagram is shown in Fig. 2, the various parts shown in this diagram being :—

The indicating instrument 1, having its scale graduated in two-degree divisions from 20°C. to 140°C. Its external appearance is the same as other meters of this type.

Parts 2, 3 and 4 are fixed resistances located in perforated cases, mounted on the back of the switchboard. Part 4 is used simply to determine whether the meter is working properly. If the plug switch 9 is placed in the first set of receptacles, the checking resistance is substituted for the transformer 6 and its accompanying copper resistance unit 5. The resistance of 4 is of such a value as to cause an indication of 80°C. providing the indicator is working correctly.

The copper resistance unit 5 consists of two insulated copper wires wound spirally about a flat insulated copper core and joined together at one end of the unit, which makes it non-inductive. The unit is from 20 ft. to 25 ft. in length, and is placed either between the turns or the strands of the coil, depending on whether one or more than one strand per turn is used.

To prevent the resistance unit forming a floating conductor (electrically speaking) in the transformer, one point of the unit is solidly connected to the adjacent conductor of the main coil. The potential of the unit being the same as that of the adjacent conductor, it is necessary to use only a light insulation; and since it is placed between two equi-temperature conductors, it assumes the temperature of these conductors. In the original article the design of the resistance unit is described in detail.

By giving special attention to the transformer design heating constants, it should not be necessary to place a resistance unit in both the high-voltage and low-voltage windings. The high-voltage windings do not necessarily run warmer than the low-voltage windings. The designer can vary the relative temperature of the windings, and consequently can make the condition such that the temperature of the high-voltage winding will not exceed that of the low-voltage winding. One resistance unit placed in the low-voltage windings of each phase should therefore be sufficient.

Part 6 is a special transformer used for insulating the resistance unit from the indicating meter. This transformer is mounted under the oil of the main transformer. One of the leads from this insulating transformer to the panel is dead grounded inside the transformer tank, so that the operator is always protected.

Part 7 of Fig. 2 is a standard type of potential transformer used for exciting the bridge. Obviously the reading of the meter used will change with a change in the exciting voltage, except when the bridge is balanced, which occurs at the most important temperature (approximately 100°C.). As the temperature varies from 100°C., the error due to changes in voltage increases. To correct for this, the primary side of the potential transformer is provided with several five-volt taps, which, by means of the dial switch 10, permits the operator to adjust the secondary voltage to within about 2·5 per cent. of its designed value. If this adjustment is made, the errors due to a voltage change at any temperature are small; and at a temperature in the neighbourhood of the balancing point of the bridge negligible.

A four-pole single-throw switch 8 is provided for interrupting all circuits leading to the panel.

The transfer plug switch 9 is used to transfer the meter from one transformer to another. Both switches are so arranged that the excitation is disconnected before the variable arm of the bridge is broken. The panel can be provided with a number of receptacles, so that the same equipment may be used for a number of transformers.

The leads 11 from the transformer bank to the panel are twin-conductor cable and may be any length providing their resistance does not exceed approximately 1·25 ohms. It is interesting to note that the insulating transformer affords a means for multiplying the resistance of the copper unit, which allows its equivalent resistance to be made large compared with the resistance of the leads in this arm of the bridge. This permits of a considerable variation in the resistance of the leads without seriously affecting the accuracy of the meter.

Experimental Examination of the Arc in Gases under Pressure.*

By W. MATHIESEN.

The first tests were carried out in oxygen: the air contained in the pressure vessel was partially removed by a pump till it reached a pressure of 50 cm. of mercury, and oxygen was then admitted till the normal pressure was reached. The mixture of air and oxygen was then allowed to escape through a cock, while fresh oxygen flowed in. After a time the pressure vessel was considered to contain oxygen sufficiently pure for the purpose of the experiment. Oxygen was, however, further admitted during the test in order to decrease the proportion of impurities. The carbons were so placed that the positive was horizontal and the negative was at an obtuse angle to it. The one was a cored carbon of 10 mm. diameter, and the other a pure carbon. The current was 10 amperes. Fig. 1 shows that with constant electric pressure, the length of the arc decreases with increased gas pressure. The voltage across the arc was 42. At higher pressures between 50 and 60 volts the arc was very unsteady, and sometimes the arc was altogether interrupted. It seems that in consequence of the rapid burning of the carbons the gases have a considerably increased conductivity. As the gas pressure increased the steadiness of the arc decreased for pressures above 42 volts. For pressures below the normal, say at 40 cm. of mercury, it was on the other hand very steady, just as in an ordinary attenuated atmosphere. Of course, the carbons burnt away very fast. Considerable lengths of the carbons glowed, and this caused rapid changes in the shapes of the tips. The negative carbon burnt away to a sharp needle-tipped cone. At two atmospheres the carbon consumption is at least four times as great as in air. After the current was cut off the tips glowed for many minutes. The arc is not bright; there is a small blue flame at the tips, which passes into a visible flame at a higher level. This is a chemical flame and increases the conductivity. The colours of the arc in oxygen are very similar to those in air; in Fig. 1, *a* is the core of dark violet, *d* is the dark zone; *g* is the mantle of the flame, which at the beginning is green, but with increased pressure of the gas becomes a yellowish-green. The parts at *b* and *c* are bright blue. If the current and voltage are kept constant at 10 amperes and 42 volts, the illumination varies in a peculiar fashion. Starting with oxygen at atmospheric pressure, it increases at first till the pressure is increased by one atmosphere; it then falls till at two atmospheres it has its initial value; after this it increases again slowly. Seeing that the shape of the tips is very variable, the question of illumination is complicated, and not easy of explanation. A second series of tests gave, however, the same results; it was necessary to keep the electric pressure constant in order to avoid the unsteadiness which arises at higher pressures. It is peculiar too to notice how little illumination is given in oxygen; at ordinary atmospheric pressure it gives only 540 c.p., while in the air under the same electrical conditions it

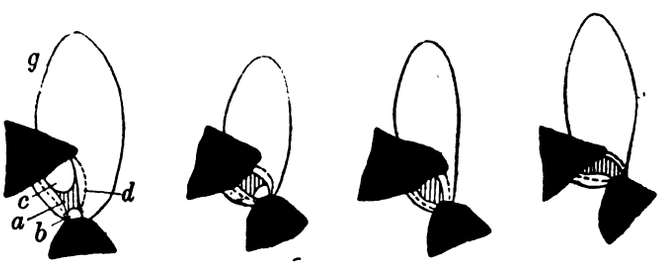

FIG. 1.—ARC IN OXYGEN AT 42 VOLTS AT DIFFERENT PRESSURES VARYING FROM ATMOSPHERIC TO 3 ATMOSPHERES ABOVE ATMOSPHERIC (from left to right).

* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 49, 1917.

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would give 1,990 c.p. It is not possible to suppose that the brightness of the positive crater in oxygen differs essentially from that in any other gas. Probably something depends on the peculiar position of the surface of the crater with regard to the photometer; the rest of the illumination will be that which is peculiar to oxygen. An earlier paper by the author stated the fact that the light decreased as the pressure of the oxygen increased. This decrease can be explained by supposing that there is a dark discharging space, which must be caused by the intense burning of the carbons at their glowing tips: it has been already stated that the carbons continue to glow, even after the current is switched off. The ionisation which arises at these hot surfaces may be very considerable; the dark discharge can be regarded as a sort of shunt to the arc, and abstracts current from it; therefore the result is that the positive crater becomes smaller in size.

Taking next the arc in nitrogen, the vessel was filled as before; the same carbons and current were used. Fig. 2 shows the results at a pressure of 60 volts; the steadiness of the arc is much greater than in air Here there is no question of the consumption of carbon; the conductivity is to be referred to purely electrical causes. The colour of the arc in nitrogen is not very different from that in oxygen and air. The core *a* is violet; the mantle of the flame *g* is green; the zone *d* is dark in colour. The core *a* gives a very faint light. The illumination varies very slightly with increased pressure of nitrogen; there is practically no change for an increase of three atmospheres beyond the atmospheric pressure; in this respect it differs from the arc in oxygen or in air. When the pressure is diminished below the atmospheric the light decreases less than it does in air under similar conditions. The characteristics of the amount of illumination under pressure in nitrogen are similar to those in oxygen, but they are less marked. Wilson's experiments were probably uncertain owing to the possible presence of the oxides of nitrogen; and it might be supposed that they were also

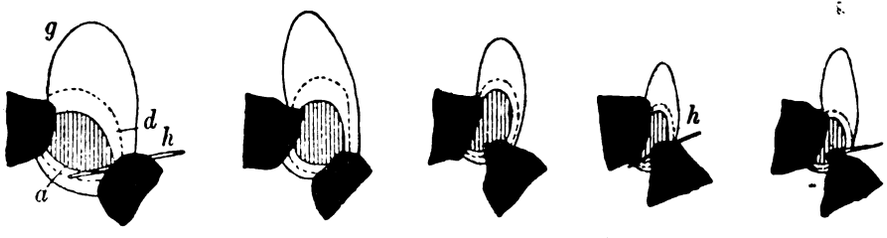

FIG. 2.—ARC IN NITROGEN AT 60 VOLTS AT PRESSURES VARYING FROM 40 CM. OF MERCURY TO 3 ATMOSPHERES ABOVE THE ATMOSPHERIC (from left to right).

present in our tests, were it not for the fact that a continuous flow of nitrogen was maintained and no trace of oxides could be detected in the outflowing gases. The position of the craters was quite favourable and small differences were probably due to accidental causes. There was one peculiarity which ought to be noticed. A greenish zone *h* was noticed, which had the shape of a narrow ring; it was odd that it did not seem to be visibly connected to any other part of the arc. It is possible that it was due to some sort of electric discharge, of which it may have been the core, the rest of the discharge being dark. Twice it bent upwards and disappeared in the mantle of the flame; but it was never noticed to re-appear out of the flame. It was curious that this green ring was so well defined; it would seem to show that the dark discharge must have been of considerable extent; the pressure vessel was only 0·5 metre broad. And the unsymmetrical position of the ring also seems strange; however, it may be symmetrical with regard to the invisible discharge. It was curious, too, that it was always seen on the kathode and never on the anode. At the lower pressures it was seldom visible, but it was generally visible at two or three atmospheres above the atmospheric; beyond these pressures the tests were not continued. It was, on the other hand, much more marked at decreased pressures below the atmospheric. A further peculiarity of the arc in nitrogen is that sharp tips form on the carbons, exactly as in air. They cannot be formed by small traces of oxygen, for in carbon dioxide the tips are quite blunt, just as in the enclosed arc. It must, therefore, be supposed that there is a tendency to the formation of cyanides, not only in the arc, but also at the glowing tips; this consumes the carbons and causes them to form a tip. Still the consumption of carbon is very much less than in air. Perhaps the arc starts an electrochemical process for the formation of cyanides, and this may explain the origin of the green ring and its formation on the negative pole.

Further tests were carried out to examine the arc under pressure in its own gases, as in the enclosed arc. Stockhausen states that at normal pressure these gases consist of hydrogen, carbon monoxide, nitrogen, marsh gas and carbonic acid, with traces of oxygen. There are also volatilised salts in flame arcs. Under pressure the oxides of nitrogen are also formed. The current was 10 amperes at 55 volts; fluor-calcium carbons (excello, yellow, 104) were used for the positive and plain carbons for the negative. The test lasted for 37 minutes; the pressure fell from 4 to 3·5 atmospheres. After 10 minutes the illumination had decreased by 50 per cent., and after this the decrease continued at a slower rate. Naturally at first the oxygen was consumed rapidly; but this consumption decreased with the amount of oxygen present. The fall in pressure of the gases would cause a decrease in the light, but this decrease would not amount to more than 20 per cent. Allowing for this (*i.e.*, making such correction as the author's previous experiments would show to be likely to be reasonable), there still remains the fact that in 37 minutes the light fell to one quarter of its initial value. It seems, therefore, likely that the vessel was filled with vapours of the volatilised salts to such an extent that they absorbed a great part of the light. Still it was noticed that these vapours formed a thick cloud at the bottom of the vessel, and to some extent they had condensed on the cold walls of the vessel. But the arc seemed so dull that doubtless much of the light was absorbed in the vapours. After 30 minutes a steady value of the illumination was reached; the vessel contained 154 litres, and the question arises as to whether the whole of the oxygen was consumed in 30 minutes. (A candle was found to extinguish itself in the vessel in 31 minutes.) It is, therefore, not surprising that under pressure the arc should consume all the oxygen in 30 minutes. The higher the pressure the more oxygen is present; but this only increases the rate at which the oxygen is likely to be consumed.

In addition, another series of experiments was carried out with ordinary carbons, in order to see whether it was due to the volatilised salts that the light decreased to such a marked extent. It was then found that in the same time the light fell from 1,840 c.p. to 1,300 c.p., *i.e.*, the loss amounted to 30 per cent. This showed that the calcium fluoride arc of itself absorbed a considerable amount of light, and probably the formation of the oxides of nitrogen under pressure contributed to the result. The other gases, which are present on Stockhausen's hypothesis, seem to have no very marked effect on the results. In earlier experiments it has been shown that the illumination increases with an increase of pressure, and while the energy-consumption increases the specific consumption decreases. It was also shown that the illumination depends on the nature of the added salts, which also affects the amount by which the light increases. In the present experiments it has been proved that the illumination increases with the pressure if the energy-consumption remains constant, but this increase is small, and depends on the nature of the gas (whether air, oxygen or nitrogen) through which the arc passes Further, if the arc passes between carbons containing an admixture of calcium fluoride and the gases, which are generated, are retained and compressed, there is a very notable decrease in the amount of light emitted.

Vibrations Due to Road Transport.—The very heavy demands made upon roads by the exceptionally heavy traffic in France since the outbreak of war has been giving some concern. According to "La Nature" one special result of the ever-increasing use of heavy motor vehicles—its prejudicial effect on buildings—is being carefully studied by the French Automobile Club and the Central Society of Architects. An instrument for recording such vibrations has been devised and applied to a number of cases in which the vibration was particularly severe. With this device numerical data can be obtained; for example, it has been shown that if the vibration due to a cab with solid tyres is represented by 2·6, that due to a motor omnibus would be 8·5. In some instances it has been found necessary to isolate buildings which have suffered severely. One method which is said to give satisfactory results in checking the transmission of vibration in such cases is to mount blocks of compressed cork along the whole frontage below the level of the side-walk.

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Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

(*Continued from page* 435.)

Summary.—The inertia of conical-drum winders is considered. Simple methods are given for finding the inertia of the loads and ropes depending from the drums, of the ropes wound on the drums and of the pit-head sheaves. The question of approximations is discussed and the method of plotting the torque-diagram on a time-base is described.

Inertia.—In order to determine the accelerating and retarding moments, the inertia of the moving masses has to be found. Knowing the inertia I and the angular acceleration ω, the accelerating moment $M_a = I\omega$.

It is convenient to divide the masses into four parts as follows :—

(*a*) Drums and coupled rotating parts.

(*b*) Loads and ropes depending from the drums.

(*c*) Ropes wound on the drums.

(*d*) Pit-head sheaves.

Of these, it is evident that only the drums and coupled rotating parts have constant inertia, the mass and radius of gyration being constant. The inertia of the loads depending from the drums varies directly as the mass and as the square of the instantaneous drum radius ρ. As for the ropes wound on the drums we have seen that the amount and, therefore, the mass of rope on the drum varies as ρ^2, and as the inertia likewise varies as ρ^2, the inertia of the rope coiled on the drum will vary as ρ^4. In order that it may be directly added to the inertia of the other moving parts, the inertia of the pit-head sheaves must be reduced to the instantaneous drum radius by the method already used in Example 1.†

The total inertia is thus seen to be a complex quantity, and it will be profitable to deal with its determination at some length.

The varying moments of inertia $W\rho^2 \div g$ of the loads and ropes depending from each of the drums can be obtained from the curves of static moments, $s9$ and $9_1 s_1$, wherein are plotted the values of $W\rho$ for the entire wind both on the ascending and descending sides, by multiplying them by $\rho \div 32{\cdot}2$. Thus,

Inertia of Ascending and Descending Loads.

Point.	Ascending loads.			Descending loads.			Total inertia. $I = I_a + I_d$.
	Static torque. M lb. ft.	Radius. ρ ft.	Inertia. $I_a = M\rho \div 32{\cdot}2$.	Static torque. M lb. ft.	Radius. ρ ft.	Inertia. $I_d = M\rho \div 32{\cdot}2$.	
Beginning ...	66,400	4·0	8,260	32,200	8·0	8,000	16,260
After 10 revs.	72,200	4·5	10,080	38,600	7·5	8,990	19,070
„ 20 „	76,900	5·0	11,920	43,000	7·0	9,330	21,250
„ 30 „	80,500	5·5	13,720	45,900	6·5	9,270	22,990
„ 40 „	83,300	6·0	15,500	47,400	6·0	8,820	24,320
„ 50 „	84,800	6·5	17,100	47,700	5·5	8,140	25,240
„ 60 „	84,800	7·0	18,450	47,000	5·0	7,300	25,750
„ 70 „	83,200	7·5	19,350	45,300	4·5	6,320	25,670
End	80,000	8·0	19,900	42,400	4·0	5,270	25,170

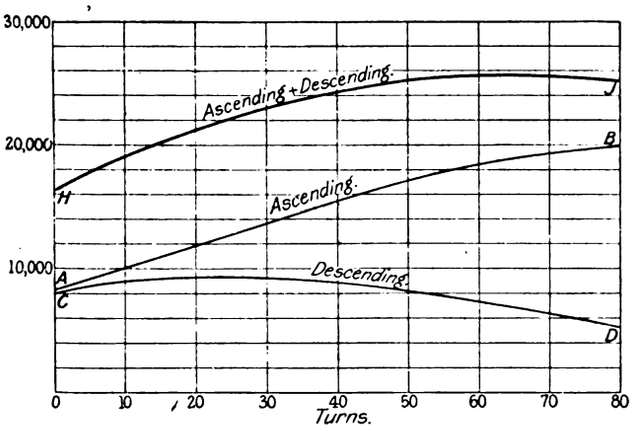

FIG. 26.—INERTIA OF LOADS AND ROPES DEPENDING FROM THE DRUMS.

At the loaded (ascending) side the static torque, or moment, at the beginning of the wind is :—

$$M = \{6{,}000 + 4{,}000 + (3{,}000 \times 2{\cdot}2)\} \times 4,$$
$$= 66{,}400 \text{ lb. ft.},$$

and since the drum radius at this instant is 4 ft., the corresponding inertia $= 66{,}400 \times 4 \div 32{\cdot}2 = 8{,}260$.

It is possible that the reader will not be satisfied with a point at the beginning of the wind. If so, let him take any other point, say, when the drum has made 30 revolutions. At this point the static torque is 80,500 lb. ft., and the instantaneous drum radius is 5·5 ft. Hence the inertia is $80{,}500 \times 5{\cdot}5 \div 32{\cdot}2 = 13{,}720$. In like manner other points have been taken for the ascending and descending loads as shown in the accompanying table. These are plotted in Fig. 26, and the total inertia of the loads and ropes depending from the drums is found by addition.

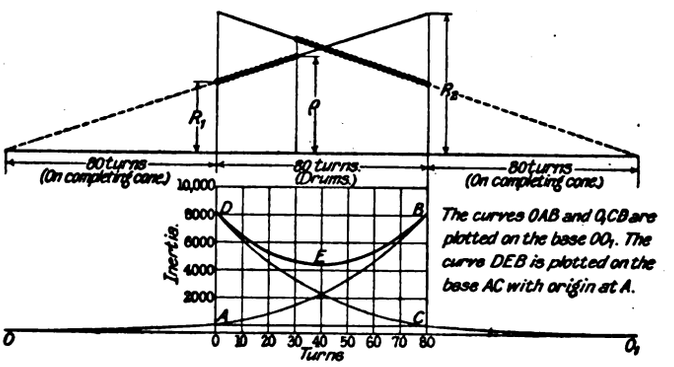

FIG. 27.—INERTIA OF ROPES COILED ON THE DRUMS.

To arrive at the inertia of the ropes wound on the drums consider the rope continued so as to cover the completing cone (Fig. 27). The length l_1 and consequently the weight wl_1 of the rope is proportional to the area of the conical surface covered by the rope, and therefrom proportional to the square of the instantaneous radius of the drum, *i.e.*, wl_1 is proportional to ρ^2. From Fig. 27 it is evident that the radius of gyration of such a conical surface is equal to $\rho \div \sqrt{2}$,* therefore the inertia I is $w_1 l_1 \rho^2 \div 2g$.

Considering the ascending side, at the end of the wind $\rho = R_2$, and $I = w_1 L_1 R_2^2 \div 2g$. Substituting, we get

$$I = 2{\cdot}2 \times 4{,}000 \times 8^2 \div 2 \times 32{\cdot}2,$$
$$= 8{,}720.$$

At the beginning of the wind $\rho = R_1 = 0{\cdot}5 R_2 = 4$ ft., and the inertia at any point being proportional to ρ^4, at this point is numerically equal to $(0{\cdot}5)^4 \times 8{,}720 = 546$. These points, and others determined in a similar manner, when plotted give a parabolic curve of the 4th degree shown by *OAB* in Fig. 27. It will be noticed that the portion *OA* of this curve represents the inertia of the rope wound on the completing cone, and that the portion *AB* represents the inertia of the rope wound on the actual drum. Since at the beginning of the wind no rope has been coiled on the drum, the inertia at this point must be nought. The true inertia, therefore, is represented by the curve *AB* on the base *AC*.

* Copyright. All rights reserved. † THE ELECTRICIAN, p. 334.

* By taking an end view of the cone.

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By symmetry, the true inertia of the rope coiled on the drum on the descending side is represented by the curve *CD*, and the total inertia *DEB* of the ropes wound on both drums is found by combining the two curves.

It remains to consider the effect of the pithead sheaves. Let their radius r_s be 8 ft., and the inertia **I** of each sheave be 4,550. The equivalent inertia at any instant varies as the square of the radius of the drum at that instant, and is equal to $\mathbf{I}_s \cdot \rho^2 \div r_s^2$. Substituting the given values for $\mathbf{I}_s$ and r_s, we get $\mathbf{I}=4{,}550\rho^2 \div 8^2 = 71\rho^2$. The equivalent inertia, therefore, is represented by a simple parabolic curve *OA*, Fig. 28, with its apex at the apex *O* of the completing cone of the drum, the value at the beginning of the wind for the ascending side being $71 \times 4^2 = 1{,}140$, and at the end of the wind $71 \times 8^2 = 4{,}550$. As in the case of the inertia curves for the ropes on the drums there will be two curves *OA* and O_1B for the sheaves drawn from

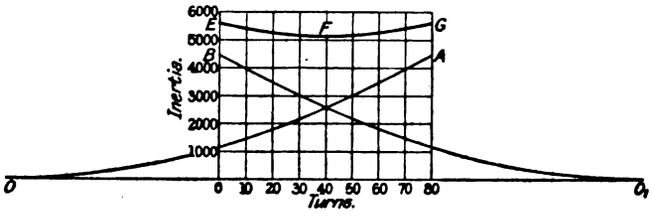

FIG. 28.—INERTIA OF PITHEAD SHEAVES.

the apices *O* and O_1 of the completing cones. The total inertia, represented by *EFG* in Fig. 28, is found by adding the corresponding ordinates.

The curves *HJ*, Fig. 26 ; *DEB*, Fig. 27 ; and *EFG*, Fig. 28, are plotted on a common base in Fig. 29, and the total inertia of the loads, ropes and sheaves, which is found by combining the three curves, is represented by the curve *KL*.

Approximations.—In comparison with the constant inertia of the drums and coupled rotating parts the inertia of the ropes wound on the drums and that of the pithead sheaves are small. Consequently the variation of this small inertia during the wind has no appreciable effect on the total inertia, and in the majority of cases the inertia of the sheaves and that of the ropes on the drums may be regarded as constant throughout the

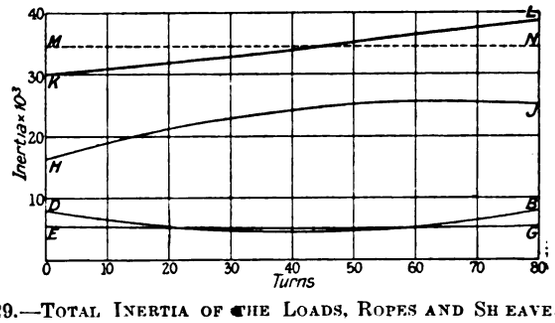

FIG. 29.—TOTAL INERTIA OF THE LOADS, ROPES AND SHEAVES (FIG 26 TO 28) OF THE CONICAL DRUM WINDER (EXAMPLE 4).

wind. Furthermore, it is convenient to regard the inertia of the loads and ropes depending from the drums as constant.

These approximations lead to the following expressions :—

Sheaves.—Equivalent inertia $= \mathbf{I}_s(R_2^2+R_1^2) \div r_s^2$.

Loads and Ropes depending from Drums.—

$$\text{Inertia} = [\{(W+W_s+w \cdot L)R_1^2+W_sR_2^2\} + \{(W+W_s)R_2^2 + (W_s+w \cdot L)R_1^2\}] \div 2g.$$

This gives the average of the inertia at the beginning and end of the wind.

Ropes Coiled on Drums.—Inertia $= w \cdot L(R_2^2+R_1^2) \div 2g$.

Substituting given values it is found that the inertia of the sheaves, loads and ropes is approximately equal to 5,700 +20,700+8,200=34,600. This is shown as a dotted line *MN* in Fig. 29.

The reader may be inclined to question the accuracy of using a constant value of 34,600 for a quantity which varies, more or less uniformly, from 30,000 at the beginning of the wind to 38,600 at the end of the wind ; but it must not be forgotten that in addition to this inertia there is the considerably greater and constant inertia of the drums and motor armature to be taken into consideration. This makes the total percentage error of the approximation negligibly small.

On the subject of approximations the following is worth noting : * " With a procedure unduly complex, involving considerable work of calculation, much of it mechanical and arithmetical, there is always the danger of errors occurring and evading detection. Simplifying calculations have then, the advantage—provided there is no sacrifice of essential truth—of reducing such chance of error, and rendering it more readily ascertained should such occur. That such lapses are possible, is evident, but they are the less likely to be committed by those who are most sensible of the possibility and most anxious to reduce the risk."

Diagram on a Time Base.—To convert a torque-turn diagram to a torque-time diagram it is necessary to determine the law connecting drum-turns and time.

If the turns per wind be *N* ; and the accelerating, constant (angular) speed, and retarding times be t_1, t_2 and t_3 seconds respectively, then the maximum drum speed is equal to $N \div \{t_2+(t_1+t_3) \div 2\}$ revs. per second. If n_1, n_2 and n_3 repre-

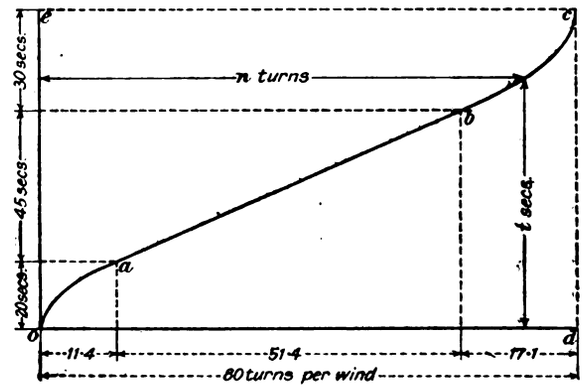

FIG. 30.—CURVE CONNECTING REVOLUTIONS OF DRUM AND TIME.

sent the turns made by the drum during acceleration, constant (angular) speed and retardation, then—

$$n_1 = N \cdot t_1 \div 2\{t_2+(t_1+t_3) \div 2\} ;$$
$$n_2 = N \cdot t_2 \div \{t_2+(t_1+t_3)\} ;$$
$$n_3 = N \cdot t_3 \div 2\{t_3+(t_1+t_2) \div 2\} ;$$

and $$n_1+n_2+n_3 = N.$$

Of the total turns *N* made by the drum during the wind, n_1 are made under constant angular acceleration, n_3 are made under constant angular retardation and n_2 are made under constant angular speed. Hence, the law connecting the accelerating or retarding turns and time is parabolic, and the law connecting the constant angular speed and time is linear.

The diagram Fig. 30 has been prepared for a conical-drum winder which makes 80 turns per wind, the accelerating, constant angular speed and retarding periods being 20, 45 and 30 seconds respectively. The corresponding turns made by the drum are : $n_1=11{\cdot}4$, $n_2=51{\cdot}4$ and $n_3=17{\cdot}1$; and the maximum speed of the drum is $8 \div 7$ revs. per second. These when plotted give the points *o*, *a*, *b* and *c*. The part *oa* of the curve is a parabola with apex *o* and axis *od* ; and *bc* is also a parabola with apex *c* and axis *ce*. By means of such a diagram the time, *t* seconds, required to make *n* revolutions of the drum is obtained. As a rule two points in addition to the points *a*, *b* and *c* will enable one quickly to convert a torque-turn diagram into a torque-time diagram.

Speed Curves.—The determination of the speed curves for a conical-drum winder presents no difficulty. During the constant angular speed period the speed of the ascending skip gradually increases as the instantaneous

* " Engineering," August 17, 1917.

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rope radius increases, and the speed of the descending skip gradually decreases. Knowing the drum radii, on both sides, at the beginning and end of this period, and the drum speed, the points d and e on the speed curve, Fig. 31, for the ascending skip, and points f and g on

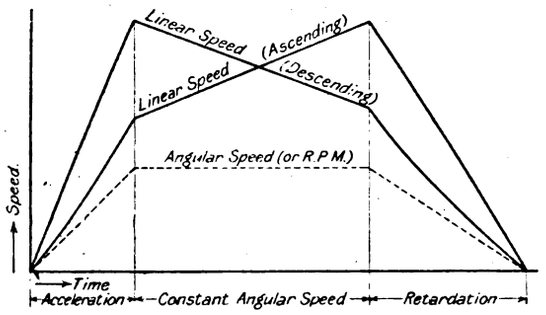

FIG 31.—SPEED TIME CURVES OF A CONICAL DRUM WINDER.

the curve for the descending skip can be calculated. During the accelerating period the angular speed increases at a uniform rate and, on the ascending side, the drum radius increases. At any instant the drum speed (revs. per min.) is known as also is the drum radius, and the linear speed at the instant is equal to the product of the drum circumference and speed. In like manner, points are found on both curves during the accelerating and retarding periods. From Fig. 31 it will be seen that these curves differ but slightly from straight lines.

(To be continued.)

Whitley Committee's Final Report.

The Committee on Relations between Employers and Employed, which was appointed by the Prime Minister in October, 1916, has presented its final report.

The Committee has already presented four reports. In the first report on Joint Industrial Councils the Committee recommended the establishment for each of the principal well-organised industries of a triple form of organisation, representative of employers and employed, consisting of Joint Industrial Councils, Joint District Councils and Works Committees. The second report on Joint Industrial Councils proposed for trades where organisation is at present very weak or non-existent an adaptation and expansion of the system of trade boards working under an amended Trade Boards Act; and for trades in which organisation is considerable, but not yet general, a system of Joint Councils with some Government assistance. A plan was also proposed whereby the Joint Council of an industry when it has agreed upon a minimum standard of working conditions for those employed in it, may have the means of making those conditions general in any district or over the whole country.

The Committee considers it no less important that in each factory or workshop, where the circumstances of the industry permit, and when the requisite conditions are fulfilled, there should be a works committee, representative of the management and the men and women employed, meeting regularly to consider questions peculiar to the individual factory or workshop. This question was the subject of the third report.

The Committee reaffirms the conviction, expressed in the first report, of the urgency of the matter. "In our opinion there is pressing need that every organised industry should equip itself with a representative machinery capable of dealing with the large questions of common interest to employers and employed arising in war time, during demobilisation and in the period after the war. Further, we believe that when the Joint Councils have gained confidence and experience in dealing with the urgent problems of the moment they will find their sphere of usefulness to be much wider than they themselves imagined at their first inception. Similarly, Works Committees, beginning perhaps with limited functions, will, we anticipate, without in any way trenching upon matters appropriate to the Industrial Councils, find a continual growth in the list of questions appertaining to the individual factory or workshop that can be dealt with by mutual agreement. We have purposely refrained, throughout our reports, from making proposals in detail with regard to the constitution of the Councils and Committees or the scope of their functions, because we are convinced that this can only be done satisfactorily by the people engaged in an industry and familiar with all its circumstances."

In the fourth report the Committee made recommendations on Conciliation and Arbitration. The new proposals were limited to the establishment of a small Standing Arbitration Council, on the lines of the present Committee on Production, to deal with cases where the parties have failed to come to an agreement under their ordinary procedure and wish to refer their differences to this Council. In this connection the Committee made suggestions designed to minimise the occurrence of conflicting awards and to secure an interchange of knowledge and experience between persons called upon to act as arbitrators. On the question of the adoption of schemes of profit-sharing and co-partnership, the Committee, having considered the evidence at present available, has come to the conclusion that "it does not justify them in putting forward any general recommendations."

In a note, signed by Messrs. J. R. Clynes, J. A. Hobson and J. J. Mallon and Misses A. Susan Lawrence and Mona Wilson, it is stated: "But while recognising that the more amicable relations thus established between Capital and Labour will afford an atmosphere generally favourable to industrial peace and progress, we desire to express our view that a complete identity of interests between Capital and Labour cannot be thus effected, and that such machinery cannot be expected to furnish a settlement for the more serious conflicts of interest involved in the working of an economic system primarily governed and directed by motives of private profit."

South African Industrial Progress.

The "Board of Trade Journal" contains an abstract of the report for 1917 of H.M. Trade Commissioner (W. G. Wickham) on the trade of South Africa.

It is stated that from the point of view of industrial development the year would be looked back to as the date when the whole question was first taken seriously as a national problem and not one to be left solely to provinces, towns or individuals. The past year was notable for the publication of the first census of industrial production, the formation of a Federation of Industries in which are associated all the provincial manufacturers' associations and the affiliation of this Federation to the British Empire Producers' Association; the formation of the Industrial Development Co. to provide practical assistance in the form of funds for new industrial enterprise; and the flotation of companies to establish vitally important primary industries.

Besides the two companies which are erecting blast furnaces at Pretoria and at Vereeniging, the following are the more important new industries which have recently been, or are on the point of being, established:—

Manufacture of: Carborundum, calcium carbide, alcohol motor fuel, asbestos sheet and goods, casting shoes and dies for gold mine stamp battery (of steel from electric furnaces), sulphate of ammonia, toys, &c., refining of antimony, tin smelting, glass-bottle blowing, &c. A number of other industries are proposed.

Cape Town has been committed by the ratepayers to a definite scheme for providing an adequate supply of water, at a total cost of £850,000, and an outlay of nearly £250,000 is also required for extending the electricity supply works and building workmen's dwellings. East London and Grahamstown have also determined on water schemes. In the case of electricity, normal expansion has had to stop, all the more important municipal generating stations being already fully loaded and some actually overloaded, and additional plant on order being unprocurable, or at least, delayed. The same consideration applies to the telephone service, for which new instruments are unobtainable. Copper cable has been on the list of prohibited exports from the United Kingdom for some time, and this fact has given the Japanese a chance of having their cable tested in use by the Post and Telegraph Department, Mines and Public bodies. The accumulation of overdue orders and of postponed development in regard to electricity, mining, water supply, and sanitation will probably, by the time normal trade conditions are once more in sight, represent a very large amount of business.

The mining industry, of all the industries of the country, has so far as production is concerned, been most nearly normal. The production of gold, coal, copper, tin, lead, chrome, &c., has been encouraged in every possible way. The certificate of indents by the Buyers' Committee, which had been in force since the early months of the war, had not involved any pooling of ideas as to what was necessary. A preliminary to centralise the whole supply business in the hands of one buyer was a gigantic stocktaking, and returns were called for and collated of all mine supplies at the mines, in the hands of merchants, &c. Further, returns of the normal consumption of all stores having been similarly collated, it was possible to begin reducing excess stock to the prescribed limit of six months' supply. Until that limit is reached no orders may be placed overseas. How far the present system is likely to be permanent is a question depending on intricate considerations. If it remains as a permanent legacy of the war it cannot but produce profound modifications in the whole business organisation for supplying the requirements of the mines.

Of the total value of the imports in 1917 Great Britain supplied 52·46 per cent., India 6·13, Australia 3·64, and Canada 2·75 per cent. The United States supplied 17·92 and Japan 2·10 per cent. Commercially, the United States is, therefore, the chief rival of the United Kindgom for the trade of South Africa.

The United Kingdom can, no doubt, retain her share, if not her proportion, of world trade by strengthening her organisation and improving her methods: but it is not reasonable to expect her, indefinitely, to limit and out-distance American export trade. Of the manufactured goods in which American gains are to be noted, the most important group is "Iron and Steel." The value of the imports of this group from the United States increased by £250,000, in fencing and baling wire £45,000, and in railway material £13,000, South Africa having had to depend almost entirely on the United States both for light railway material and wire, instead of Germany, which had an important share of both.

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The Census of Industries reveals creditable progress. Engineering is an easy first, with an output of £7,000,000, but nearly £4,000,000 were contributed by the Government railway shops, and £2,500,000 by the engineering shops of the Mines, leaving only £500,000 as the output of all other engineering works in the Union. Of the other industrial groups returning an output of over £2,000,000 are building and contracting, and electricity and gas generation and distribution.

The restriction of British commercial manufacturing and limitation of export, particularly in lines which have in the past been specially regarded as British preserves, have given golden opportunities to commercial rivals to introduce their goods in this market and to obtain much valuable information as to the precise needs of the market and how such goods should be placed on the market, advertised and distributed. It is for this reason that firms which have through war necessities lost part or all of their normal trade with South Africa should in proportion as they have lost trade increase their preparations for after war business by strengthening and improving their selling organisation. They should satisfy themselves that for their particular class of goods they have the best system of distribution. Manufacturers who have a new product to put on the market after the war or who, not having previously been represented in the South African market, consider that through an agent they could do improved business should take early steps to conclude arrangements for representation. Those firms who have agency arrangements which have proved satisfactory in the past should avoid any possible risk of alienating their agent or dispersing their organisation. That the question of oversea selling organisation and the study of the most economical and effective methods of distribution are of vital importance can hardly be gainsaid. It was by efficient distribution quite as much as by organisation of manufacture that Germany attained to success in the South African market.

In connection with the study of distribution it cannot be too often emphasised that the manufacturer must concern himself with his goods until they reach the consumer. There may be economy in the employment even of a multiplicity of highly specialised middlemen. But it is often forgotten that unless middlemen are bound to the handling of particular makes of goods by specific agency contracts they cannot be expected to have any partiality for one make over another, except on the sole ground that it is more readily and more profitably saleable. Another matter connected with distribution which needs some care is the printing of prices on goods and in catalogues. It may safely be laid down as a general rule that, for export, retail prices should never be marked on goods prior to shipment unless—(*a*) at the request of, or at least with the consent of, the oversea importer, or (*b*) as a matter of deliberate policy matured with full knowledge of local conditions and local selling expenses with a view to controlling prices in the interests of increased turnover.

New Works of Benjamin Electric, Ltd.

On Thursday last we were given the opportunity of inspecting the factory which Benjamin Electric, Ltd., have recently acquired in North London for the manufacture of fittings and illumination material of every description. For some time past the old works of the Company in Rosebery-avenue, Holborn, have been too small to accommodate the growth of the business. The Company is one which specialises in metal spinnings and stampings, the majority of which are made up complete as shades and reflectors for industrial and commercial lighting; a considerable quantity is also used for aircraft work. Previous to the war a large quantity of these products came over complete from the United States, but the company realised the value of manufacture in Europe and laid down machinery for this purpose.

Another department in the works which is kept constantly busy is that devoted to metal spinning. This is essentially a craft of its own, and the men employed display an exceptional degree of skill. In this department reflectors of very large diameter are spun from one piece of metal, and the process ensures uniformity of thickness and evenness of reflecting surface. It is also possible to market large diameter reflectors at figures which handwork would make quite uncommercial. Adjoining the main machine shop are the annealing and enamelling departments. In the latter connection the company have planned a vitreous enamel plant, which will be installed in course of time. The equipment of these sections is quite modern, and the quality of the finished product in so far as enamels are concerned is of the highest class. Steel reflectors are now becoming the recognised accessory for industrial lighting, and the company's works are equipped for turning out quantities to meet the demand which will undoubtedly arise after the war.

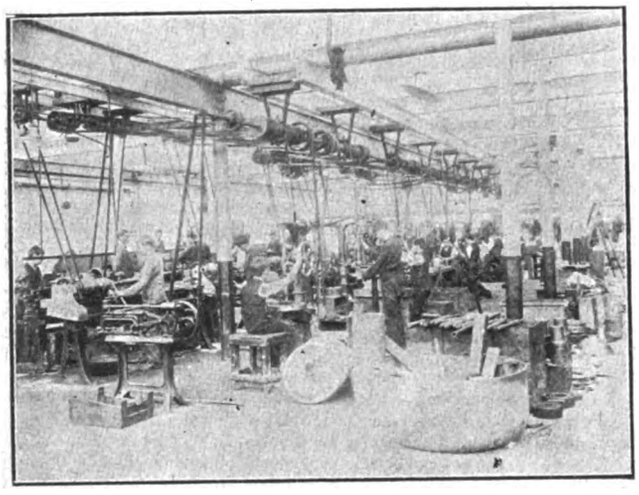

Fig. 1.—General Machine Shop.

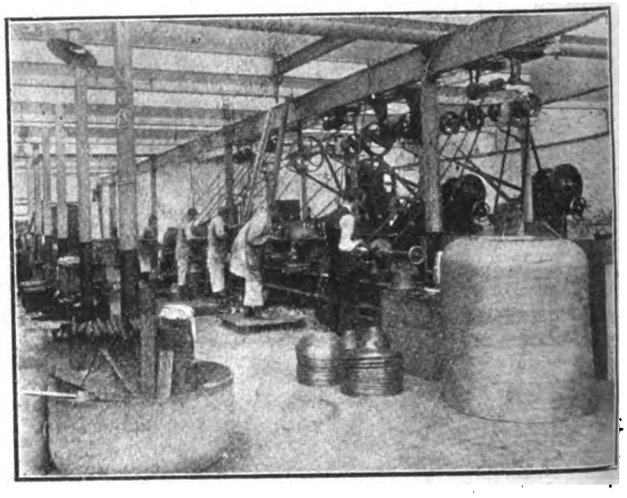

Fig. 2.—View in Spinning Shop.

The Benjamin electric fittings are doubtless well known to our readers, as we have from time to time published detailed descriptions of them. The works are of interest on account of the machine tool equipment, which includes a considerable number of presses and special tools for the production of illumination material in large quantities The company is keenly alive to the value of standardisation and specialisation in this direction and appreciate the utility of stamps and presses which ensure uniformity of product. We should think that their stamp and pressing plant is one of the most complete in this country for turning out lighting accessories. Considerable interest was shown in a machine for rolling the threads which, when completed, form the outside screw contact of the company's "Goliath" holders for half-watt lamps. These holders are provided with a patented locking device which prevents the lamp working loose and falling out, and which is also independent of temperature rise.

Mr. Guy Campbell, the managing director, who showed us round the works, was justly proud of the fact that all the departments are on one floor, in marked contrast to Rosebery-avenue, where the works were accommodated in a building of five stories. All the shops are covered with a saw-tooth roof, glazed so as to give a north light. This construction dispenses with the necessity for windows in the side walls. The work has been planned to facilitate the free movement of the raw material from the stores through the various processes to either the packing and shipping department or to the finished stores as required. The works buildings were acquired from another manufacturer who used very little power. It was, therefore, possible to plan the motor driving equipment for the machine tools on modern lines, the motors being bolted to the

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floor and driving in sections to overhead shafting which is attached to a gantry built up of steel girders. This arrangement facilitated the grouping of the various machine tools in a way which afforded the most efficient drive. It also admits of easy extensions. The present buildings have a floor area of over 2,000 sq. ft., and adjoining them is a piece of land representing 3,000 sq. ft. available for extensions. This part of the site is at present occupied by allotments, which are tended by the employees and seem to show encouraging results. The company is keenly alive to the welfare of the workers, and in addition to providing these allotment facilities they have also included a mess-room which will accommodate 200, and in

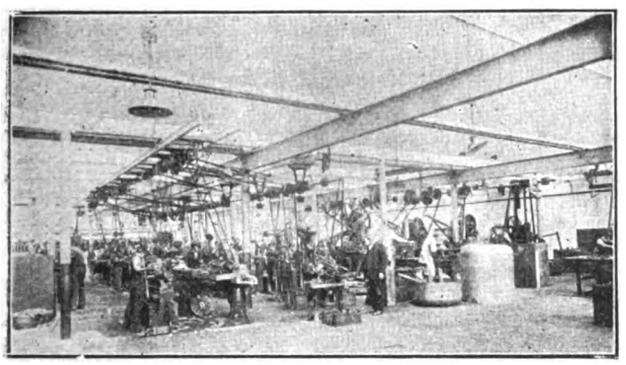

FIG. 3.—MACHINE SHOP SHOWING PRESSES ON THE RIGHT.

which a cooking stove and warming ovens are fitted. This mess-room is in charge of a cook, who looks after the comestibles, which are brought by the workmen, during shop hours.

The factory is a welcome addition to the home means of electrical production, and we anticipate that it will require considerable extensions in the near future. We feel sure that home buyers will appreciate the necessity of supporting British products, and we wish the company every success in its efforts. Our thanks are due to Mr. Campbell and Mr. Mahoney for showing us round the works and for providing the illustrations which accompany this article.

The Labour Outlook.

(BY OUR LABOUR CORRESPONDENT.)

Last week I referred to the recently published Interim Report of the Committee on Adult Education dealing with industrial and social conditions in relation to adult education. Those who would understand the interests and aspirations of the new Labour movement cannot do better than invest threepence in this document.

The reader will learn from it of the widespread desire amongst working people for education—not, it should be noted, education of a vocational character, which they so often suspect; but humane education. This will probably be new to the readers of this paper. They may, however, hearken to the words of a Committee presided over by so distinguished a scholar and educationist as the Master of Balliol College, and composed of four responsible trade union officials, two employers of labour, two women, a county director of education, an ex-president of the National Union of Teachers, and seven people of academic standing interested in adult education.

This Committee bears witness to "the wide and growing demand" among men and women for educational opportunities. The motive is "partly the wish for fuller personal development"; but partly it is social. "Indeed," say the Committee, "so far as the workers are concerned, it is, we think, this social purpose which principally inspires the desire for education. In many cases, therefore, their efforts to obtain education are specifically directed towards rendering themselves better fitted for the responsibilities of membership in political, social and industrial organisations."

On another occasion I may describe in outline the educational organisations through which working people are fitting themselves by the study of social, political and economic problems for their responsibilities. The work which has already been done is very considerable, and its effects far reaching; but the conditions of industrial and social life both "hamper the fullest use of existing educational opportunities and deter or even prevent many people from seeking to take advantage of these opportunities."

The Report sets forth the experience and views of working men and women and others on the obstacles which industrial and social conditions plant in the way of educational development.

Miners and draymen, engineers and shop assistants, railway workers and potters, trade unionists and educationists, all point to the serious handicap of the worker's life. Long hours of labour, overtime, the shift system, night work, monotony of work, heavy and exhausting forms of labour, unemployment, lack of adequate holidays, bad housing and what not are all shown to be factors depriving many workers of the full opportunity of becoming efficient citizens.

The value of the Report lies in its human attitude towards industry. It looks at industrial conditions from the point of view of human well being, and considers what are the essential needs of people as individuals, parents, citizens. Their proposals undoubtedly have the support of organised labour. The trade unions base their demands for improved conditions and opportunities upon the claims of the worker to consideration as a human being. Hence the recommendations of the Committee bear a strong resemblance to the resolutions passed from time to time by the Trade Union Congress. Amongst the proposals of the Committee are a legal maximum working day of eight hours, a shorter working day in heavy and exhausting kinds of work, and for shift workers the closer regulation and reduction of overtime, the abolition of night work except where it is absolutely essential, and the establishment of an annual holiday with pay.

The Committee looks for "a new orientation of our industrial outlook and activities," and for "the diffusion of responsibility for the proper conduct of industry"; in other words, for the satisfaction of the claims of the workers for what is called "industrial control."

Prior to the war many people would have regarded these proposals as Utopian. But the demands of organised labour for human treatment, supported as it is by eminent educationists, such as the Master of Balliol, the Vice-Chancellor of the University of Manchester, and others are now backed by the non-industrial population of the country as reasonable.

Some employers realise the justice of the claims made by Labour; others, if they would avoid disaster, must also be prepared to admit the justice of them, too. The demand is that workpeople should not be expected to tolerate conditions of life to which people in other classes of society would not submit. If we believe in justice, freedom and democracy, the claim must be considered. Human welfare must come before material progress.

As the Committee point out, "material progress is of value only in so far as it assists towards the realisation of human possibilities. Industry and commerce and the social conditions, which are in a large degree dependent upon them, must in our opinion be regarded from this point of view, and if they cramp the life of the individual no amount of economic argument will suffice to justify them. We do not think, however, that there is of necessity a fundamental antagonism between ethics and economics. The proposals outlined above, say the Committee, "are the indispensable conditions of economic efficiency; they are also amongst the elementary rights to which the citizen, as such and in virtue of his responsibilities, is entitled."

To this view Labour would give its heartiest assent. Employers would do well to ponder it.

New Large Generating Stations in the United States.—Recent issues of the "Electrical Review and Western Electrician" contain particulars of several interesting new generating stations in the United States. For example, the Warrior steam-driven station of the Alabama Power Co., which is auxiliary to the hydro-electric system, is of considerable interest. The plant has the largest generating units in the South. At present one 25,000 k.v.a. generator, developing 6,600 volt three-phase power is installed, but two more units, probably of greater power, are to be added, resulting in an estimated coal-consumption of 1,500 tons per diem. The voltage is raised to 45,000 volts for distribution, the power being intended mainly for Government industries near Sheffield, Ala. A second station of note is that being erected by the Kansas City Light and Power Co., with a total capacity of 150,000 kw. Two three-phase 25,000 kw. turbines (13,200 volts) are to be built by the General Electric Co. and installed this year, and six boilers, each having over 13,000 sq. ft. heating surface. A feature of interest is the provision of a pit of 50,000 tons capacity, wherein coal will be stored submerged under water and transferred from the pit to the bunkers by bucket conveyers.

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Electric Power in British East Africa.

We have received from Mr. JAMES MCBLAIN, Government Electrical Engineer at Nairobi, particulars of the Electric Power Bill now awaiting its final reading in the Legislative Council of the East Africa Protectorate. This measure is particularly interesting because it seeks to avoid all the hopeless muddle into which electricity supply in this country has developed owing to lack of direction. The East Africa Protectorate is fortunately free from any serious commitments. From the power point of view it starts with a clean slate, for it is a country which has not yet been appreciably developed. Although it is capable of a prolific production of vegetable oils and alcohol, from which thermal and mechanical energy can be obtained, other fuels are not available. On the other hand, in the highlands water-power is available, and in the more distant regions such power is probably considerable. Evidently, then, the East Africa Protectorate is a country where hydro-electric power may be developed to great advantage, and it is highly desirable that the whole matter should be placed on a proper footing, so that only standardised plant and systems are utilised, and so that a national scheme as a whole is developed. We are glad to find that the Government have acted upon expert advice. Mr. MCBLAIN has elaborated a scheme for the purpose, and the first draft was submitted to Mr. J. H. RIDER for approval. There have, of course, been difficulties. There has been the proverbial red tape, and there have been certain intrigues against any such action. Fortunately, however, these difficulties have been surmounted.

It is interesting to note that the Bill provides for a Power Board, and that it is based largely upon British Acts and practice, with such modifications as appeared to be desirable for the particular conditions holding in the Protectorate. We are glad to find that certain pitfalls from which we are trying to escape at the present time have been avoided. Thus, the powers possessed in England by the Postmaster-General and by local authorities have been curtailed. According to the proposed Bill, although a local authority has the first claim to a licence for its area, it cannot veto the use of overhead mains if the licence is held by some other body, and the Power Board may even dictate that the local authority shall itself use overhead mains. This is a point of great importance. Much difficulty in this country has been experienced through the veto. On the other hand, it is very necessary to protect the "first user."

In regard to standardisation, we may mention that the standards and specifications of the Engineering Standards Association are to be followed. The system is to be three phase and 50 periods, the medium and low standard pressures being 415 and 240 volts respectively. In order to prevent a multiplicity of small undertakings, it is stipulated that no public or local authority may generate its own supply except under licence, which will not be granted within the area of another licencee. Another restriction is to the effect that no licence will be granted to any body within the limit of economical transmission from existing or authorised works until the licencee for the latter has had an opportunity of tendering the supply. Three kinds of licences are contemplated—namely, licences for bulk supply, for distribution and for local generation. The general supply will be given under distributing licences, and the authorised distributor will obtain his supply from a bulk supply licencee, or he may obtain temporarily a local generating licence. Further, the bulk authority may absorb any works operating under local generating licences which exist in the area entrusted to him.

There is, of course, the large question of Government supply *v.* private enterprise. The view was expressed that the service, being a national one, should be undertaken by the State. Mr. MCBLAIN has had experience of both industrial practice and Government service, and thus he has formed the most unqualified conviction that official efficiency in industrial matters is impossible of attainment, and that the correct function of the Government is administration, which must be co-ordinated with the interests of any industry which it presumes to control. This opinion has prevailed, and we think that Mr. MCBLAIN is correct in his views. The net result is that, while it is possible under the Bill for a department of the State to undertake bulk supply, such departments would be subject to precisely the same provisions as would a private company, and therefore it is improbable that development will take place in that direction. Further, there is the question of compulsory purchase which has had such a harmful influence in this country. The contention was put forward that after, say, 50 years a bulk company's works should become the property of the State at a more or less nominal payment. Fortunately, this idea was defeated. It is difficult to see the advantage of State purchase so long as a bulk licencee is discharging his obligations in a competent fashion. On the other hand, the idea of a concession in perpetuity raised much opposition. It was, therefore, necessary to devise a course which would give security to the licencee, and which would at the same time protect the public interest. A statutory sole right to supply is not granted, and this fact affords a safeguard. On the other hand, such a right virtually exists by reason of the competent conduct of the licencee. If incompetence is shown, the licence may be revoked or another licence may be granted. We are glad to see that the licencee is protected by the fact that he must be given 9½ years' notice before the expiration of his licence, whether or not he will be given a renewal. Thus the undesirable condition which has sometimes arisen in this country is prevented, that condition in which the licencee is quite uncertain of the future. No statutory right is given to any authority to acquire the works of a bulk licencee. Therefore, such a licence cannot be revoked except for default. In other words, the bulk supply licence is virtually a grant in perpetuity. It will be seen, then, that the scheme practically amounts to the development of bulk supplies by private enterprise, operating under the auspices of a composite power board of official and non-official members. Financial stability is assured by reserve funds which must be accumulated, more particularly by bulk supply licencees. But after a certain limit half the profits are to be paid as bonuses to authorised distributors.

After reading the details of this scheme, we only wish that Great Britain were in such a condition that similar action could be taken; or, rather, we wish that Parliament in the early days could have put forward and have developed an enlightened policy which would have avoided all the dismal chaos into which the electric supply industry of this country has fallen. It is, of course, easy to be wise after the event; but, even so, the fact remains that legislation in regard to electricity supply in this country has been no testimonial to those who have directed our public affairs.

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The Calculation of Single-Phase and Three-Phase Lines.*

By J. R. DICK, B.Sc., M.I.E.E.

(*Concluded from page* 441.)

Size of Conductors on Three-Phase Systems.—All the formulæ and methods already given for single-phase are applicable to three-phase systems; allowance has only to be made for the effects of the 120° phase displacement of the currents in the wires.

The cross-sections are usually calculated for a stated percentage loss p in the line at a given pressure, or they are based on the economic current density. If P is the power supplied, this is equal to $C_0 V \cos\varphi\sqrt{3}$, from which we can find C_0. The line losses are $pP = w = 3C_0^2 r$, where r is the resistance of *one wire*. Since $r = l/\rho s$ $w = 3C_0^2 l/\rho s$ or $s = 3C_0^2 l/\rho w$.

If the economic current density D is fixed, $s = C_0/D$. We may note here the relative losses in three-phase and single-phase lines with equal pressures and the same cross-sections and loads.

In three-phase

$$C_0 V \cos\varphi \,.\, \sqrt{3} = P \,.\, \text{or}\ C_0 = P/V\cos\varphi \,.\, \sqrt{3}\,.,$$

and the line loss

$$= 3C_0^2 r = \frac{3P^2 r}{3V^2\cos^2\varphi} = \frac{P^2 r}{V^2\cos^2\varphi}.$$

In single phase where C_1 is the current,

$$C_1 V\cos\varphi = P, \quad \text{or} \quad C_1 = \frac{P}{V\cos\varphi},$$

and the line loss $= 2C_1^2 r = 2P^2 r/V^2\cos\varphi$.

This is double the loss for three phase, but the volume of copper is less in the proportion of 2 : 3. Consequently, if the volumes of copper are made equal by increasing the sections of the single-phase conductors by 50 per cent. the three-phase loss will be only 75 per cent. of the single-phase loss.

As regards the voltage drop in a three-phase circuit, it follows at once from the phases of the currents in any pair of wires differing by 120°, that the ohmic drop between them, if each wire is of resistance r, is $v = rC_0\sqrt{3}$. Therefore, if we take all the previous formulæ for single-phase circuits and insert $r\sqrt{3}$ instead of the *total* circuit resistance r, the results will be perfectly valid for three-phase working. The vector diagrams, as given in Figs. 2 and 3 for single-phase, will be true also for three-phase if we bear in mind the following points.

The voltages V_1 and V_2 (Fig. 2) now represent the values between *any pair of wires* in the system, which is assumed to be balanced or nearly so. DE or v_0, the ohmic drop, will now be $rC_0\sqrt{3}$, r being the resistance of one wire, and similarly the inductive drop v_1 will be $\sqrt{3}$ times the inductive drop in one wire.

1. For *non-inductive* mains with *inductive* loads we found for single-phase $V_1 - V_2 = v = C_r = C_0 r\cos\varphi$, and $s = \frac{2C_0 l}{\rho v}\cdot\cos\varphi$, l being the length of one wire. Hence for three-phase under the same conditions we have

$$V_1 - V_2 = v = Cr\sqrt{3} = C_0 r\cos\varphi\sqrt{3},$$

and s becomes

$$\frac{C_0 l\cos\varphi\sqrt{3}}{\rho v},$$

l also being the length of one wire.

2. With *inductive mains and loading* we obtained the formula for single-phase

$$V_1 = \sqrt{(V_2\cos\varphi_2 + C_0 r)^2 + (V_2\sin\varphi_2 + 2\pi n L\,.\,2lC_0)^2}.$$

For three-phase we substitute $C_0 r\sqrt{3}$ for $C_0 r$, but r is now the resistance of one wire only, instead of the complete circuit. Similarly we substitute

$$2\pi n LC_0 l\sqrt{3} \quad \text{for} \quad 4\pi n LC_0 l,$$

L being the coefficient of self-induction per mile of single conductor, and l the length in miles from supply to load.

Thus, for three-phase

$$V_1 = \sqrt{(V_2\cos\varphi_2 + C_0 r\sqrt{3})^2 + (V_2\sin\varphi_2 + 2\pi n LC_0 l\sqrt{3})^2}.$$

From this we obtain the drop $v = V_1 - V_2$.

3. The composition of the capacity and load currents follows the same procedure as in single-phase working. If K microfarads is the Y capacity of the three-core cable, or the capacity of the imaginary condenser formed by one core and the sheathing, then the capacity current C_k is $2\pi n KV/10^{-6}\sqrt{3}$. When combined with C_0 it gives the value of C_r, which is substituted in the formula instead of C_0 if appreciable capacity effects exist.

This substitution in the single-phase or three-phase formula is not strictly accurate, since the value of the current varies from C_0 to C_r, along the line, owing to the distribution of the capacity. The average value of C_r and C_0 would give more accurate results, when determining V_1, but usually C_r gives a close enough approximation.

Further, the distributed capacity produces a varying phase angle between the vector of the ohmic drop and that of V_2. Except on very long lines, which must be calculated by less simple methods, this effect can be neglected without serious error.

We shall now illustrate the use of these formulæ by calculating a three-phase transmission line, and we shall assume this to be a three-core cable. If the working out is clearly understood the calculations for single-phase will present no difficulty. The load P to be supplied is 1,500 kw. with a power factor $\cos\varphi_2 = 0{\cdot}8$ at a pressure V_2 of 10,000 volts and a frequency n of 50 per second The distance from the supply station is 25 miles. From the data available it is found that the economic current density D is 1,100 amperes per square inch, and

$$C_0 = \frac{P}{V_2\cos\varphi_2\,.\,\sqrt{3}} = \frac{1{,}500{,}000}{10{,}000\times 0{\cdot}8\times\sqrt{3}} = 109 \text{ amperes}$$

Then the cross-section

$$s = \frac{C_0}{D} = \frac{109}{1{,}100} = 0{\cdot}099, \text{ or } 0{\cdot}1 \text{ sq. in. (nearest standard)}$$

For a three-core 0·1 sq. in. 10,000-volt cable the Y capacity is found from the cable makers' tables to be 0·4 mfds. per mile. The total capacity K of the 25 mile line is therefore $25\times 0{\cdot}4 = 10$ mfds.

The capacity current

$$C_k = 2\pi n K\,.\,\frac{10{,}000}{\sqrt{3}}\,.\,10^{-6}$$

$$= 2\times 3\,.\,14\times 50\times 10\times\frac{10{,}000}{1{\cdot}732}\times\frac{1}{1{,}000{,}000} = 18 \text{ amperes.}$$

The resultant current C_r is equal to

$$\sqrt{C_0^2 + C_k^2 - 2C_0 C_k\cos(90^\circ - \varphi_2)}.$$

As $\cos\varphi_2 = 0{\cdot}8$, we find from the tables $\varphi_2 = 37^\circ$ and $(90 - \varphi_2) = 53^\circ$, and $\cos 53^\circ = 0{\cdot}6$.

Thus $C_r = \sqrt{109^2 + 18^2 - 2\times 109\times 18\times 0{\cdot}6} = 99$ amperes.

The line pressure at the supply end is

$$V_1 = \sqrt{(V_2\cos\varphi_2 + C_r\,.\,r\sqrt{3})^2 + (V_2\sin\varphi_2 + 2\pi n LC_r l\sqrt{3})^2}.$$

* From the forthcoming new edition of "Electric Mains and Distributing Systems" (Dick and Fernie).

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These quantities in figures are $V_2 \cos \varphi_2 = 10{,}000 \times 0{\cdot}8 = 8{,}000$ volts, $C_r \cdot r \cdot \sqrt{3} = 99 \times 0{\cdot}44 \times 25 \times 1{\cdot}732 = 1{,}886$ volts. (The resistance per mile of a cable 0·1 sq. in. is 0·44 ohm.) $V_2 \sin \varphi_2 = 10{,}000 \times 0{\cdot}6 = 6{,}000$ volts.

L per mile of conductor in a 0·1 10,000-volt three-core cable is approximately 0·5 millihenry and l is 25 miles. Then

$$2\pi n L C_r l \sqrt{3} = 2 \times 3{\cdot}14 \times 50 \times \frac{0{\cdot}5}{1{,}000} \times 99 \times 25 \times 1{\cdot}732 = 678 \text{ volts.}$$

and
$$V_1 = \sqrt{(8{,}000+1{,}886)^2 + (6{,}000+678)^2}$$
$$= \sqrt{9{,}886^2 + 6{,}678^2}$$
$$= \sqrt{142{,}330{,}000} = 11{,}930 \text{ volts.}$$

Voltage drop in the line

$$V_1 - V_2 = 11{,}930 - 10{,}000 = 1{,}930 \text{ volts.}$$

The power loss is $3C^2r$, where C is the mean of C_r and $C_0 = 3 \times 104^2 \times 0{\cdot}44 \times 25 = 356$ kw. The total power required at the supply end P_s is

$$1{,}500 + 356 = 1{,}856 \text{ kw.}$$

The percentage line loss p is $\frac{356}{1{,}856} \times 100 = 19$ per cent., which is too high a figure for good regulation, if the line is worked in parallel with other lines. The improvement in power factor due to the capacity is apparent when we calculate $\cos \varphi_4$ (*see* Fig. 3). By adding the losses at the supply end to the load we know that P_s is 1,856 kw. But P_s also $= C_r V_1 \cos \varphi_4 \sqrt{3}$, and thus $\cos \varphi_4 = \frac{1{,}856 \times 1.000}{99 \times 11{,}930 \times \sqrt{3}} = 0{\cdot}9$, instead of 0·8 at the load end. Contrary to the conditions on overhead lines, the inductance of the cable has no great influence on the supply voltage. If we omit this factor, 678 volts and calculate V_1, it proves to be 11,560 volts. If capacity and inductance in the main are both absent, or rather negligible, the drop is $C_0 r \cos \varphi_2 \sqrt{3} = 109 \times 11$ ohms $\times 0{\cdot}8 \times 1{\cdot}732 = 1{,}660$ volts and V_1 is 11,660 volts. For absolutely non-inductive conditions the drop is $v = \frac{P_s}{V\sqrt{3}} \times r \times \sqrt{3} = \frac{1{,}500{,}000}{10{,}000} \times 11 = 1{,}650$ volts, and V_1 is 11,650 volts.

From this example it will be seen that the arithmetical methods are simple, and they have the advantage of indicating quickly the relative effects of the inductance of the load, and the capacity and inductance of the line.

The necessity for trying to keep a good power factor on the mains is so obvious that special devices are used for counteracting the effect of inductive loads and lines, when the power factor falls below a certain figure. The condenser effect of the cables being in itself insufficient, the only alternative is to supplement it with static condensers or to use synchronous motors with proper excitation to furnish leading currents. The latter method implies expensive machines, and regular attention to their running. The static condenser for power factor improvement was until recently considered to be only a physical laboratory piece of apparatus, but there are now on the market robust practical designs, such as the B.I. & Helsby Co.'s oil immersed type which are efficient and reasonable in cost. As some power companies increase their charges for power factors below a certain value or give a bonus for a high power factor, it will certainly pay the consumer, in such cases, to consider the use of condensers, which should be installed as closely as possible to the point where the inductive load is taken off the main.

Analysis of Alternating-Current Networks.

When loads of different power factors are connected to distributors or to the branches teed off a ring main they must be treated as vectors, before the direct-current methods of analysis can be used. Any current C_0 with power factor $\cos \varphi$ can be resolved into $C_0 \cos \varphi$ and $C_0 \sin \varphi$, which are the energy and wattless components at right angles to each other. (The j notation for two axes at right angles is used by Steinmetz and others, instead of the method with $\sin \varphi$ and $\cos \varphi$ components.)

At any point, where several currents meet, we have first to determine the two sets of vectorial quantities and then combine them according to the law of vector addition.

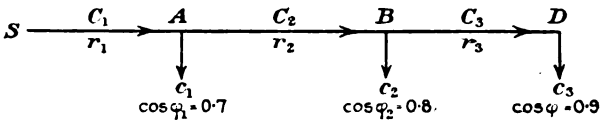

FIG. 4.

If C_0' is the arithmetical sum of all the $\cos \varphi$ vectors, and C_0'' the sum of the $\sin \varphi$ vectors, the value of the current in the line which they enter is

$$C_r = \sqrt{(C_0')^2 + (C_0'')^2}.$$

From the trigonometrical rule for a right-angled triangle the power factor of C_r or $\cos \alpha$ is

$$1 \Big/ \sqrt{1 + \left(\frac{C_0''}{C_0'}\right)^2}.$$

The method will be at once clear from the following example:—

In Fig. 4 we have three loads each of 100 amperes, c_1, c_2 and c_3, with power factors as shown, on a single-phase system. Resolving them along $\cos \varphi$ and $\sin \varphi$ axes we obtain:—

$c_1 \cos \varphi_1 = 100 \times 0{\cdot}7 = 70$, and $c_1 \sin \varphi_1 = 100 \times 0{\cdot}7 = 70$.
$c_2 \cos \varphi_2 = 100 \times 0{\cdot}8 = 80$, and $c_2 \sin \varphi_2 = 100 \times 0{\cdot}6 = 60$.
$c_3 \cos \varphi_3 = 100 \times 0{\cdot}9 = 90$, and $c_3 \sin \varphi_3 = 100 \times 0{\cdot}44 = 44$.

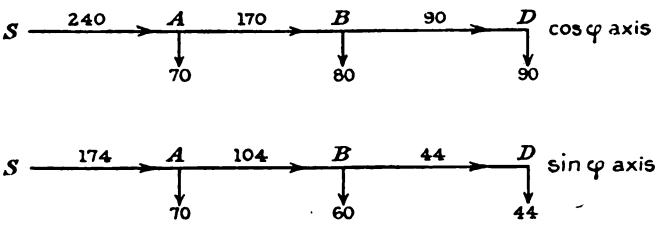

FIG 5

In Fig. 5 is shown the distribution of the component currents:—

Thus $C_1 = \sqrt{(240)^2 + (174)^2} = 296$ amperes.
$C_2 = \sqrt{170^2 + 104^2} = 199$,,
$C_3 = \sqrt{90^2 + 44^2} = 100$,,

The power factors are as follows:—

$$\text{For } C_1 \quad \cos \alpha_1 = 1 \Big/ \sqrt{\left\{1 + \left(\frac{174}{240}\right)^2\right\}} = 0{\cdot}81.$$

$$\text{For } C_2 \quad \cos \alpha_2 = 1 \Big/ \sqrt{\left\{1 + \left(\frac{104}{170}\right)^2\right\}} = 0{\cdot}85.$$

$$\text{For } C_3 \quad \cos \alpha_3 = 1 \Big/ \sqrt{\left\{1 + \left(\frac{44}{90}\right)^2\right\}} = 0{\cdot}9.$$

The size of the conductor, s, in a non-inductive main can be found, if we have to design

(1) for a given drop, v, since

$$v = C_1 r_1 \cos \alpha_1 + C_2 r_2 \cos \alpha_2 + C_3 r_3 \cos \alpha_3$$
$$= C_1 \frac{l_1}{Ks} \cos \alpha_1 + C_2 \frac{l_2}{Ks} \cos \alpha_2 + C_3 \frac{l_3}{Ks} \cos \alpha_3,$$

or (2) for a given power loss, w, since

$$w = C_1^2 r_1 + C_2^2 r_2 + C_3^2 r_3$$
$$= C_1^2 \frac{l_1}{Ks} + C_2^2 \frac{l_2}{Ks} + C_3^2 \frac{l_3}{Ks}.$$

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Calculations of this kind, if attempted for a complete network would become extremely laborious. It is generally a sufficient approximation to calculate for non-inductive conditions and then apply a correction for the average power factor.

When supplying several sub-stations from an E.H.T. trunk main, the capital cost of which is heavy, it would certainly be worth while to carry out accurately the analysis we have indicated above.

Correspondence.

ELECTROMAGNETIC THEORY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I trust I may be considered free of presumption if I venture to criticise the comparative value placed by your journal upon such matters as are treated in Mr. A. C. Crehore's Paper "Some Applications of Electromagnetic Theory to Matter." It is very rarely indeed that we get a Paper by a first-class man dealing comprehensively with the state of theory and practice on this, the most important, subject. Take, for instance, your issue of the 6th September, which happens to be in my hands. It is no reflection upon the other Papers and articles to say that they are all comparatively on small matters of detail, and they could very well be delayed, or even altogether omitted, from the standard premier Electrical Journal. This would have permitted of Mr. Crehore's article being published in one complete instalment, in decent type, and presumably with the illustrations, which are unfortunately missing.

I feel that to the great majority of your readers this subject is, as it is to me, far and away the most interesting, as it is the most important, and such a summing-up and explanation of the position as given by Mr. Crehore is like being shown a new and distant landscape through a pair of the finest field glasses. From the prophetic point of view, it is important that practical electrical engineers should read such an article under the most favourable circumstances at least now and again, even sometimes at the expense of the so-called practical articles.—I am, &c.,

Derby, Sept. 18. J. SAYERS.

[As we refer to this letter in the Editorial Notes, we need say no more here than to remark that the original contained no illustrations, and that it was given in THE ELECTRICIAN practically without abbreviation.—ED. *E.*]

Reconstruction in France and Belgium.

In the industrial reconstruction of the invaded districts of France and Belgium, electricity supply will play an important part, and the directors and representatives of the large power stations and electric lighting plants in the invaded regions of France have formed the Syndicat Professionnel des Producteurs et Distributeurs d'Energie Electrique, in order to study the problem of reconstructing their power stations.

According to "Commerce Reports" those interested have constituted a committee (the Comptoir Central d'Achats Industriels pour les Régions Envahies, 40, rue du Colisée, Paris), and the data in the possession of the Committee indicate that the power stations in the regions occupied by the enemy represented (including units in process of installation) a capacity of about 300,000 kw. The Committee has learnt that in the majority of cases the electrical machinery, boilers, transmission lines, and in many cases the buildings themselves, have been destroyed. Therefore, it will be necessary to replace the whole of the installations in the invaded regions. However, in order to avoid undertaking a programme which would be too ambitious, and as the reconstruction of the invaded regions will demand several years, the Committee has agreed to limit its plans for the time being to the restoration of one-third of the supply of the period before the war, *i.e.*, about 100,000 kw.

Advantage will be taken of the opportunity for securing as largely as possible the standardisation of new equipment and transmission systems. Among other advantages, standardisation will enable the manufacturers of the electrical equipment to lower the net selling price. It is proposed to use turbo-alternator groups of 5,000 kw., supplying three-phase current at 10,500 volts 50 cycles. In order to develop as quickly as possible the desired energy of 100,000 kw., it will be necessary to provide for the installation of 20 identical sets, with boilers, switchboards, distributing lines, transformers, &c. At first the generating plant would be in temporary stations, designed to reinforce central stations already in operation on the French side of the firing line. A part of the new plant would perhaps be left in reserve in order to be ready for installation in strategic locations in the regions still occupied by the enemy the moment their liberation has been brought about. In spite of the uncertainty with regard to the conditions in which the liberation of the invaded territory will be brought about, it is necessary to provide for the most effective method of distribution, and the Committee thinks it better to leave out of consideration the old transmission lines, for the chances are that all the copper wire has been either destroyed or carried off by the enemy, and the old lines were only designed for supplying local communities. A map has been prepared showing the distribution lines existing in 1914, and also a map indicating in a general way the transmission lines that will be necessary for the distribution of energy in the invaded regions after the war. The provisional and theoretical transmission lines thus sketched out have been developed purely from the point of view of the general public interest. No account has been taken of the more restricted interests of electric supply companies and their consumers. The transmission lines contemplated by the Committee have been classified in various categories according to the urgency of their installation.

By the creation of a vast system of power generation and distribution, capable of realisation by successive stages as the needs of the invaded regions may dictate, the Committee hopes to achieve the maximum efficiency by avoiding the creation of numerous small private central stations, and thus obviate a waste of fuel.

A scheme for the electrical reconstruction of Belgium has also been drawn up by an expert for the consideration of a Belgian Government Committee, and has for its object the supply of ample cheap electric power for railway and industrial use. Seven "super-power" stations, ranging in capacity from 100,000 to 300,000 kw. are proposed, with high-pressure transmission. These would be laid down at Charleroi, Mons, Limburg, Liége, Antwerp, Ghent and Ostend, and coal would be subject to destructive distillation at these stations for the recovery of by-products, as outlined in the scheme of the Electric Power Committee of the Board of Trade. It is calculated that the adoption of the proposals would result in the saving of over 5,000,000 metric tons of coal per annum.

A Watertight Lantern.

Simplex Conduits, Ltd., have placed on the market a new deep watertight lantern. This is cast with a deep recess in the top, into which the lamp-holder goes. The deep cast body and standard well glass make a pleasing well-balanced combination and avoid the necessity of stocking extra deep well glasses, which at the present time are more difficult to obtain than the standard glasses. This deep body lantern used with the firm's new sheet-metal shade, throws the light downwards, and none is wasted by horizontal rays. The inner reflecting surface is white, and if regularly cleaned an excellent illumination on the ground beneath the unit is obtained. The illustration shows the chief features of the unit, with and without the reflector.

WATERTIGHT LANTERN.

Electrolytic Copper Refining in Belgian Congo.—The Union Minière, Haut Katanga, has decided to erect plant for the electrolytic refining of copper. The plant, as well as some additional railway rolling stock, has been ordered from America.

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Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 SPECIFICATIONS.

109,053 EVENSEN & JOHANNESSEN. Apparatus responsive to sunlight for completing an electric circuit for giving a signal or for other purposes. (25 8 16.)
112,123 WESTINGHOUSE ELECTRIC & MFG. CO. Geared turbine installations. (11 12 16.)
112,442 AKTIEBOLAGET LJUNGSTROMS ANGTURBIN. Rotary field magnets. (19 12 16.)
114,829 AKT. GES BROWN, BOVERI ET CIE. Mechanism for varying the point of ignition in magneto-electric ignition apparatus. (23 3 17.)
116,895 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Control of electric motors. (13 6 17.)
118,296 PESCATORE. Electrodes for arc soldering. (21 5 17.)
118,300 BERRY. Electric heating elements suitable for cooking and similar heating apparatus. (18 7 17.)
118,318 MARKS. (Stilldorf Electrical Co.) Ignition dynamos. (21 8 17.)
118,319 HIRD & IRELAND. Electric ignition apparatus for internal combustion engines. (21 8 17.)
118,320 AUTOMATIC TELEPHONE MFG. CO. (Automatic Electric Co.) Telephone systems. (21 8 17.)
118,324 HIRST & BROOKS. Switchgear for starting and controlling electric motors. (22 7 17.)
118,329 HOLDEN. Electrically-operated mechanism suitable for driving clockwork trains, or the like. (24 6 17.)
118,330 AUTOMATIC TELEPHONE MFG. CO. & REMINGTON. Electric signalling systems, more particularly for use in mines. (25 8 17.)
118,352 BREWER & SPENCER. Air-speed indicators for kite balloons. (24 9 17.)
118,355 STATHAM. Electrolytic cells adapted for the manufacture of caustic alkali from sodium chloride. (26 9 17.)
118,357 WADE. (Booth Hall Co.) Electric furnaces. (27 9 17.)
118,370 FULLER ACCUMULATOR CO. & WELCH. Magnetic locks or fastenings for use on electric lamps or other apparatus. (14 11 17.)
118,378 CRUST. Electric switch plugs. (14 12 17.)
118,380 SELLMAN & ALLMANNA SVENSKA ELEKTRISKA AKTIEBOLAGET. Free-release electric circuit-breakers. (4 1 18.)
118,392 BUPLEIGH. Dynamo-electric machinery. (2 3 18.)
118,416 JORGENSEN. Combustion night-light and electrical heating apparatus. (20 8 17.)

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

July 27, 1918.

12,236 HAMBLET. Fireproof and unbreakable coating for telegraph and telephone wires, &c.
12,238 KNOWLES. Telegraphing apparatus.
12,246 ALLEN. Trolley retriever.
12,262 WATNEY. Incandescent lamps.
12,266 QUAIN. Electric heaters.

July 29, 1918.

12,306 BROWN & EVANS. Non-accumulative electric signalling indicator for collieries, &c
12,313 WILSON. Control of dynamo electric machinery.
12,315 MENCO-ELME SYND. Electro-magnetic speed changing gear. (22 9 17, U.S.)
12,322 B. T.-H. CO. (G. E. Co.) Electro-pneumatic braking systems.
12,327 BRAY, MARKHAM & REISS. Friction drive for electric switchgear, &c.

July 30, 1918.

12,353 BLAYMIRES. Lamp holders.
12,367 LIVERTON. Electric time transmitter or master clock.
12,382 LUCAS. Electric signalling lamps.
12,413 CALLENDER & BRAGG. Electrically locating submarines.

July 31, 1918.

12,470 WILSON. Control of dynamo electric machinery.
12,477 MACINTOSH. Direct-current starting switches.
12,487 EXLEY & LEITNER. Electric cells.
12,488 FRANCKS. Operating electric switches from a distance.
12,490 GUTZWILLER. Electric internal tube heaters. (8 8 17, Switzerland.)
12,507 KORESSIOS. Electric speed governor.
12,510 BLOXAM. (Russische A. G. L. M. Ericsson & Co.) Valves for generating electric oscillations, &c.

August 1, 1918.

12,488 TELEPHOS DOMESTIC & STREET LIGHTING CO. Operating electric switches from a distance.
12,545 TAVANI. Instantaneously varying photo-electric resistance.
12,554 WESTERN ELECTRIC CO. Telephone exchange systems.
12,555 ACCUMULATOR SERVICE CO., JOLLEY & KNIGHT. Electric hand lamp.
12,567 BENJAMIN. Electrolytic apparatus. (1 8 17, U.S.)
12,593 S. SMITH & SONS, TRIER & MARTIN. Constant current dynamos.
12,600 & 12,601 TINSON. Electric connectors, &c.

August 2, 1918.

12,642 BUESS & GUTZWILLER. Feeding polyphase current circuits with monophase current. (6 8 17, Switzerland.)
12,643 COLQUHOUN. Heating elements and means of conveying heat therefrom.
12,650 MCLEOD. Preventing rapid exhaustion of primary batteries.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain of the Week.—Capt. E. G. Fleming.
Next for Duty.—Capt. W. Hyndman.
Sunday, Sept. 29.—Commandant's Parade at Waterloo Station, 8.45 a.m., opposite No. 9 platform, for work at Esher. Drill Order without rifles. Mid-day and tea rations to be carried.
Monday, Sept. 30 to Saturday, Oct. 5.—Drills as usual.
Sunday, Oct. 6.—Annual Musketry Course at Pirbright. Parade Waterloo Station, 8.45 a.m. Drill Order with Rifles and Side-arms. Mid-day and tea rations to be carried.

SPECIAL ORDERS.—All drills will take place at headquarters unless otherwise stated.

The medical officer will attend for the examination of recruits on Thursday evening at 6.30.

Commercial Topics.

Industrial Councils.

Up to the present eleven Joint Industrial Councils have been constituted on the principles laid down in the Whitley Report, and the first meetings have been held. The industries affected are:—

Pottery, building trades, furniture, heavy chemicals; gold, silver, horological and allied trades; matches, rubber, silk, baking, china clay and vehicle building. Recent progress has accordingly been marked, and the formation of Joint Councils for many other industries is proceeding vigorously. In some cases the precise demarcation of particular trades has called for careful handling, but it is stated that in every case where a Joint Council has been formed the proceedings at the first meeting have been invariably most amicable.

* * * *

Non-Ferrous Metal Licences.

The Board of Trade notify companies, firms and individuals holding licences under the Non-Ferrous Metal Industry Act that these licences do not dispense the holders from complying with the regulations made under the Defence of the Realm Act with respect to the sale or purchase of non-ferrous metals. The necessary permits under these regulations must be obtained from the Ministry of Munitions in respect of any sales or purchases of non-ferrous metals in the same manner as before the licences were granted.

* * * *

Income Tax and Depreciation of Buildings.

Financial and business circles are devoting considerable attention to the effect of Sub-section 4 of Section 34 of the Finance Act, 1918.

This section permits the deduction of the whole of schedule A assessment (*i.e.*, in respect of lands, tenements, &c.) in calculating profits assessable under schedule D (*i.e.*, profits from trades, &c.) "in the case of any premises being mills, factories or other similar premises."

Prior to the present year the allowance has been restricted to five-sixths of the schedule A assessment—that is to say, the amount upon which the tax was actually charged under schedule A. "The Times" points out that, while it is generally understood that the concession has been granted to provide an allowance for depreciation and buildings reference to the section would not appear to justify this view, and the allowance is more of the character of a deduction on account of wasting assets. Electric supply undertakings, gas works, &c., are not assessed to schedule A, and they will, therefore, get no relief under the clause in this year's Act, although their works and buildings are assets of a much more wasting character—depreciate more rapidly—than mills, factories or similar premises. Consequently, inequality in assessment will be created as between one class of taxpayer and another. Electric supply and gas companies contend that, whether the allowance is made to provide for the loss of value of buildings only, or to provide for the depreciation of assets generally, is irrelevant. The loss is not peculiar to the undertakings expressly provided for in section 34, and legislation which gives an advantage to certain interests over others in the matter of taxation cannot be justified.

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Foreign Companies and War Taxation.

A number of Anglo-foreign companies, including some tramway and electric supply undertakings, have removed their head offices from London in order to avoid the heavy income tax. One of the most recent cases was that of the Alianza Co. (Ltd.), which last week decided to alter its articles of association in order to place the control of the company in the hands of a local board in Chile.

The chairman of the company (the Hon. Herbert C. Gibbs) stated that, so far as the British shareholders were concerned, there would be little practical change, except that the management would be transferred from the present board to a local board in Chile. After referring to the constitution of the local board and that nothing had yet been settled as to the domicile of the company after the war, he said that even the transfer of the control of that one company to Chile was to some extent injurious to British interests, both directly and indirectly; but the real significance of the action which they felt bound to take was that it was indicative of what might occur in future in weakening the position of this country as a directing centre of industry and in abolishing the considerable indirect gains to British commerce, finance and manufacture which arose therefrom. In the present case the disturbance of control was due as much to British income-tax methods as to the actual weight of taxation, for the British Government treated as profits the cost of the raw material which nitrate companies used in earning their revenue, and they now levied income-tax upon that capital expenditure at the rate of 6s. in the £. The sense of injustice and irritation which was thereby created was a strong incitement to foreigners and British subjects alike to avoid British jurisdiction. The excess profits duty, plus income-tax, as levied at present on the balance of excess profits remaining, made that tax prohibitive, and would, if the company remained under British control, cause its production to be decreased.

* * * *

The "Embargo" Strike Committee's Report.

The Committee on the Labour "Embargo," of which Mr. Justice McCardie is chairman, has published an interim report dealing with the recent Coventry strike and the circumstances which led up to it.

The report states that the stoppage of work at Coventry and Birming-

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ham was due to the issue by the Ministry of Munitions of "Embargo Letters" to three munition firms in Coventry prohibiting further engagements of skilled men without the licence of the Ministry. The Committee find that the explanation of the "embargo" had not been sufficiently brought home to the minds of the workmen and the actual stoppage might have been avoided if further steps had been taken in June to make known to the men and their leaders the object and scope of the "embargo."

The evidence is conclusive that the "embargo" scheme was necessary in the national interests to secure the most effective use of available labour, and the Committee are of opinion that the action of the Government in establishing the scheme was justified. The evidence established the fact that the "embargo," although the immediate cause of the stoppage at Coventry and Birmingham, was not the only, or, indeed, the substantial cause of it. Although the vast majority of those who stopped work are in every way anxious to maintain the output of munitions, there is evidence that a small section of the community, not confined to the ranks of labour, is hostile to the constitutional procedure of the trade union organisations of this country, and desires to take advantage of causes of irritation to bring about, if possible, a stoppage of work for other reasons than the redress of immediate grievances.

The Committee recommend that means should be devised to provide that changes or developments in Government policy with respect to labour matters (so far as they concern munitions work) should be immediately and effectively communicated to the workmen and employers concerned. They also suggest that a joint committee of a consultative and advisory nature be established forthwith consisting of representatives of employers and workmen with a chairman appointed by the Government. The members of the Committee, other than the chairman, should be subject to re-appointment every three months. The Committee should meet weekly in order to maintain close and constant touch with the problems which may arise. The meetings of the Committee should be attended by the heads of the Labour Departments of the Admiralty and the Ministry of Munitions or by responsible officers of those Departments.

Electricity Supply.

General.

Belfast.—At a meeting of the Electricity Committee on the 18th inst. tenders were considered for the supply of additional generating plant, &c., and offers aggregating £200,000 were accepted.

On the following day a number of representative citizens, together with members of the Committee and Sir John Snell and Mr. J. H. Rider, paid a visit of inspection to the East Bridge-street station and to the site of the new station. The chairman of the Committee (Councillor J. C. White) subsequently entertained the party to luncheon, after which he explained the reasons for the plant extensions and for the erection of the new station.

In the course of his speech, Sir JOHN SNELL alluded to the report made by him to the Committee, in which he stated that the only course to adopt was to instal a high-tension three-phase system, and to put the station in the most advantageous site possible with regard to coal and water supply. Owing to the outbreak of war nothing was done at the time, but at the end of last year, when the demands from the great shipyards began to arise, the Corporation were driven to embark on the new scheme—that is, if they were to accept the responsibility of supplying electricity to the great industries of the city. Having accepted the responsibility, they had to spend a very large amount of capital, and he warned them that they would have to continue to spend a large amount of capital; but if that capital soundly expended enabled them to supply energy at a proper and reasonable rate, and the revenue from it paid all the capital charges and enabled them to put by a reasonable reserve fund, then a great Corporation such as that of Belfast could unhesitatingly undertake the responsibility of spending that great amount of money. The only danger that he could possibly foresee was that of a temporary slump in trade, but that had been provided for. Each of the large consumers had undertaken to take a minimum amount of power per year, and he was satisfied that if the worst came to the worst, and the big users of electricity only took the minimum covenanted for, the concern would still be making a substantial profit. Judging by past experience, he saw no reason why that great electricity department, which in the course of the next three years would be very nearly trebled in size, would not be, if properly managed, a sound financial investment and a source of great comfort and help to the important industries in the city. He believed that the Corporation would be asked in the not remote future to do more than supply electricity merely within the city boundary. Belfast was unquestionably the centre for any electrical distribution which could be given in the surrounding counties. Scattered around the city there were a large number of important industries and mills, and he believed that in the course of time they would be asked to face the responsibility of sending their electricity out to those mills, and possibly lighting the smaller townships in their vicinity, and probably also undertaking the supply of energy for railway traction. At the new station the plant would consist of water-tube marine-type boilers, and to begin with two 6,000 kw. turbo-alternators, which would generate electricity, and they would distribute electricity to the shipyards, and would also convey electricity to East Bridge-street, where it would be transformed and distributed in the city. They must lay out the station with an eye to the future. The next step would be a 12,000 kw., or possibly a 15,000 kw., set: but they did not stop even there. They were laying out the building to contain eventually as large a unit as a 25,000 kw. set. As their system developed and demands for large blocks of power were made upon them, they must face the responsibility of having to put in such large units. When that station and system were properly established they would be supplying the whole of the demands of the shipyards, a great deal of the demands of their mills and certainly all the small industries within the city, and that must have a very beneficial effect upon the cleanliness of the city and upon its industrial prosperity.

Dublin.—A conference of electricity consumers was held last week in order to consider the situation brought about by the coal shortage.

The president of the Dublin Industrial Association (Mr. Mitchell) gave a summary of the efforts made to obtain supplies of coal and of the negotiations with the Electric Lighting Committee and the Coal Controller. It is proposed that all early closing shops (wholesale and retail) shall close at 5 p.m., all shop window and outside lighting to be prohibited; licensed houses, tobacconists and late closing shops to be closed between 3.30 and 5.30 p.m. Offices not connected with or incidental to industrial work are to be closed at 4 p.m., and private houses are to be rationed according to a fixed scale. Hotels, clubs and boarding houses to be reduced by 25 per cent. of the 1914 supply; theatres and other places of amusement to be closed by, 10.30 p.m.; and picture theatres and other places of entertainments shall also be closed from 3.30 to 5.30 p.m. Outdoor lighting of theatres is prohibited, and all theatre lighting must show a reduction of 25 per cent. of the 1914 consumption, and the electricity used in public lighting shall not be more than one-half that consumed in 1914.

Major CREAN stated that the Coal Controller (Mr. Burgess) promised to provide the necessary coal to carry out the above arrangements.

Lr. SHERLOCK said the position of the Electricity Committee was that for the year ended March, 1915, they imported 32,000 tons, in 1916, 33,000; 1917, 34,000; and in 1918, 24,000, representing a drop between 1917 and 1918 of 10,000 tons. Since March they had been endeavouring to arouse public spirit in the hope of forcing the Government to deal equitably not only with Dublin as a whole, but with the electricity undertaking, which had been so badly treated in the preceding 12 months. They usually used over 30,000 tons every year. The proposed reductions would relieve them, if the Government put them into operation, to the extent of 5,000 tons in the year, leaving them in the position that for the remaining needs of Dublin they must have 26,000 tons of coal. More stringent regulations than those suggested might have to be made later on. The 5,000 tons of coal would save the electricity department something like about £10,000 or £11,000, but the loss in income to their concern by the adoption of those changes would be £40,000 a year.

Electric Power Supply.—The Manchester Chamber of Commerce has endorsed the findings of the Board of Trade Electric Power Supply Committee.

Electrical Power Engineers' Association.—A general meeting of the members of the West Yorkshire section of this Association was held at Leeds, on Saturday evening last.

Mr. J. E. Ellis, of Morley, was in the chair, and there were 70 members present, including the full Committee, the president (Mr. A. L. Lunn) and one of the vice-presidents (Mr. R. C. Atkinson). A general review of the progress of the Association was given, also a detailed account of the activities of the West Yorkshire Section since its formation. It is intended to hold during the winter session a series of meetings for members, and a programme drawn up by the sub-committee was submitted.

Electricity in Shipyards.—Middlesbrough Corporation has agreed to give a supply of electric current to Sir Raylton Dixon & Co.

The approximate cost of laying two mains to a suitable point on Dixon's premises, together with the necessary transformers and switchgear, will be £10,000. The load to be connected immediately will equal about half a million units per month and the profit on this is expected to pay interest and redemption charges on the whole of the extension. Under the arrangement, all the energy required for extensions at the Cleveland Dockyard for some years to come will be supplied.

Hull.—The Electricity Committee recommend the Corporation to increase the salary of the acting borough electrical engineer (Mr. J. F. Magoris) from £425 to £700 per annum.

Increased Charges for Electrical Energy.—The charges are being increased at the following places:—

Aylesbury Council has decided to increase its charges by 20 per cent.

At Stirling the charges for current has been increased. For private lighting the price is 7d. per unit.

Southend Corporation has decided to further increase the charges for current for all purposes by 15 per cent.

From Sept. 30 Liverpool Corporation's charges will be increased by 10 per cent. over the additions of 12½ per cent. and 17½ per cent. already in force.

Darwen Electricity Committee recommend that the charge for electric current be increased to 8d. a unit.

At Wallasey the lighting rate is being increased by ½d. and the power rate by ¼d. per unit.

On Oct. 1 Birkenhead electricity department will increase its charges to the following percentages over pre-war rates: Borough lighting flat rate and motive power 50 per cent., Borough lighting m.d. 33⅓ per cent., Borough prepayment meters 39 per cent., special consumers on kilowatt and miscellaneous rates 40 per cent., and township's motive power 37

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per cent., Borough heating and cooking varying from 16½ to 50 per cent., and township's heating and cooking 25 per cent., and prepayment meters 45 per cent.

From Oct. 1 Belfast Corporation is increasing its charges by ½d. for domestic, shop and factory lighting, and ¼d. for power, heating, &c.

Stretford Council has increased its charges for lighting from 20 to 30 per cent. and for power from 20 to 40 per cent. over pre-war rates.

At Sheffield the charge for all units supplied at 2d. or under is to be subject to an increase of 45 per cent. instead of 33⅓ per cent. as at present.

Ayr Council has increased its charges to 50 per cent. over pre-war rates.

Dudley Council is recommended by its Streets, Tramways and Lighting Committee to agree to an increase in the Shropshire, Worcestershire and Staffordshire Electric Power Co.'s charges in the borough by 12½ per cent., making 37½ per cent. over pre-war charges.

Swansea.—As the Board of Trade Committee has intimated that it would allow the demand for a reduction of 15 per cent. per annum in the consumption of coal for the tramway service to be made good by the substitution of coke, the borough electrical engineer (Mr. Burr) is engaged upon experiments with a view to such substitution.

Messrs. Richard Thomas & Co., owners of the Cwmbwrla Tin-Plate Works and the Cwmfelin Steel & Tin-plate Works, propose to erect and lay cables for supplying energy from the Cwmfelin works to the Cwmbwria works. The Corporation will also supply current to the Landore & Morriston foundries.

Tewkesbury.—The local electric light company has applied to the Board of Trade for authority to raise the maximum price of electric current to 10d. per unit; but the company has given an undertaking to the Council that it will not charge more than 8½d. per unit except with the consent of the Council.

Electric Traction.

Edinburgh.—A special meeting of the Corporation was held on Friday to consider the position of the Queensferry tramway scheme.

The Tramway Committee recommended the Corporation to proceed with the application for a provisional order, notwithstanding the demand of the Admiralty for concessions. The Admiralty asked for a 50 per cent. reduction in fares for naval ratings using the tramways and the construction of a loop line from Port Edgar passing Dalmeny station. The loop line was originally considered by the Corporation, but owing to local opposition that part of the proposal had to be withdrawn.

After discussion, the Council decided to postpone the scheme, and to withdraw their application for a provisional order.

Light Railways Order.—The Board of Trade has confirmed the Swansea Corporation Light Railways (Extension) (Revival and Extension of Time) Order, 1918, reviving the powers granted and extending the period limited by the Swansea Corporation Light Railways (Extensions) Order, 1914, for compulsory purchase of lands.

Middlesbrough and Stockton Tramways.—Middlesbrough Corporation has decided to exercise its option of purchasing the local tramway undertaking of the Imperial Tramways Co. Stockton and Thornaby Councils have also decided jointly to purchase the tramways in their districts.

Unusual Claim for Tramway Breakdown.—The agent for the Mid and East Lothian district of the Scottish Mine Workers' Association has preferred a claim against the Musselburgh & District Electric Light & Traction Co. for loss of wages sustained by 300 miners who were prevented by a breakdown of the tramcars on the morning of the 16th inst. from getting to their work at Preston Links, Wallyford and other collieries.

Imperial Notes.

Australasia.—At the recent half-yearly meeting of the Electric Light and Power Supply Corpn. (Sydney), a dividend at rate of 8 per cent. per annum for the half-year ended April 30 was declared.

The last half-yearly report of the Kalgoorlie Electrical Engineer shows that for the period ending May 15, 361,384 units were sold, against 354,934 for the previous six months. Cost of production was £5,306, against £5,417. The revenue was £8,005 (increase £249).

Sydney Council has announced that, while new consumers cannot be served by the Corporation's electric mains during peak hours, the electricity department is prepared to connect consumers who will, at their own expense, provide apparatus for automatically cutting off the supply from 8.30 a.m. to 5.30 p.m. The Council has recently been able to obtain only a few time-switches.

In the annual report of the Lyttelton (N.Z.) Harbour Board it is stated that the conversion of the electric lighting system, now in full operation, had resulted in a saving of about £400 per annum, in addition to other advantages. During the year small 100 c.p. lights were installed on the wharves to give greater safety on the parts of the jetties not fully lit by the large lamps. The receipts from the supply of extra lights to vessels working at night had been reduced during the year, because such vessels as visited the port were not able to work at night. A heavy source of expense at present is that of lamp renewals, partly due to the excessive cost of electric lamps at present, and the impracticability of contracting for large supplies on favourable terms.

Mr. Struan Robertson, engineer and manager of the tramways controlled by the Hawthorn Tramway Trust, reports that 9 miles out of the 9½ miles of track urgently require reconstruction, at a cost of over £30,000.

The Hydro-Electric Power & Metallurgical Co.'s new carbide plant at Electrona (Tasmania) is now in operation. The Government having stipulated that the Company should undertake the manufacture of carbide, the main purpose of the Company—the electrolytic production of zinc by the Gillies' process has remained in the background. The great difficulty which the Company had in securing electrodes for its furnaces rendered it necessary that the group of premises built for the production of carbide should be added to in order that future supplies of electrodes might be depended upon, and this new branch of the business is likely to prove a boon to the big steel works of the Commonwealth where electric furnaces are in use. The main purpose of the Hydro-Electric Power & Metallurgical Co.—the production of electrolytic zinc, is being kept in mind, and the metallurgical works are being pushed forward.

Australian Association of British Manufacturers and their Representatives.—At the recent annual meeting in Melbourne, Mr. M. C. Coates (president), in presenting the seventh annual report, pointed out that during last year British export trade to Australia had again been carried on under most difficult circumstances. American and Japanese enterprise had captured a considerable amount of trade which previously went to British manufacturers.

Mr. T. W. HEATH, representing the Sydney Council of the Association, complained of the unfair and unpatriotic action of certain traders in sending British registered designs to Japan and America to be copied.

Mr. R. W. Knox has been elected president in succession to Mr. Coates.

Mining Stores for South Africa.—Amongst mining stores which have been standardised by the Transvaal Chamber of Mines are electric lamps. The standardisation of truck wheels and axles, conveyor belts and idlers and pulley centres is under consideration.

Foreign Notes.

American Hydro-Electric Development.—The International Joint Waterways Commission, Washington, has granted the application of the Aluminium Company of America to construct and maintain for the period of the war a submerged weir across the Longsault section of the St. Lawrence River.

Canada opposed the application on the ground that Canada could not submit to an invasion of its treaty rights. The representative of the company said that the United States and Canada depended upon the aluminium concern for munitions of war. The construction of the canal would enable them to increase the production of aluminium.

Italy.—The Società Anonima Ferrovie Torino Cirie Valle di Lanzo has increased its capital from 2,300,000 lire to 10,000,000 lire in order to electrify the whole of its system within the period of a year.

A meeting of representatives of the Northern Italian railways and tramway lines recently took place at Rome, when final plans were adopted for electrifying the services in all Northern Italy. Current will be supplied from hydro-electric works, thus partly emancipating Italy from its dependence on the coal supply of foreign countries.

The Società Idroelettrica dell' Ozola has been formed at Milan, with a capital of 1,000,000 lire, in order to erect a hydro-electric works in the province of Reggio Emilia.

The Società Elettrica della Sicilia Orientale has decided to increase its capital to 32,000,000 lire, and to change its title to the Società Generale Elettrica della Sicilia. The company proposes to undertake the supply of electricity throughout Sicily, and to extend its existing hydro-electric plants and to erect new works.

Miscellaneous.

Alien Enemy Patent.—Last week Messrs. W. Suckling & Son applied to the Patents Court for a licence to manufacture a sparking plug under patent 26,436 of 1907, granted to Robert Bosch.

Mr. COLEFAX, K.C., for applicants, explained that the plug was an important one, and not at present obtainable in this country.

Mr. JOSEPH SUCKLING stated his firm were prepared to place their resources behind the venture. It was impossible to blow out this plug under compression, and an expert motorist risking his life on the Brooklands track would throw out all other plugs and use that one. When six plugs which had been manufactured in Germany before the war were sent to be tested at Brooklands the tester retained three. He (Mr. Suckling) had secured this man in a consultative capacity, cut one of the plugs through, made working drawings, and was now prepared to manufacture in any quantity. The plug was required for aerial engines and for high-pressure internal-combustion engines. It was practically essential for all kinds of magnetos. Before the war it was intended to place the plug on the British market as a German article. Our own manufacture would now render it unnecessary that any German plugs should come to this country.

Mr. Imray watched the proceedings on behalf of interested parties, and Captain J. V. Armstrong, of Messrs. W. P. Thompson & Co., of Liverpool, was present on behalf of the Lodge Sparking Plug Co., of Rugby.

The CONTROLLER OF PATENTS (Mr. Temple Franks) observed that Messrs. Bluemel Bros. (Ltd.), of Coventry, applied for a license to use the patent on May 24, and a license would be granted to Messrs. William Suckling & Sons on the same royalty terms as those offered by Messrs. Bluemel Bros.—a penny on every sparking plug manufactured.

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Certificated Occupations.—The Minister of National Service has issued a revised list of certified occupations qualifying, conditionally, for exemption from military or other national service.

The list came into operation on 26th inst. A man claiming exemption must show that he has been engaged as his principal or usual occupation in the occupation mentioned, and if in Grade I. that he was born in or before the year shown in column A., or if in Grade II. in or before the year shown in column B. Grade III. men are entitled to be treated as in a certified occupation where no limit is indicated in a footnote.

	A.	B.
Electrical Engineering.		
Foremen	1882	1888
Turner, fitter, erector, electrician, or other skilled workman	1882	1888
Wireman	1880	1888
*All other classes of workmen	1874	1877
Local Authorities' Undertakings.		
Officials on administrative or technical staffs of (excepting those in trading undertakings carried on by local authorities, or in other classes mentioned elsewhere in the list)	1883	1885
Road construction and repair, including workmen employed by contractors working for local authorities:—		
Road foreman; ganger	1883	1888
Driver of steam roller or of power-driven vehicle	1887	1890
Stone-spreader; sett, curb, or channel dresser; smith; fitter	1875	1883
*All other classes of workmen	1875	1877
Electric generating stations, transmission and distributing mains and lines (including those for tramway undertakings and electric railways):—		
Station engineer, shift engineer, sub-station attendant-in-charge	1890	1893
Switchboard attendant, cable jointer, overhead linesman, electrical fitter(sub-stations) engineman, stoker	1888	1890
*All other classes of workmen	1875	1877
Maintenance and Repairing Staffs.		
Mechanic, electrician or electrical fitter and other skilled men engaged in the maintenance or repair of employer's plant, &c.	1884	1888
Boiler and Insurance Companies.		
Boiler, machinery or electrical inspector; technical office staff	1888	1890
Railway Service, Including Workshops and Sheds.		
Man certified by railway company as indispensable	1894	1894

National Association of Supervising Electricians.—This Association was registered on the 6th inst. as a trade union. Its registered number is T 1680.

Scottish Fuel Order.—The Household Fuel and Lighting (Scotland) Order, 1918, comes into force on Tuesday next.

The fuel allowance is 4 tons where not more than three rooms are occupied, and a ton extra is given for each room occupied, until a maximum of 20 tons is reached.

In addition to the quantities stated for fuel, gas or electricity for lighting will be allowed according to the following scale:—

No. of Rooms.	Cub. ft. of Gas.	Or units of Electricity.
1, 2, or 3	9,000	150
4, 5, or 6	13,500	225
7, 8, or 9	18,000	300
10, 11, or 12	22,500	375
13, 14, or 15	27,000	450
16, 17, or 18	31,500	525
19, 20, or 21	36,000	600

The Coal Situation.—The President of the Board of Trade (Sir Albert Stanley) attended a conference of the mayors, councillors and other officials of the Metropolis and Home Counties, which was convened by the Lord Mayor of London at the Mansion House on the 20th inst. for discussing the coal situation and the steps to be taken by local authorities in order to bring home to the people the need of economy in the use of fuel and light.

After giving the coal ration in France and Italy, Sir Albert Stanley said he felt that they could pull through the winter without anything like the discomfort or hardships that had been experienced in France and Italy for more than one winter. Each one must, however, see that every pound of coal was economically used and that there should be no waste. If they succeeded in saving the coal which the scheme of rationing provided, they would be able to lay aside during the year some 8,000,000 tons of coal for other purposes. The actual deficit was 36,000,000 tons, and there still remained 28,000,000 tons to be found somewhere. They had to fulfil the debt of honour to their Allies. He believed it would be possible for the miners to improve the output, and that the deficit could be wiped out. The Miners' Federation was doing its best to increase output, and he was hopeful that good results would attend its efforts. The rationing of coal was the most difficult of the whole of the rationing problems, and it was only because of the difficulties and the many contingencies to be provided for that the Order had had to be so very elaborate. He appealed to the public not to ask too much of those who had the responsibility of administering the Order, and would ask that each one of them should constitute himself or herself a coal controller. He had heard that attempts were being made to find substitutes and to try by all sorts of devious ways to maintain comfort in individual cases as against everybody else. That was wrong. By their attempt to evade the Order and their responsibility persons were only robbing the poor of something they absolutely need.

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400 experts have been appointed by the Coal Controller to consult with and advise steam power users how to eliminate waste. It is clear that there is a great wastage of coal, and even if a supreme effort were made by all industrial firms it would take several years to recover the whole of this loss, as it is impossible to install more efficient plant during the war. Another cause of wastage of coal is the employment of unskilled stokers. There are 45,000 users of steam plant in Great Britain. Up to the present, reports on 364 firms have been scrutinised, and it is estimated that a saving of approximately 106,000 tons will result. This saving can be effected without any serious alteration to plant in the following directions: Obtaining greater efficiency in the combustion of fuel, education of stokers, utilising the heat in the gases to better advantage, using exhaust steam for heating feed water, adjusting engines to use more efficiently the steam generated, using the hot water from the condenser discharge for boiler feed purposes instead of cold water, effective lagging of steam pipes, and disconnecting steam pipes not in use, &c.

Educational.

Battersea Polytechnic.—The courses at this polytechnic prepare for the B.Sc. (Eng.) of the University of London and for the Polytechnic Diploma.

The day courses commenced on Sept. 24 and the evening courses begin on Sept. 30. The latter cover c.c. and a.c. engineering, electrical design, electric traction generation, distribution, &c. Calendars may be obtained from the secretary, Battersea Polytechnic, London, S.W. 11.

Northampton Polytechnic Institute.—The full day courses in civil, mechanical and electrical engineering will commence on Sept. 30.

The courses in civil and mechanical engineering give a thorough grounding in engineering work, and, in the third and fourth years, include specialisation in various directions, such as automobile and aeronautical engineering. In electrical engineering, with similar grounding, the specialisation is in the direction either of heavy electrical engineering or of telegraphy and telephony, including radio telegraphy. There are also full and part time courses in technical optics.

City of Bradford Technical College.—The 27th (1918-19) session began on Sept. 23, and an abridged prospectus gives particulars of the day courses in engineering, chemistry, &c. There is a special course for engineering apprentices, and arrangements have been made for attendance of students at certain courses of Leeds University.

Appointments Vacant.

Paisley Corporation invite applications for the position of manager of the Burgh electricity works. Salary £600 per annum, with free house, &c. Applications to Town Clerk, Paisley, by Oct. 9. *See an advertisement.*

A sub-station attendant is required by Stepney Borough Council. Applications to the engineer (Mr. W. C. P. Tapper), 27, Osborn-street, Whitechapel, London, E. 1, by Oct. 1.

A temporary assistant lecturer and demonstrator in physics is required for the University College of South Wales and Monmouthshire. Salary £100 for the two terms, with certain fees. Applications to the Registrar by Sept. 30.

An electricity supply company advertises for an outside working foreman.

Business Items.

The Western Electric Co., Ltd., North Woolwich, notify that their export sales department has removed to Oswaldestre House, Norfolk-street, London, W.C. 2. Telephone "City 5400."

Switchgear.—The General Electric Co. (Ltd.), 67, Queen Victoria-street, E.C.4, has recently issued section X. of the 1918 edition of its catalogue, which is devoted to high-tension switchgear, lightning arrester equipment, &c.

Compton Accumulators.—A printer's error occurred in the advertisement of the Compton Trading Co. which appeared in the issue of THE ELECTRICIAN for Sept. 6. The price of Compton accumulators was erroneously given as 10s. per dozen. The actual list price is 60s. per dozen. The company holds a good stock of the three months' guaranteed battery.

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* To be within the certificate a man in Grade III. must have been born in or before 1893.

Inclusion in the list does not in itself confer exemption, but each man must obtain a certificate from a tribunal, and exemption is not necessarily granted.

A de-certificated man desiring to renew application for exemption on any of the other prescribed accounts must lodge his application with the appropriate tribunal not later than the fourth day after the certificate ceases to be in force.

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Municipal Accounts.

Birkenhead.—The gross capital expenditure of the tramways department at March 31 was £375,699, of which £185,320 has been repaid or provided for repayment.

Revenue was £97,838 (compared with £80,748 in previous year), and working expenses were £53,815 (£42,106). Interest required £16,492, and sinking fund, &c., £10,138. leaving net profit £17,372 (£13,653). Passengers carried were 20,538,476 (17,950,433) and car-miles run 1,219,250 (1,186,186). Revenue was 19·25d. (16·33d.), and working expenses, including power, were 10·39d. (8·26d.) per car-mile.

Blackpool.—The electric light fund accounts for 1917-18 show gross capital expenditure £255,409. Sinking and reserve funds amount to £68,692.

Revenue was £57,941 (compared with £47,038 in previous year), gross profit £18,267 (£19,070) and net profit £358 (£2,478). Units generated were 6,375,398 (5,957,485) and sold 5,451, 827.

Hastings.—The electricity department accounts for the year ended March 31 show gross capital expenditure £179,724 (increase £696), of which £83,144 is outstanding.

Income was £20,941 (compared with £19,087 in previous year), working expenses were £14,404 (£13,056), gross profit was £6,537 (£6,030). Interest and sinking fund required £11,114 (£11,126), and the net result was a deficit of £4,628 (£5,257). Total costs, exclusive of capital charges, were 3·28d. (3·60d.) per unit sold. Units generated were 1,150,553 (905,042) and sold 933,904 (799,674). Total maximum supply demanded was 531 kw. (460 kw.) and load factor 20·08 (19·84) per cent.

West Bromwich.—The accounts of the electric supply and tramways department for year ended March 31 have been issued.

The total income of the electricity undertaking was £41,951, compared with £32,047 for 1916-17. The expenditure was £44,564, an increase of £15,106, and the deficit was £2,613, compared with £2,589 surplus. The price of current has been increased as from July 1.

The accounts of the tramways show, after charging interest on loans and sinking fund instalments, a deficit for the year of £545. After deducting the credit balance from 1917, the net deficit is £82.

Worcester.—The accounts of the electricity department for the year ended March 31 were recently adopted by the Council.

The revenue was £31,393 (against £25,178 in previous year), working and general expenses were £16,086, leaving gross profit £15,307. Instalments of loans required £7,282, dividends and interest £4,574, and income tax £314, the net profit being £1,762. Total works cost was 0·77d. against 0·86d.) per unit

New Companies.

BOWLING & CO. (LTD.) (151,365)—Private company. Reg. Sept. 5, capital £10,000 in £1 shares, ironfounders, mechanical and electrical engineers, ironmongers, tool makers, &c. First directors are A. T. Simpson, F. A. Harris and W. W. Crawford. Reg. office, 100, High-street, Sutton.

COVENTRY FOREMEN'S ASSOCIATION OF ENGINEERING & ALLIED TRADES (LTD.) (151,281.)—Reg. Aug. 26, capital £4,000 in £1 shares, to promote the mutual acquaintanceship of and exchange of opinions by foremen, managers and departmental heads of the engineering and allied trades of Coventry, to organise lectures, demonstrations and visits to works and other places, to encourage inventions, &c. The subscribers (who are also the first directors) are: J. H. A. Bagley, W. Greenall, F. G. Meadows, E. L. Roberts, G. W. Donald, G. W. Eastwood, and L. W. Williamson. Reg. office, 7, The Quadrant, Coventry.

A. LEGE & CO. (LTD.) (151,226)—Private company. Reg. Aug. 20, capital £2,000 in £1 shares, to take over business of mechanical and electrical engineers and scientific instrument makers, carried on at 47, Lofting-road, London, as A. Légé & Co. First directors: W. Jepson, F. W. Bailey and A. E. Walker. Reg. office: 47, Lofting-road, Islington, N.

E. NASH & CO. (LTD.) (151,397)—Private company. Reg. Sept. 11, capital £5,000 in £1 shares, to take over the business carried on as "Johnson's Motor Works," and to carry on the business of motor, mechanical and electrical engineers, &c. First directors are E. Nash, C. R. Ellis and J. Hartas. Reg. office: Springfield-avenue, Harrogate.

NATIONAL ALLOYS (LTD.) (151,317.)—Private company, reg. Aug. 29, capital £10,000 in £1 shares. Manufacturers of and blenders of alloys, galvanisers, aluminium and zinc workers, metallurgists, electric cable manufacturers, &c. First directors are E. Le Bas and H. R. Everson. Reg. office, Dock House, Billiter-street, E.C.

TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN (LTD.) (151,298.)—Private company, reg. Aug. 27, capital £3,000 in £1 shares. To acquire business of Technological Institute of Great Britain carried on by G. L. Bonnaud. Reg. office, Thanet House, 231, Strand, W.C. 2.

A. G. TURNEY ENGINEERING CO. (LTD.) (151,323.)—Private company. Reg. Aug. 30, capital £2,000 in £1 shares, mechanical, motor, electrical and marine engineers, machinists, &c. First directors are J. Ismay and A. G. Wood.

WESTON ELECTRICAL INSTRUMENT CO. (LTD.) (151,376.) Private company. Reg. Sept. 6, capital £10,000 in £5 shares, electrical and mechanical engineers, metal workers, &c. Reg. office: Audrey House, Ely-place, E.C. 1.

City Notes.

BRITISH INSULATED & HELSBY CABLES (LTD.)—Owing to the condition of his health, Dr. E. K. Muspratt has resigned the chairmanship of this company, and Mr. James Taylor has been elected chairman in his stead. Dr. Muspratt has consented to remain on the board as an ordinary director, and Sir Alexander Roger has also been elected to a seat on the board.

COMPANIES STRUCK OFF THE REGISTER.—The following companies were struck off the Register of Joint Stock Companies on Sept. 3:—Argentine Electrolytic Synd., Bachelet Levitated Railway, Bridgwater Construction Co., Crowther & Co.'s Electrical Industries, Davis Electrical Co., Electromobile Co., Miners' Lamp Electric Lighting Co., Salt Lake & Ogden Gas & Electric Light Co., Spiral Regulating Dynamo Co.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The board have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at rate of 4 per cent. per annum, tax free, on the ordinary shares, both for the half-year ended June 30 last, and payable on 1st prox.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—Mr. J. M. Falkner presided over the ordinary general meeting last week, and after dealing with the accounts for 1916 and 1917 gave reasons for increasing the capital of the company. He said they were preparing for a great diminution of the present demand for war material and providing for corresponding civil expansion. They had under consideration schemes for directing their resources into such channels as were best suited for their equipment and capacity. They had anxious times before them and the period of transference would not be easy. One of the main requisites for development was that they should be able to put their hands upon money. Their financial advisers strongly counselled them to take the present opportunity of strengthening their financial position, and they were, therefore, asking the shareholders' authority for an issue of third preference shares. The money market had changed so completely in the past four years that it would be useless to attempt to issue at present the £1,000,000 of second preference shares. They held those in reserve, and were asking for £2,500,000 non-cumulative third preference shares. They intended to issue at once £1,000,000 at par at 6½ per cent. interest.

The Round Table.

By "kVA."

A correspondent calls my attention to the following headline:—"Ten thousand prisoners captured with the Wotan Switch." Evidently this switch is a "line breaker"!

* * * *

A good story comes to hand, which illustrates the type of "engineer" now in the service of the Government. One of these individuals, whose department does not matter for the moment, had ordered some pinions in the provinces and chafing at non-delivery wired to know the cause. A reply-wire stated that the pinions were ready except for cutting the keyways. The departmental genius replied: "Despatch pinions at once, *let keyways follow*"!!!

* * * *

A writer in *The Times* is in a quandary as the following shows:—"A short time since the Ministry of Food sent the following:—'It is unnecessary to use electric light for passages, bath-rooms or bed-rooms. A candle would be amply sufficient, or a nightlight where continuous light is not needed.' In *The Times* of Monday, Sept. 16, I read:—'The Fuel Controller wishes to point out that the use of candles and lamps in bedrooms and other parts of the house where there is gas or electricity is an unpatriotic action. If this growing practice is not stopped there will soon be a famine in paraffin and candles.' I am honestly most anxious to carry out the directions issued to us by the authorities. But I confess that I find a difficulty in complying with both of the above requests at the same time."

Perhaps some "Round Table" reader will offer a suggestion.

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, September 24, 1881.]

ELECTRIC LIGHT IN INDIAN COTTON MILLS.—It is stated that Muir Cotton Mills, at Cawnpore, started some years ago by some of the European residents, are in a flourishing state. The electric light is working well, and nearly doubles the out-turn of the mill.

THE TELEPHONE IN SOUTH AUSTRALIA.—We hear that a telephone line has been erected between the Exhibition in Adelaide and the Exchange; also that the Government, for the benefit of the public, intend to form a telephone exchange to be worked under their own control.

ELECTRICAL ILLUMINATION IN VENICE.—The illuminations of various portions of Venice on the occasion of the Geographical Congress, combined with a visit of the King and Queen, have been very brilliant and beautiful. In these illuminations the electric light has played a conspicuous part, the façade of St. Mark's being lighted by reflected electrical light so disposed as not to interfere with the general illumination, the effect of which is said to have been very beautiful.

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ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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CONTENTS.

NOTES 467
Arrangements for the Week 469
Municipal Tramways Association. Annual General Meeting 470
Electric Winding Engines and Mine Hoists. By H. H. Broughton. Illustrated.—*Continued* 473
New Commonwealth Edison Turbine. By J. F. Johnson. Illus... 475
The Labour Outlook. By Our Labour Correspondent 477
THE DISABLED SOLDIER 478
REVIEW 478
The Snook Apparatus for the Generation of High-Tension Uni-Directional Currents. By Russell S. Wright, M.I.E.E. Illus. 479
CORRESPONDENCE 480
The Manufacture of "B.L.I.C." Magnetos. Illustrated 480
Motor-Operated Oil Break Switches. Illustrated 481
B.T.-H. Lever Switches. Illustrated 481
Volunteer Notices 481
Patent Record 482
Commercial Topics 482
Electricity Supply 483
Tenders Invited and Accepted 484
Companies' Meetings and Reports 486

Notes.

The Municipal Tramways Association.

MOST annual conferences in these days are more or less half-hearted affairs, and this can only be expected. The annual general meeting of the Municipal Tramways Association was no exception to this rule. The President, Alderman S. FLINT, who is chairman of the Leicester Tramways Committee, delivered an address in which he dealt with the affairs of the Association generally. Among these, prominence was given to labour questions. Tramway undertakings during the past year have had little freedom from such questions, which have caused considerable anxiety. Advances in wages and increased cost of materials have led to inevitable increases in fares, and in certain cases the Board of Trade has given authority to raise the statutory limits. As is well known, the Committee on Production has recently granted a 5s. extra bonus to the women employed on tramways as well as to the men, on the basis of equal pay for equal work. It is interesting to note from the Presidential Address that the cost has been proved to be higher when cars are run by women than by men. Presumably this refers to women drivers. As to the main technical business of the meeting, this consisted of a Paper by Mr. E. HATTON, engineer and general manager of the Newcastle-on-Tyne Corporation Tramways. Mr. HATTON is already well known for his criticism of the wholesale generation of electric power as proposed by the Coal Conservation Sub-Committee and by the Board of Trade Electric Power Supply Committee. The objection consists briefly in the view that the increased capital expenditure will be so heavy as to destroy any benefit. At the same time Mr. HATTON admits that a national scheme must ultimately lead to a general reduction in charges, and his chief objection seems to be that these reports put forward too rosy a view of things, and thus "even estimable people" are led to believe that within a few weeks at most they will have a power supply at extraordinarily cheap prices. All we need say in regard to this view is that these estimable people must be very extraordinary people if they are so misled, and must be entirely devoid of any knowledge of engineering matters. In all probability the Committees in question never thought of safeguarding themselves against readers of this class. At the same time, we agree with both Mr. HATTON and with certain speakers in the discussion which followed, that it is undesirable to rush any scheme of this kind. It appears to us that engineers should not go to either one extreme or to the other, and this surely is one good reason for the appointment of commissioners

No Extreme Views.

IN the discussion there was some indication of extreme views which are illogical. Thus, Mr. R. H. WILKINSON remarked that if Huddersfield had not established a tramway power station the department would have had to pay about 3d. per kilowatt-hour, whereas the cost of generation had not reached ¾d. We can scarcely believe that any power station in these days would make a charge of this kind, but 10 or 15 years ago it was a different matter. Similarly, Mr. C. L. E. STEWART expressed the view that some little stations can beat the big stations. This again is an extreme view. It is only fair to compare up-to-date stations of both types. Obviously it is quite possible for a small modern station to give better results than an old larger station, but this is no argument in favour of the small station. We think that the point of view that should be taken was well expressed by Mr. C. FURNESS, of Blackpool, who remarked that there was no intention of scrapping efficient plant. On the other hand, since the year 1914 capital expenditure has been stopped. Immediately after the war a very large expenditure will be required, and it is undoubtedly in the national interest to see that this expenditure is made in the most efficient way. Efficient expenditure will certainly not result by each town developing a small station, but rather by the development of large schemes on proper, standardised lines. We are also inclined to agree that in comprehensive schemes power supply for tramways is a comparatively small item, and that the Association might have found a subject for discussion which had not already been to a large extent exhausted by discussions elsewhere.

The Extension of Foreign Trade.

THE desirability of increasing our foreign trade immediately after the war is generally agreed, if there is to be a prompt recovery from the present financial position. From this point of view it is, therefore, desirable that full knowledge should be obtained of the needs of foreign markets. So far, we have relied to some extent upon our Consular Service, and this has proved to be far from satisfactory. In the future we hope that this service will be very much improved, and that it will be able to assist our industries to a much greater extent. In any case, however, it will take a considerable time for our suggested trade commissioners to get thoroughly to work, and, therefore, in some cases it may be desirable to take more immediate steps. This, evidently, is the opinion of the British Engineers' Association. This Association has decided to investigate certain

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markets by sending out their own commissioners, and it is interesting to note that the Government has agreed to bear half the cost of the first investigation, which is to be concerned with Brazil. There is always the question as to how far the Government should assist private enterprise in various directions. It seems to us that the policy should depend on whether the Government will ultimately gain by the steps that are to be taken. It is quite clear that if a considerable trade can be developed by an investigation of this kind in a country like Brazil, the Government will gain by increased revenue, and thus it is quite justifiable that Government should give assistance. We welcome this step on the part of the Government as indicating a greater desire to take a proper interest in industry. As far as the scheme itself is concerned, we note that a single commissioner is to be sent out, and he will spend something like a year in investigation. We rather doubt whether one man can cover so large a field adequately, and we suggest that it would be well for him to have some assistants well acquainted with those branches of engineering activity with which the commissioner himself may not be thoroughly familiar. We hope that the Association have this point in mind, as it would be unfortunate if the scheme were not thoroughly fruitful for lack of a small additional expenditure.

Electric Welding for Ships.

The importance which electric welding is assuming in ship construction has been brought before public notice by the account of the launch of the first entirely electric welded vessel a few weeks ago. Further evidence of progress is afforded by the tentative regulations on the subject issued by Lloyd's Register of Shipping, to which we referred recently. While there is nothing of great novelty in the regulations themselves, this decision to authorise electric welding in substitution for riveting marks an important step forward, and it may be expected that in the near future such methods will be very widely used. Experience has shown that greater speed of construction is undoubtedly facilitated by electric welding, and this advantage will become more marked in course of time as the process becomes more familiar. The difficulty of its application to shipbuilding lies in the fact that the stresses at sea are so complex and difficult to determine, and the consequences of a failure so exceptionally serious. Authorisation of this method for maritime work is thus a strong testimony to its reliability. While electric welding has long been used for ship repair work, it is only within recent years that sufficient experience has been attained to warrant its application to portions of vessels subjected to exceptional stress. The regulations accordingly prescribe in some detail the form of weld to be used. A welded joint in general requires to be either lapped or strapped. The tensile stress of butt welds is about 90 to 95 per cent. of the unwelded metal; in the case of lap-welds, 70 to 80 per cent. is anticipated. We observe that according to "Engineering," the connection by electric welding of mild steel containing about 0·15 per cent. of carbon presents special difficulties, as the weld tends to become deficient in ductility during the process. It appears that operators can be trained very quickly for repetition and routine work. Much more resourcefulness and experience is needed in much of the special work involved in shipbuilding, but the process, once mastered, is undoubtedly lighter and less tedious in operation than many operations now done by hand. One point of interest is the saving of material possible through the avoidance of angle bars to connect surfaces at right angles. In many cases connecting material might be eliminated if sure means could be found for keeping the surfaces in good contact while the weld is being performed. With this end in view electromagnetic methods have been suggested, and it is probable that the wider application of electric welding will bring with it many other interesting and subsidiary applications of electrical methods.

Industrial Reconstruction Council.—A conference on Interim Industrial Reconstruction Committees will be held under the auspices of the Industrial Reconstruction Council on Tuesday, Oct. 8, at 6 p.m., in the Hall of the Institute of Journalists, 2 and 4, Tudor-street, E.C. 4. The subject will be introduced by Mr. W. Henderson Pringle, of the Ministry of Reconstruction, after which the discussion will be open. No tickets are necessary.

"Steel Structures."—In our issue of Sept. 20 we mentioned in a note that the British Engineers' Association were now publishing a quarterly publication dealing with steel structures, and we pointed out the undesirability of increasing publications at a time when there was a serious shortage of paper. We are glad to learn from the Association that one of the reasons for issuing the publication was that it obviated the necessity for each member of the section to issue a catalogue, and also that it was a co-operative form of advertisement.

Waterways in the United States.—The proper utilisation of the water-ways in the United States for the conveyance of freight is being actively taken up. We note that two commissions on the subject have been formed, dealing respectively with the Lower Mississippi and Warrior rivers, and the inland system between Boston and North Carolina. As an indication of progress it is interesting to note that $8,000,000 have been appropriated for barges on the Lower Mississippi. The New York State barge canal, which, it is anticipated will be opened during the present year, is also an interesting engineering project.

Electric Headlights on Swiss Locomotives.—According to "L'Industrie Electrique," electricity has only recently been introduced for lighting on Swiss locomotives, although its application for signals and train-lighting is quite familiar. A description is given of the method employed on the St. Gothard railway, the current being supplied from a small turbo-dynamo installed on the locomotive, weighing about 70 kg. The turbo-sets are made to generate three chief pressures, namely, 24, 36 and 47 volts with a corresponding power of 250, 300 and 350 watts. This enables lamps for headlights giving respectively 200 c.p., 240 c.p. and 280 c.p. to be employed.

Shortage of Tungsten.—According to the "Iron Trade Review," the demand for tungsten has become so vast that there is a probability of a severe shortage in the near future. Mr. J. H. McKenzie, of the Bureau of Mines, U.S.A., is quoted to the effect that there is not a sufficient supply of tungsten in sight for one year's requirements for the world. It is stated that Great Britain, France and the United States are entering into negotiations for the division of the world's supply, the proposition being that Great Britain should retain all the tungsten available from Burma, the United States all produced within her own borders, and the production from other sources divided between the three countries named.

Wireless as an Aid to the Police.—With the many special applications of wireless in the war one is apt to overlook new developments likely to prove of service in times of peace. An instance is presented in the use of portable wireless installations in the service of the police, to which reference is made in the "Wireless World." The New York Police Department Signal Corps are now employing a wireless telephone and telegraph motor truck which is likely to prove of value in the event of ordinary means of communication being temporarily out of service, and would no doubt also be uesful in districts where telephone or telegraph connections are scanty. The antennæ extend from one high mast on the front of the truck to a shorter mast at the rear. The wireless

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truck is an essential part of the signal equipment of armies in modern warfare, and it will doubtless find many other applications when peace is restored.

A Standard in Radiotherapeutics.—The problem of a suitable standard of quantity for use in radiotherapeutics has received much attention, and cannot be said to have been completely solved. Most of the devices have been based on the application, as the unit, of a certain fraction of the energy required to produce inflammation or redness of the skin, but this is naturally a somewhat indefinite measure, as is shown by the fact that the ratio most commonly employed, originally one-third, is now taken as one-fifth. Mr. Bordier, in a recent communication to the Académie des Sciences, proposes as an alternative a method depending on chemical dissociation, and has devised a "chromo-radiometer," providing five chief scales (based on colouration) which will suffice for all clinical cases. The unit is defined as the quantity of X-rays capable of liberating 0·1 milligramme of iodine in a cubic centimetre of a 2 per cent. chloroformic solution of iodoform of a thickness of 1 cm., and placed in the shadow of the radiation. This unit, it is contended, depends on precise physical processes, which is not the case in the methods previously mentioned.

"Key Industries" Exhibition.—The Key Industries Exhibition, which has been organised by the Industrial Section of the Tariff Reform League, with the sanction of the Ministry of Munitions, will be opened on Monday, Oct. 7, by the Rt. Hon. J. Austen Chamberlain, M.P., at the Central Hall, Westminster, London, S.W. 1. This exhibition will be one of the most remarkable ever held, and will indicate to what extent national industrial expansion is possible through the establishment in this country of certain vital key industries. Its object is purely educational, and the exhibits have been strictly confined to products capable of illustrating the factors of the more important key industries. Many of the largest and most important industrial companies in Great Britain have actively co-operated with the Industrial Secrion of the Tariff Reform League in working out the facts concerning the different sections of the Exhibition, which are arranged on an entirely novel but striking principle. No charge will be made to the public for admission to the Exhibition, which will remain open until Oct. 22, after which it will be shown in Manchester and other leading provincial centres.

Extension of Water Transport in Germany.—The overwhelming demands made on the German railway systems since the outbreak of war have led to the re-consideration of many ambitious pre-war schemes for extending her facilities for water transport. The completion of the Midland Canal between Hanover and Magdeburg would ease matters considerably, and much might be done by improving the conditions of navigation on the chief rivers. In many cases, however, the consent of other nations is needed for the full development of such schemes. For example, on the Rhine and the Elbe the co-operation of Austria and Holland respectively is needed. The lists of projects include a Main-Weser canal, and the linking up of German rivers with the Danube. Finally, there is the vast scheme of securing a complete waterway connection between the Baltic and the Black Sea by using the courses of the Dwina and the Dnieper. These plans are urged mainly on the ground that they would place the Central Powers in a better position to carry on the war against the Western Powers. As, however, it seems to be admitted that most of them could not be embarked upon in the present circumstances, they may probably be regarded as essentially problems of reconstruction.

Glass as a "Key" Industry.—We have received a letter from the chairman of the Glass Industry Interim Industrial Reconstruction Committee calling attention to the importance of glass as a "key" industry in this country. From the German Press it appears that Germany will seek to restore her credit abroad after the war by a concentration of effort upon export of certain chosen manufacturers. Chemicals are named as the first of these, and then comes glass. The prominent position given to glass is not because it will directly bring wealth to the German people, but because it is a "key" industry and opens the gate to many others. There is at present an opening in the glass trade for investment of capital and for well paid skilled labour, but there will be danger if the industry is not supported in a prompt and practical way after the war. Germany's rise in this industry has been attributed directly to the English policy of the "open door." It is feared that this policy may be carried to such an extent that the British glass industry may become extinct. The Committee do not ask for support to bolster up an inefficient industry so that profits may be given at the expense of the nation, but that a chance of full development may be given to this "key" industry which may thus be saved from the hands of Germany, who is determined to capture it at all costs owing to its position.

Regulations for Automobile Headlights.—A very comprehensive report on automobile headlights has been issued by a committee of the Illuminating Engineering Society in the United States. Some concrete suggestions are made for the limitation of the spread of the beam, combined with the requisite minimum illumination. The essential principle appears to be to avoid, so far as possible, light emitted above a certain horizontal plane, 42 in. above the road being selected in this case. Another important point is the discretion to be allowed to the driver. From the ideal standpoint it is doubtless preferable that the brightness of headlights should be varied according to the conditions under which driving is undertaken, but it is rather an open question whether such latitude is not liable to abuse. We notice that it is suggested that there should be restrictions as to driving where the road illumination is less than 0·001 ft.-candle—a condition which we imagine must be very frequently violated in streets as at present lighted in this country. At present the restrictions imposed by the authorities in England necessarily invalidate any attempt to prescribe general conditions for headlights. But in view of the darkness it seems all the more desirable that military and ambulance cars, which are allowed greater freedom, should not be unduly brilliant. We notice that a committee of the London Safety First Council has recently issued a Report on this subject suggesting conditions, similar in principle to those being advocated in America, with which such cars should comply.

Obituary.

Sec.-Lieut. W. S. Thain.—Sec.-Lt. W. S. Thain, formerly with the General Electric Co., Witton, and later with the Midland Railway Co., was accidentally drowned in France on Sept. 15.

Personal.

Mr. A. E. Berriman, chief engineer to the Daimler Co., has been appointed by the Minister of Munitions to be Deputy Controller of the Technical Department of the Department of Aircraft Production of the Ministry, in succession to the late Prof. Bertram Hopkinson.

Mr. E. Pelham Bennett, London and South of England manager for Simplex Conduits (Ltd.), and formerly the company's manager in Liverpool, has been appointed to the Royal Air Force, Air Construction Service, and leaves his present position immediately to take up his new duties.

Lieut. W. P. Durtnall, R.N.V.R., has been appointed a Staff Officer, 3rd class, of the Royal Air Force, and has been granted a temporary commission as Captain.

Arrangements for the Week.

FRIDAY, Oct. 4th (to-day)

Institution of Mechanical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. Annual Thomas Hawksley Lecture, "The Experimental Study of the Mechanical Properties of Materials," by Dr. W. C. Unwin, F.R.S.

FRIDAY, Oct. 11th.

Electro-Harmonic Society.

8 p.m. At the Holborn Restaurant, London, W.C. First Smoking Concert of the Season.

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Municipal Tramways Association.

Annual General Meeting.

The 17th annual conference of this Association was held in the Town Hall, Leicester, on Thursday and Friday last, Ald. S. Flint, J.P., chairman of the Leicester Tramways Committee and president of the Association, occupying the chair.

Amongst those present were Messrs. R. G. Acland (Chesterfield), J. Aldworth (Nottingham), A. Baker (Birmingham), J. Barnard (Bolton), H. E. Blain (L.G.O.C.), F. Buckley (Wigan) J. F. Cameron (Northampton), W. Chamberlain (Oldham), C. Clarke (Birkenhead), W. Clough (Bury), J. H. Cowell (Blackburn), G. T. Craven (Reading), Jas. Dalrymple (Glasgow), A. R. Dayson (Sunderland), James Devonshire (Chairman of Board of Trade Tramways Control Committee), A. T. Eardley (Stockport), W. H. Ellis (Chester), C. R. Everson (Plymouth), A. R. Fearnley (Sheffield), A. L. C. Fell (L.C.C.), P. Fisher (Dundee), W. Forbes (Aberdeen), C. Furness (Blackpool), J. W. Galloway (Halifax), T. B. Goodyer (Croydon), R. H. Greene (Ilkeston), J. B. Hamilton (Leeds), E. Hatton (Newcastle), E. Holt (Ashton-under-Lyne), R. L. Horsfield (Walsall), H. Jagger (Rotherham), T. Kendrew (Southport), A. T. Lambert (Maidstone), A. F. Lucas (Leicester), J. M. McElroy (Manchester), J. D. S. Moffet (Belfast), H. Mozley (Burnley), W. Murray (Walthamstow), G. Naylor (Nelson), G. A. Newsome (Darwen), E. S. Rayner (Doncaster), F. H. Saunders (Lowestoft), F. Schofield (Stalybridge), C. O. Silvers (Wolverhampton), J. F. Simpson (Preston), A. B. Slater (Burton-on-Trent), L. Slatter (West Ham), T. U. Smith (Leicester), C. J. Spencer (Bradford), W. R. Spaven (Portsmouth), C. L. E. Stewart (Rawtenstall), H. P. Stokes (Bexley and Dartford), W. C. Ullmann (East Ham), H. Webber (Keighley), J. White (Hull), T. R. Whitehead (Coventry), J. C. Whiteley (South Shields), R. H. Wilkinson (Huddersfield), J. C. Williams (Erith).

Sir Albert Stanley (President of the Board of Trade) was unable to attend owing to the recent railway strike; but he sent a telegram to the President, stating that a matter to which he had intended to refer in an address to the members was the vital question of coal economy. He was sure he could rely upon the members to make every effort to economise. Tramway undertakings were most certainly not being singled out for special treatment. If and when coal rationing for industrial purposes was put into force, many industries would be compelled to make a much greater reduction than 15 per cent. Even certain munition works were short of coal, and for several months it had not been possible to ship to our Allies or to neutral countries the amount of coal which the Government was under obligation to despatch. With regard to those undertakings which made the reduction asked for, if would be a special obligation of the Board of Trade and the Coal Mines Department to see that they obtained the coal necessary to run the reduced services.

The Mayor (Ald. J. North) delivered an address welcoming the members, whom he subsequently entertained at luncheon.

PRESIDENTIAL ADDRESS.

In the course of his Presidential Address, Ald. Flint dealt with the history and the industries of Leicester, and the public utility undertakings of the Corporation. He said the gas, electric and tramway undertakings and markets were all owned and run by the Corporation, the two electricity stations being controlled by the Tramways Committee. Dealing with the work done by the Executive Council during the past year, he had no hesitation in saying that the work and the strain had been much greater than during any previous period. While the Association congratulated Mr. Spencer (the secretary) on his recent appointment, they would be sorry to lose him as a member of the Association, to which he had rendered valuable services. The secretarial duties of this Association were becoming so numerous and so heavy that unless extra assistance were given he was afraid no one would be willing to accept the post, and the Executive Council should be empowered to make suitable arrangements for carrying on the work of that office.

Amongst the more important matters the Executive Council had had to consider were the twin questions of coal conservation and electric power supply and the Parliamentary reports thereon. These had raised discussions of immense importance. Mr. Hatton, of Newcastle, would read a Paper on this subject. Another matter that had occupied much time and consideration of the Council was the question of the creation of Joint Industrial Councils, as suggested in the Whitley Report. This matter is very much to the front. They had had several conferences with the men's representatives, and he believed the outlines of a scheme would be submitted to the members at an early date. The continued advances in wages and all classes of materials had placed heavy burdens on many of their undertakings, necessitating further increases in tram fares. Those municipalities that had hesitated or refrained from taking action in this respect were in some cases faced with probable deficits when making up their annual accounts. In the interests of sound finance, charges should be increased under present conditions where it could be done. In many cases it had been found that it could not be done unless the statutory limits were raised or abolished. The Council had had joint conferences with the Tramways and Light Railway Association on this matter. Joint deputations secured interviews with the Board of Trade, with the result that Parliament had given authority to the Board of Trade to raise the statutory limits under certain conditions. Whether those conditions met the case was for that conference to consider and decide. As the result of an appeal in regard to increased bonus for tramway employees, the Committee on Production granted the 5s. extra bonus to the women as well as to the men, thus reversing their former decision, and in spite of the fact that it was clearly proved that it cost much more to run the cars by women than by men. This raised a very serious question. If one side to an arbitration were allowed to appeal against an award, then the other side might claim the same right, and that might lead to serious results. Another matter of considerable interest was the appointment of the Tramways (Board of Trade) Committee. He was not very favourably impressed with this proposal from the first. Perhaps he was over jealous for the freedom of their municipalities from red tape and central control, especially in the management of their trading undertakings. The avowed object for the appointment of this Committee was to assist their undertakings in securing sufficient labour and materials to carry on their work. If that were its chief object, then good only should result. The success of the municipal tramways of the country had been obtained, not so much by Government assistance as by local enterprise and effort, and he was rather alarmed when it was proposed to set up other authorities to exercise control over them. All the indications were that they would have to carry on under greater difficulties than any they had yet had to face.

Mr. E. Hatton (engineer and general manager of the Newcastle-on-Tyne Corporation tramways, then read a Paper, of which the following is an abstract:—

SOME NOTES AND CONSIDERATIONS ON THE POST-WAR POSITION OF ELECTRIC POWER SUPPLY.

Entering so closely as it does into the daily life of the majority, either in domestic requirements, industries or travelling facilities, the production and distribution of electric power calls for the most careful consideration of the public.

In its inception, electricity was primarily regarded as an illuminant, and not until the advent of street traction did it make much headway on a large scale in this country. The power companies in the north-east coast area were amongst the foremost in rapid development, due to the exceptional facilities in this area and wide range of action in their operations. Municipalities, however, not enjoying these advantages were compelled to adopt a more cautious policy in the expenditure of the ratepayers' money. In addition, their efforts were regarded by many as encroaching on private enterprise, and in a measure this also had a retarding effect. The limitation of local areas also was too restricted, and in the event of a local authority desiring to break the bounds, local feeling was created which, as a rule, could only be appeased by concessions adding to the cost of power production.

This great war, however, has caused searching investigations, and now we all appear to be seized with a strong desire to put the industries of the country upon a proper basis. These investigations have produced two reports on Electric Power Production, which contain valuable suggestions. It would, however, have shown a better spirit if some of the insinuations regarding the past efforts of municipalities had been omitted, and it would also have ensured a better reception for these reports. The implied benefits that will be

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derived from their complete adoption appear too rosy, and have the effect of inducing many people to believe they are about to receive something for nothing, or electric power at impossible figures. Electric power can be produced very cheaply in large quantities with proper facilities in most large commercial centres in this country, but it is the economical distribution of such commodities or keeping middlemens' profits within reasonable limits which ultimately determines the price of any article. In our large cities the costs incurred in taking up and relaying street works is a very heavy item of expenditure, but whilst trying to avoid expenditure due to not laying mains of sufficient capacity in the early stages of development, one has at the same time to keep in mind the annual charges from too venturesome a policy in this direction. When possible, space should be left at the sides of roads to accommodate electric cables, &c., arranged so that the cost of taking up and relaying would not be expensive. The policy pursued in most towns in this country has been to have one authority responsible for production of electric power for general commercial uses, light and traction supply, and it is alleged that the traction supply has been overcharged to support the sale of power to other users at lower charges than were warranted. Without the traction demand in the early stages the power production in some cases would have cut a poor figure, but where the local authority is the owner of power supply and traction and where the surplus profits, if any, go into a common fund, is there any reason or argument against the one helping the other? If the traction authority had produced its own power it would as a rule have obtained its supply at a less inclusive cost than purchasing it from some other committee, the result being that the surplus profits of the tramway would have been greater. There would, therefore, have arisen demands for reductions in fares and other concessions and with the continual increase in the costs of operation, a point would have been reached earlier when the fares would have had to be materially increased or the up-keep of the undertaking neglected. It, however, must not be overlooked that the separate policy of some tramways owning and producing their own power did stimulate the desire and efforts of the advocates of the combined policy to produce power at lower costs; hence the policy of competition in all matters affecting public life must not be lost sight of. The two reports previously mentioned insinuate that we have only in the past been dealing with the subject in a playful mood, and that if we do not now alter our methods we shall be hopelessly left behind by other nations. Criticism, however, on our past conduct does not get rid of our annual charges on existing undertakings, and these charges coupled with the new annual charges on capital account on the proposals in these reports, will ultimately be the measure of our future success and charges for electric power, reduced, of course, in proportion by the influence that increased output will have if these schemes are developed. At present this is an unknown quantity, but must subsequently be very great. In some cases it may, even under the most favourable circumstances, be some time before we again get inclusive prices per unit which will compare with the charges made in 1914, but if the schemes or some modifications of them are adopted it must ultimately lead to a general reduction in charges.

I have been regarded by some technical journals as a reactionary because I dare differ with some of the suggestions outlined in the reports referred to. I deprecate the too rosy view put forward in matters of this kind, leading even estimable people to believe that within a few weeks at most they will have a power supply at extraordinarily cheap prices. Any scheme of general power supply, if it is to be a success, must within a reasonable period be able to carry on its back the annual charges upon the plant which will be superseded or closed down by its adoption, and it seems to me that much of the plant which will be superseded in some areas under the proposed schemes could well be transferred to areas with lesser immediate demands, and be in the meantime used with advantage.

When it was demonstrated by results that electric traction could carry the existing capital charges of the obsolete horse traction out of the additional revenue and profits from its operation, the electrification of tramways forged ahead. If the controlling authorities decide upon the electrification of the railways, the whole policy of the country with regard to electric supply will require to be treated from a wider standpoint, as the existing stations, whilst suitable for ordinary commercial purposes, would not, either in plant capacity or location of the station in many cases, be suitable for the larger purposes. Take the case of an isolated town with its own power station working economically according to its present demands, say located on the main line of any of our principal railways, should that railway be electrified it would rarely be advantageous to extend the small local power station to meet the larger demands. Generally the most advantageous way of dealing with such a case would be to shut down this small station as a generating centre and make it a sub-station of the greater electric supply to the railway system passing through the town. Some declaration should be made by the authorities at the earliest possible moment, as it would allay many conjectures and cause a concentration of thought upon the whole problem from a national point of view, and it would also allay the local jealousies of each municipality desiring to grab a super-power station within its own area, as they would quickly realise there are only certain places where such stations or groups of stations can be economically located. If the railways are electrified then it will bring power supplies into almost every area in this country with great advantages in the future to street and road traction services, &c. Some areas will be able to produce power at lower costs than other areas, and it is a matter which should receive the closest attention of the authorities as to whether standard rates and charges should eventually be set up; in other words, should a universal rate be adopted or differential rates in areas? In the event of differential rates the tendency will be in the future for intense development in some areas where undertakings will gravitate to those areas supplying power at the cheapest rates, whereas I am of the opinion that general development all over the country should be encouraged instead of intensive developments in some areas.

Some areas will have the advantage of waste heat from certain manufactures and processes, and where possible the erection of such works having a surplus of waste heat which could advantageously be used in the generation of power, should be encouraged in areas not now enjoying these advantages. I am of the opinion, having in mind the existing electric power developments of the North-east Coast, that an area embracing the North Riding of Yorkshire and the counties of Northumberland and Durham should be chosen, in the first instance, for a practical demonstration of the policy of general power supply operating over a large area under one authority. The constitution of the Power Boards set up in the areas should in every case have a majority control of public representatives elected by the area, together with the representatives of large consumers. All generating stations in the area, together with the main transmission system of the area, including the power supply to railways and all public bodies, should be under control of the Board, but those localities or towns where preference is in favour of local distribution should, in the first instance, be allowed to act in that capacity only, but, in any case, the power generation and supply mains must be under the complete control of the Power Board.

DISCUSSION.

Mr. J. M. McElroy (Manchester) said the tramway authorities were vitally concerned in the proposals regarding power supply which were now receiving the Government's consideration, as 25 per cent. of the total output of the power stations in the United Kingdom was used for tramway purposes. Their industry provided the central station engineers with the largest and, should he say, the best paying class of customers. There were 93 municipal and 83 company tramway undertakings, and they used 620 million units per annum. Of the total consumption for tramway purposes 79 per cent. was used for municipal and 21 per cent. for companies' tramways. Thirty-eight undertakings had their own power stations and 138 purchased their energy. About 50 per cent. of the total energy consumed was generated in the tramway power stations and the other 50 per cent. was purchased. It had been argued in the past that tramway undertakings could purchase their current more cheaply than they could generate it, but experience had not justified that. Many tramway managers said they had been called upon in the past to pay prices which could not be justified when compared with the charges for energy for other purposes of equal load-factors. Mr. Hatton had asked whether there was any reason why the traction side should not help the power side financially. Tramway managers suspected that exceedingly low prices had been charged to other power consumers, which would not have been possible but for the high prices the tramways had been called upon to pay. To develop our industries by the supply of cheap power obtained at the expense of the millions of workers using the tramways was wrong in principle. He was out for the development of the power supply in a way which would benefit all industries, including tramways. In that connection he welcomed the two valuable reports which had been issued in regard to electric power supply, viz., those of the Coal Conservation Sub-Committee and the Board of Trade Committee on Electric Power Supply. In the former many points were open to criticism, but he thought its main conclusions were worthy of favourable consideration. It suggested the appointment of a Board of Electricity Commissioners, with powers to arrange for the handing over on equitable terms of the generating, transmission and main distribution systems to a new body, and the standardisation for each area of the frequency and voltage of the transmission and main distribution systems. The report of the Board of Trade Electric Power Supply Committee (dated April 29, 1918) proposed that the new Electricity Commissioners should have conferred upon them powers for regulating and encouraging the generation and distribution of electricity, that the existing system under which electricity is generated for small areas should be abolished, that the United Kingdom should be divided into districts suitable with an Electricity Board for each district to

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purchase the generating stations in their district and become responsible by themselves or their lessees for the generation of electricity, and for the establishment of new generating stations and main distribution systems, the present electrical undertakings retaining the right, if they so desire, to distribute electricity in their local areas. A paragraph in the report said the parochial system of generation and distribution should give place to more economical methods, with wider areas of distribution and with standardised pressures and frequencies. The main proposals of the Committee were sound principles, which those best qualified to judge would not dispute. The details would have to be carefully considered before Parliament took steps to give effect to the Committee's recommendations, particularly the financial side of the proposals, and the question of who would be eligible for appointment on the District Boards. Something would have to be done quickly to deal with the present unsatisfactory position of the electric supply industry and to direct its future development. To continue the present wasteful condition of affairs was against the National interest. If we were to keep our end up in competition with foreign countries a cheap supply of power was of great importance, and the subject should be considered nationally and not parochially.

Mr. Harry Webber (Keighley) said he quite agreed with Mr. Hatton's remark that the two reports referred to were too rosy in their anticipations of great results in the immediate future. This new scheme was going to be burdened with a tremendous capital expenditure. It would not only have to compensate existing local authorities for their generating stations, but would have new stations to put down, and a tremendous length of feeder cables. It was also a moot point whether the transmission losses would not almost equal the cost of transit of coal by railroad. The North-East Coast had a big power scheme developed on lines similar to those now proposed, and he did not think they supplied electrical energy much cheaper than it had been supplied in Keighley. For some time before the war the average price for power at Keighley was below ½d. per unit. With 20,000 or 30,000 kw. stations, there would no doubt be a saving in labour, but there would not be much improvement in regard to steam consumption per unit, and a breakdown in a super-station would be more serious than in a smaller one, and therefore the trunk feeders would have to be duplicated perhaps twice or three times, to avoid what would be almost a national calamity. The scheme would, he believed, develop into a satisfactory organisation, but it should not be rushed. At Keighley they were well placed for coal and water, and there were power requirements of 30,000 or 40,000 h.p. in a compact little area, so he thought it was a moot point whether the new Commissioners would shut down such a station and give the Corporation a bulk supply from 20 or 30 miles distant.

Mr. H. P. Stokes (Bexley and Dartford) said the matter should be looked upon in its broad outlook from the national point of view. The principal point was to make the best use of coal, which should be used in a much more economical way than the present means—chiefly by raising steam. That was not a sound way of using this mineral wealth. The National Committee would consider first the primary use of coal, and use it to its utmost advantage, and it seemed to him that they would eventually arrive at a point where electricity would be the by-product and be almost given away. We were rather too apt to think of everything in standardised form. Electricity as it was used in various industries could not be confined to one form, and it might be advisable to set up special standards in certain areas. Coal should be utilised for all it was worth first, and electricity should be a side issue.

Mr. W. Murray (Walthamstow) said from the national point of view there was a consensus of engineering opinion that the scheme was a desirable one. Its success seemed to depend upon what was done with the present generating stations. If they were to be scrapped the new scheme would be handicapped with an enormous burden of debt which would go a long way to prevent its being able to supply electricity at a low figure. Main laying was now exceedingly costly, and there was a possibility of the gain in cost of generation being lost in the cost of distribution, and the Board of Trade Committee made no suggestion as to who was to bear any such loss. The report proposed that tramway power stations should be taken over, while manufacturers' private stations would be left alone. That should not be done when the tramway stations were successful and efficient. The selection of the five Electricity Commissioners should not be left entirely in the hands of the President of the Board of Trade. The report proposed that the District Boards should be small. He thought there was greater safety in greater numbers. The compensation of engineers displaced by the scheme should be compulsory.

Mr. R. H. Wilkinson (Huddersfield) said if Huddersfield had not established a tramway power station the department would have had to pay about 3d. per unit. The cost of generating did not reach ¾d., and they were earning £170,000 per annum.

Mr. E. S. Rayner (Doncaster) said he took it that Mr. Hatton's opinion of the scheme had somewhat altered between the writing of his report and his Paper. No station should be taken over unless the town or area had a guarantee that it would receive a cheaper supply. Whether Government control was more economical and efficient than municipal or company control, was in some cases open to question. It did not appear to be so in the case of the telephone. He was dubious about handing over absolute power to a Board who first of all went in for a clean sweep. Low generation costs were all very well, but if the scheme were burdened with capital charges which counterbalanced the cheapness of generation, the scheme was of little use. Mr. Hatton spoke of a variable price, but if the price to a small town was to be raised to the price of the present generation, why take over the small town. The idea of lumping the supply in any area was that they should have a universal price. It seemed to him that the only way was to have a standard price. Manufacturers could not be spread over any districts where the power was available. Industries were settled in their respective districts because of suitability in other respects. Steel was made in Sheffield because the necessary raw materials were at hand, and Manchester had cotton because the environment was suitable, and so on.

Mr. C. L. E. Stewart (Rawtenstall) said it had been found that some little stations could beat the big stations. At Rawtenstall their works cost was 0·4d., but they had to get a price of 0·9d. a unit to cover all the charges. At the last I.M.E.A. meeting Mr. Fedden said he found that with a station over 10 miles away, having ideal conditions, energy would cost more, with the transmission, than it would if he put down a station somewhere near the centre of the load and had cooling towers and practically every disadvantageous circumstance. He gathered that the Board of Trade Committee's report meant that it was not intended to scrap all existing stations. The less efficient stations were to drop out as circumstances arose, but if necessary, suitable stations in suitable areas would be extended. The important question was the pounds of coal the super-station would have to burn per unit delivered to the consumer. He believed any system with that large area would lose more in distribution than it gained in generation. In taking over the whole show the Government were going to lose one of the most valuable assets—competition between the engineers of the stations in different towns. There were only two things that must be standardised. They must have three-phase, and there must be a standard frequency. Any voltage could be had by putting in a transformer.

Mr. C. Furness (Blackpool) thought the report was in the right direction from the national point of view. There was no intention of scrapping plant that was efficient and generating cheap units. The electricity works had been marking time since 1914 in regard to capital expenditure. He knew of seven towns within a six-mile radius of Blackpool who wished to spend nearly £300,000. Which was the best way? Should these towns buy generating plant and buildings (which later was unremunerative expenditure) or should they have a joint board and find out the best means of spending the money and possibly put down generating plant five times as large. He could not congratulate the Executive upon asking Mr. Hatton to read a Paper on this matter. He thought there were more important matters in connection with the tramway world than the discussion of that report. He would have liked to have had a discussion on trailers. He thought Mr. McElroy had given rather an inflated view of the importance of traction supply. In Manchester the traction demand was only 15 per cent. of the total supply. Taking undertakings generally it was near 18 to 20 per cent. In Manchester the power cost for the tramways was 13 per cent. of the revenue obtained, in Newcastle 7 per cent., in Blackpool 12½ per cent., in Cardiff 5 per cent., and in Burnley 20 per cent. It was not a dominating factor.

Mr. Hatton, in reply to the discussion, said that Mr. Webber's station was well placed. His outlay on plant might be small compared to his load. He did not think the argument that breakdowns were more serious in big stations than in small ones was borne out by the experience of the Newcastle Company. With regard to Mr. Stokes' remarks on the use of coal for other purposes before generating electric power, he thought a Government Committee was considering that. On the North-East Coast there was a plant in which electricity was generated as a by-product. Mr. Wilkinson was quite right as to the value of tramway authorities having their own stations. When he (Mr. Hatton) prepared the report, which Mr. Rayner mentioned, the Board of Trade Committee's report had not appeared, and therefore he could not have dealt with it. He could not understand Mr. Furness' taking exception to tramway managers discussing this matter. If electrification of the railways came about it would have a vital effect on tramways—possibly to their enormous expansion.

Mr. T. B. Goodyer (Croydon) was elected President for the ensuing year, Ald. Sir John Courtis (Deputy Lord Mayor of Cardiff) vice-president, Coun. J. Timpson (Portsmouth), Mr. R. L. Horsfield (Walsall), Mr. A. L. C. Fell (London County Council Tramways), Mr. J. B. Hamilton (Leeds) and Mr. G. W. Holford (Salford) members of the Executive Council, while Mr. W. Clough (Bury, Lancs.) was appointed hon. secretary in the place of Mr. C. J. Spencer (Bradford), resigned. The following is a full list of the Council: Messrs. A. Baker (Birmingham), J. Dalrymple Glasgow), A. L. C. Fell (London), J. B. Hamilton (Leeds), G. W. Holford (Salford), R. L. Horsfield (Walsall), W. J. McCombe (Hull) and J. M. McElroy (Manchester), Coun. R. Mayne (Newcastle), Ald. J. Timpson (Portsmouth), Ald. C. F. Spencer (Halifax) and Ald. Wood (Stalybridge).

ANNUAL REPORT OF EXECUTIVE COUNCIL.

The members include 75 local authorities and 110 managers and assistants.

Mr. J. B. Hamilton (Leeds) has acted as chairman of the Executive Council during the year. Mr. C. J. Spencer consented again to take up the position as hon. secretary for the remainder of the association year, and relinquished the office of hon. treasurer for this purpose. Mr. A. R. Fearnley, on handing over the duties of hon. secretary, was appointed hon. treasurer. Mr. W. Clough, general manager, Corporation tramways, Bury, was appointed assistant hon. secretary.

The Decimal Coinage Association proposed to introduce a Bill in Parliament for the purpose of establishing a decimal system of coinage. A committee was formed to investigate and report, and the Executive Council decided to support the proposals.

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A Trade Advisory Committee has been set up by the Ministry of Labour in conjunction with the Ministry of Pensions to advise those two departments as to the conditions under which the training of disabled men in this industry can best be given. Mr. Alfred Baker (Birmingham) was nominated by the Council to serve on the committee.

The Executive Council invited the Tramways and Light Railways Association to appoint representatives to sit on the committee formed to consider the advisability of standardising overhead line material, and four representatives were duly appointed. This joint committee has confined its attention chiefly to the consideration of trolley wire.

At the last annual meeting it was decided to communicate with the Home Office in order to ascertain if it were possible for the present practice of pedestrians keeping to the right of the footpath to be altered to "keep to the left," so that pedestrians would be facing the traffic on the carriage-way. The Home Office stated that they had no authority to make the regulation. It would probably involve legislation.

Particulars are next given of the correspondence between the association and the Tramways (Board of Trade) Committee, the terms of the reference to the committee and the memorandum defining its duties.

The Executive Council has during the year taken active steps in the direction of the establishment of a Joint Industrial Council for the tramway industry on the lines of the Whitley Report. A committee was appointed to deal with the matter, and held a number of meetings, and subsequently attended joint conferences with the representatives of the Tramways and Light Railways Association and of the National Transport Workers' Federation, at which a representative of the Ministry of Labour was present. A small sub-committee prepared a scheme and submitted it to their respective associations. The Council made certain suggested amendments to the draft, and again remitted it to the committee. At this stage the matter was considered by a joint committee consisting of representatives of the Municipal Tramways Association and the Tramways and Light Railways Association. Whilst the representatives of the two associations were in agreement as regards the main outlines of the scheme, a difference of view was expressed on the subject of voting on the employers' side of the proposed council. The point has not yet been adjusted, but it is hoped that an arrangement will shortly be come to which will meet with the approval of both associations. The draft* which your Executive Council now submits must not be taken as a final draft because further meetings with the representatives of the tramway companies and of the employees will be necessary before the scheme can be put forward in its final form. When the scheme has received the provisional approval of the executives of the constituent associations, it is proposed to submit the same to each municipality for consideration and approval.

The Executive Council decided that in view of the difficulties of transport and the numerous conferences and meetings which were being called from time to time in different parts of the country, it was not advisable to hold a meeting of the managers' section this year.

Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

(*Continued from page* 455.)

Summary.—In this article the reel winder is briefly discussed.

REELS.

From the dynamical standpoint the reel winder is of considerable interest, and many ingenious graphical methods have been devised for finding the torque conditions when tapered ropes are used. Such winders are seldom installed nowadays, and they need not, therefore, be dealt with in detail.

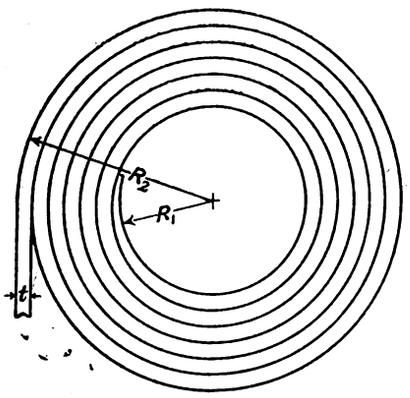

FIG. 32.—ROPE COIL.

When the rope is of uniform section the problem of determining the torque diagram is analogous to that previously given for conical drums, the radius of the rope-roll being increased by an amount equal to the thickness of the rope for each turn of the reel. After n turns of the reel the radius of the rope-roll, in feet, is $R_1+(nt\div12)$, where t is the thickness of the rope in inches, and R_1 is the initial radius of the reel, in feet. During these n turns the length of rope wound on the reel is $2\pi n\{R_1+(nt\div24)\}$, and, if the depth of the shaft be L ft., the length of rope depending from the reel, on the ascending side, is

$$l_a=L-2\pi n\{R_1+(nt\div24)\}.$$

The corresponding moment about the drum shaft is

$$M=w\,.\,l_a\{R_1+(nt\div12)\},$$

w being the weight of the rope per foot of length.

To compensate completely for the weight of the rope, the initial and final radii R_1 and R_2 of the rope-roll must bear the same relation to the loads on the two sides as for conical drums; but, since for a given value of R_1 the value of R_2 is determined by the length and thickness of the rope coiled on the reel, it may so happen that it is impossible to secure a uniform static torque throughout the wind owing to the relatively small number of different thicknesses of flat rope which are obtainable.

Referring to Fig. 32 it will be noticed that the area available for coiling the rope is equal to $\pi(R_2^2-R_1^2)$, and the area of the rope—which corresponds to the edge view of the rope (Fig. 32)—is $tL\div12$. Since the two must be equal, by putting $R_2\div R_1=a$, and eliminating R_2, we get $R_1=\sqrt{\{tL\div12\pi(a^2-1)\}}$. If the value of R_1 so found results in too great a bending stress in the rope, and if the rope thickness cannot be altered, then the radius must be increased at the expense of the compensation.

In the author's opinion too much importance has been attached in the past to the complete compensation of the rope, but the effect of lack of compensation need not be discussed because the reel winder is of little or no practical importance.

Although we do not propose to deal with reels as fully as we have dealt with drums, it may, nevertheless, be profitable to refer briefly to the torque conditions when a given winder is run under widely varying loads, as these enter into the calculations relating to winders of all kinds.

One of the winders installed at the Grand Hornu Mines, near Mons, Belgium, will serve as an example. Apart from the fact that these winders are amongst the earliest to be electrically driven, they are of no particular interest. Their behaviour has, however, been critically examined in a series of informative Papers by a number of engineers on the Continent. Those who desire to make a special study of the dynamics of the reel winder are referred to these Papers for further information on the subject.

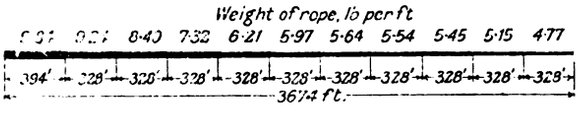

FIG. 33.—TAPERED ROPE FOR A REEL WINDER.

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* The Press representatives were informed that the draft must not be published in its present form, and the discussion which took place on the subject was private.

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The calculation of the winders was based on the following data :—

Depth of shaft	3,280 ft.
Coal raised per hour	55 tons.
Effective load per trip	5,700 lb.
Weight of cage	4,410 lb.
Weight of tubs per cage	2,780 lb.

The type of rope specified was the flat aloe-fibre rope of tapering section, which, at one time, was largely used in Belgium. The rope in this case begins with a section measuring 12·8 in. by 1·9 in. at the reel and finishes at the cage with a section 8·5 in. by 1·3 in., the length of each section and weight per foot being as shown in Fig. 33. The diameter of the hub of the winding reels is 4 ft. 7 in., but in order to obtain a good balancing of the weight of the rope it was necessary to have an initial winding radius of about 4 ft. For a complete trip of 3,280 ft. the reel makes 64 turns and the final radius is about 12 ft. 3 in. An hourly output of 55 tons necessitates 25 trips, each trip being of 144 seconds duration, and, reckoning 38 seconds for changing the tubs, there remain 106 seconds for the actual winding period. To prevent the speed from exceeding 3,000 ft. per min., a constant angular acceleration is allowed for 15 seconds to reach the rated speed of 42 revs. per min. in 77 seconds, and stopping is effected in 14 seconds by a constant retardation. The moments of inertia ($WR^2 \div g$) of the several parts are :—

Two reels and brake drums	133,000
Motor armature	60,460
Pithead sheaves	9,680

In the absence of exact data the moment of friction and windage is taken as constant during the whole of the wind, and a value given equal to 15 per cent. of the maximum statical moment of the loads.

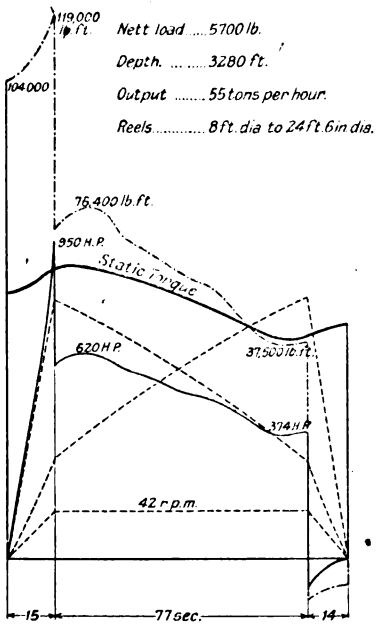

Fig. 34.—Reel Winder Starting under Constant Angular Acceleration.

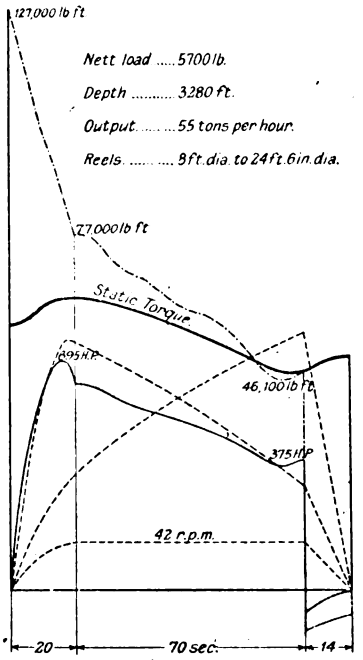

Fig. 35.—Reel Winder Starting under Uniformly Decreasing Acceleration.

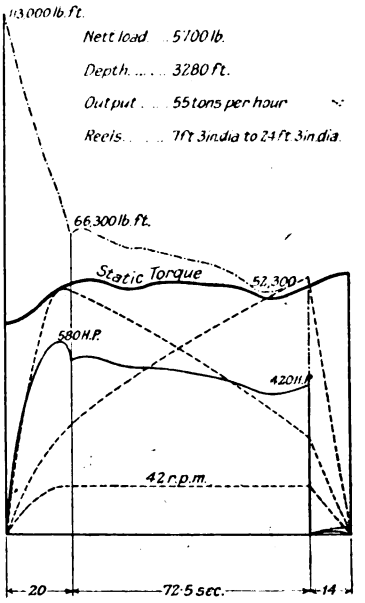

Fig. 36.—Reel Winder Diagrams with a Higher Value of $R_2 \div R_1$ to that Shown in Fig. 33.

The diagrams, Figs. 34 to 36, have been prepared from an elaborate analysis made by Prof. P. Habets.* In one of these diagrams, Fig. 34, a constant angular acceleration of 0·292 radian per second per second is assumed, and in Fig. 35 uniformly decreasing angular acceleration is assumed. Although a rather greater torque is required in the latter case during the starting period, the power required is less variable than when the angular acceleration is uniform. Prof. Habets showed that by altering the initial radius of the rope-roll from 47·24 in. to 43·4 in., and thereby making the statical moments less regular, the power would be more uniform throughout the wind. This is clearly shown in Fig. 36.

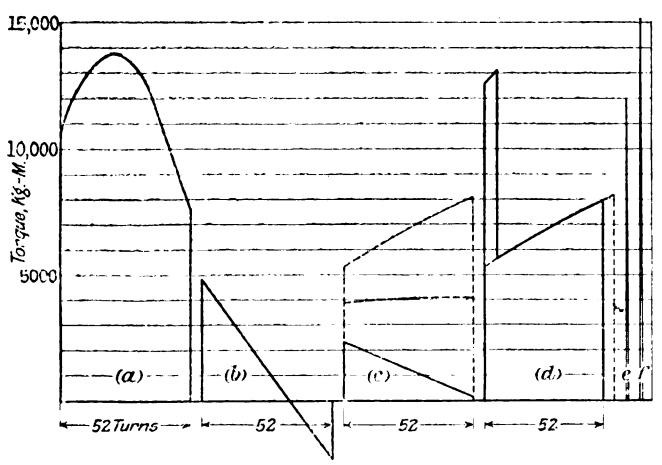

Fig. 37.—Torque Diagrams of a Reel Winder Operated under Widely-varying Conditions.

(*a*) One reel winding with one empty cage. (*b*) Both reels winding with both cages empty. (*c*) Both reels winding with six empty tubs in each cage. (*d*) Winding at normal load and speed. (*e*) Relifting loaded cage at the surface. (*f*) Relifting loaded cage at the bottom of the shaft.

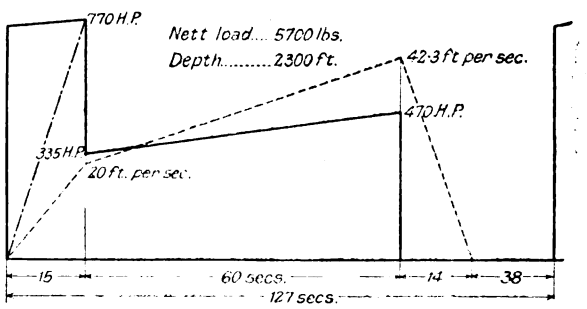

Fig. 38.—Load Diagram of the Grand Hornin Winder Operating under the Torque Conditions, Fig. 37 (*d*).

When set to work in 1904 the machine was arranged to wind from a depth of 2,300 ft. The rope was shortened by a suitable amount at its wide end, and the initial and final radii of the roll were 3 ft. 9½ in. and 10 ft., the turns per wind being 52·1. The torque diagrams for this depth are given in Fig. 37 (*a*) to (*f*), and from (*d*) of this diagram, taking into account the angular velocity, the load diagram, Fig. 38, has been developed.

(To be continued.)

* "Proceedings" Inst. Mech. Eng., June, 1905, p. 429.

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New Commonwealth Edison Turbine.*

By J. F. JOHNSON.

The tandem compound turbine-generator unit recently installed in the Northwest Station of the Commonwealth Edison Co. of Chicago is the largest single shaft, single generator unit built by the Westinghouse Co., and presents new and interesting features of design. This unit has been in operation since October 1917, normally carrying loads of from 20,000 kw. to 30,000 kw., with peaks as high as 37,000 kw. It comprises a tandem-compound turbine consisting of separate high-pressure and low-pressure elements on a continuous shaft, designed for 220 lb. gauge steam pressure, with 200°F. spuerheat at throttle, and an absolute pressure of 1 in. mercury at the exhaust; driving a 35,300 k.v a., three-phase, 60 cycle, 12,000 volt generator, with a 160-kw., direct-connected exciter at 1,200 revs. per min., and is served by a 56,000 sq. ft. surface condenser built in two shells of 28,000 sq. ft. each, and capable of maintaining 29 in. vacuum at 30,000 kw. load with 58°F. circulating water.

Turbines of small size are designed to best meet general conditions and without regard to any particular installation or purchaser. Larger machines, however, are usually built to order, and considerable variation in design is therefore to be expected. Nearly every large power station to-day is a pioneer institution in which new problems have to be dealt with, and new and improved designs and arrangements of apparatus, usually involving larger capacities, have to be developed and perfected.

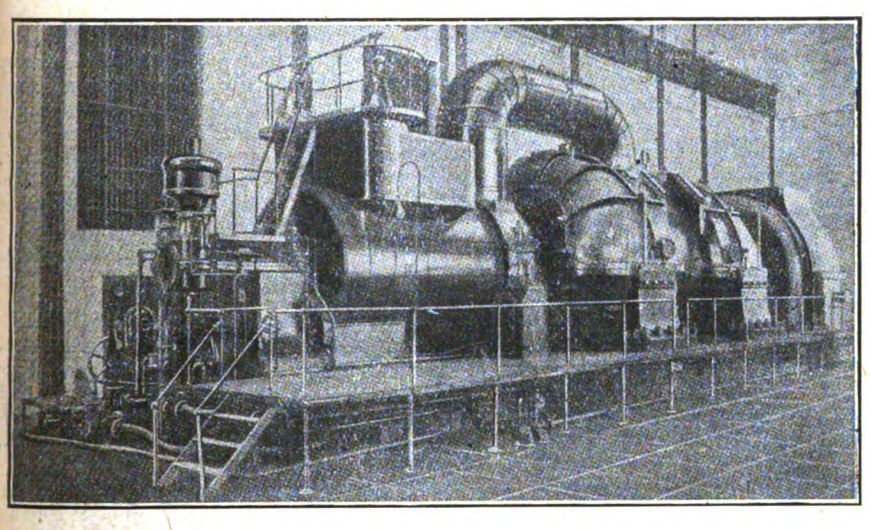

Fig.1.—35,300 k.v.a., Three-phase, 60-cycle, 12,000-volt, 1,200 revs. per min. Tandem-Compound Turbine Generator Installed in the Northwest Station of the Commonwealth Edison Co., Chicago.

The present unit was designed for maximum reliability and efficiency with the turbine driving a single generator capable of delivering 30,000 kw. continuously at 85 per cent. power factor; the highest efficiency to be at loads between 20,000 kw. and 30,000 kw., and the unit to carry 35,000 kw. for short periods. The speed of 1,200 revs. per min. was chosen because it permitted employing ample blade lengths and areas to expand the steam efficiently to 29 in. without exceeding blade speeds and stresses previously used. Also standard design and materials could be employed.

The turbine is of new design but of standard reaction type construction. No impulse element is employed because, for the given conditions, its efficiency would be less than that of the shortest reaction blading and there would be no other advantages sufficient to justify its use. Two separate turbine elements are employed to carry out the steam expansion so that blade lengths and diameters conducive to the highest efficiency may be used and yet the physical dimensions of the turbine structure and the distance between bearings can be suitably proportioned to obtain the maximum degree of ruggedness and reliability. Another feature of this construction is the reduction of temperature difference between the inlet and exhaust portions of each turbine element.

When operating at its point of highest efficiency, which is at 25,000 kw. to 26,000 kw., the steam enters the high pressure element at approximately 225 lb. absolute and a temperature of 594°F., and leaves it at a pressure of approximately 30 lb. absolute and a temperature of 258°F. It leaves the low-pressure element at a pressure of 1 in. Hg. absolute and temperature of 79°F. The maximum temperature difference in the high-pressure cylinder is therefore 336 deg. and in the low-pressure cylinder 179 deg. At loads greater than 25,000 kw. this temperature difference decreases in the high-pressure element and increases in the low.

In the reaction-type turbine all blades, both rotating and stationary, are virtually nozzles in which steam expansion takes place, and 126 pressure stages are employed in expanding the steam from throttle pressure to condenser pressure. The area of the steam passage through each row is proportioned to give the desired pressure drop and steam velocity. The proportions of total power developed in the high and low-pressure elements are approximately 42 and 58 per cent. respectively.

High design factors, liberal steam passages, and the best known mechanical construction have been used, and the blade sections are exceptionally wide and heavy. Increased rigidity and durability are thus secured. All blades are profiled or reduced in thickness at their free ends, so that in case of contact between stationary and rotating elements due to failure of bearings, or improper adjustment, no serious damage to either blading or blade carrying elements will result. The most prolific cause of blade failure, *i.e.*, blade vibration caused by the flow of steam, has been reduced to safe limits by lashing the blades together; the length of free blade section in no case exceeds 6 in. In the 18 in. low-pressure blades, three lashings are used. The blade speeds, and consequently blade stresses, employed are low, the maximum mean speed being 513 ft. per second, the minimum 210 ft. per second.

Main Bearings and Couplings.

The rotating elements of the turbine and generator are carried on five main bearings, three on the turbine and two on the generator. In addition to these, a double Kingsbury thrust bearing is mounted on the free end of the high-pressure rotor, just outside the main bearing, to maintain the correct longitudinal alignment, and also to carry the unbalanced portion of the end thrust. Of the three main turbine bearings, two are on the low-pressure element and one on the high pressure. The exhaust end of the high-pressure rotor is carried on the adjacent low-pressure bearing, the two rotor shafts being connected by means of a solid flanged coupling, the flanges of which are integral with the shafts. Between the low-pressure turbine and generator a standard flexible pin-type coupling is used. This is believed to be the most perfect type of flexible coupling known for the purpose, and has important advantages over the solid claw type, which it replaced. Sufficient elasticity is provided in the pins to distribute and absorb the shocks produced by heavy short-circuits without danger of injury to the coupling; and both contact surfaces, that is the pins and bushings, are renewable in case of excessive wear due to prolonged operation with improper alignment or poor balance of one of the rotating elements.

It might appear that the three-bearing construction for two turbine elements would render the adjustment of clearances and alignment difficult and complicated; but means are provided whereby the operation becomes quite simple. To carry the exhaust end of the high-pressure spindle when the coupling between the two elements is disconnected, a short alignment bearing is provided to be substituted for the lower half of the oil baffle ring between the coupling and the gland. This bearing is provided with liners similar to those used on the main bearings for adjusting its position. With the coupling disconnected and this alignment bearing in place, regular clearances can be taken on the high-pressure and low-pressure elements separately, and each rotor set in the correct position with relation to its stator. The whole high-pressure element may then be raised or lowered, or moved sidewise at either end until the two coupling flanges match up perfectly; this adjustment, once made, will seldom require changing.

The exhaust end of the high-pressure cylinder is supported on the low-pressure cylinder as close as possible to the low-pressure bearing support. Thus any slight change in the position of the high-pressure rotor (due to temperature, &c.) will produce a corresponding change in the position of the high-pressure cylinder. The position of the

* Abstract of an article in the "Electric Journal."

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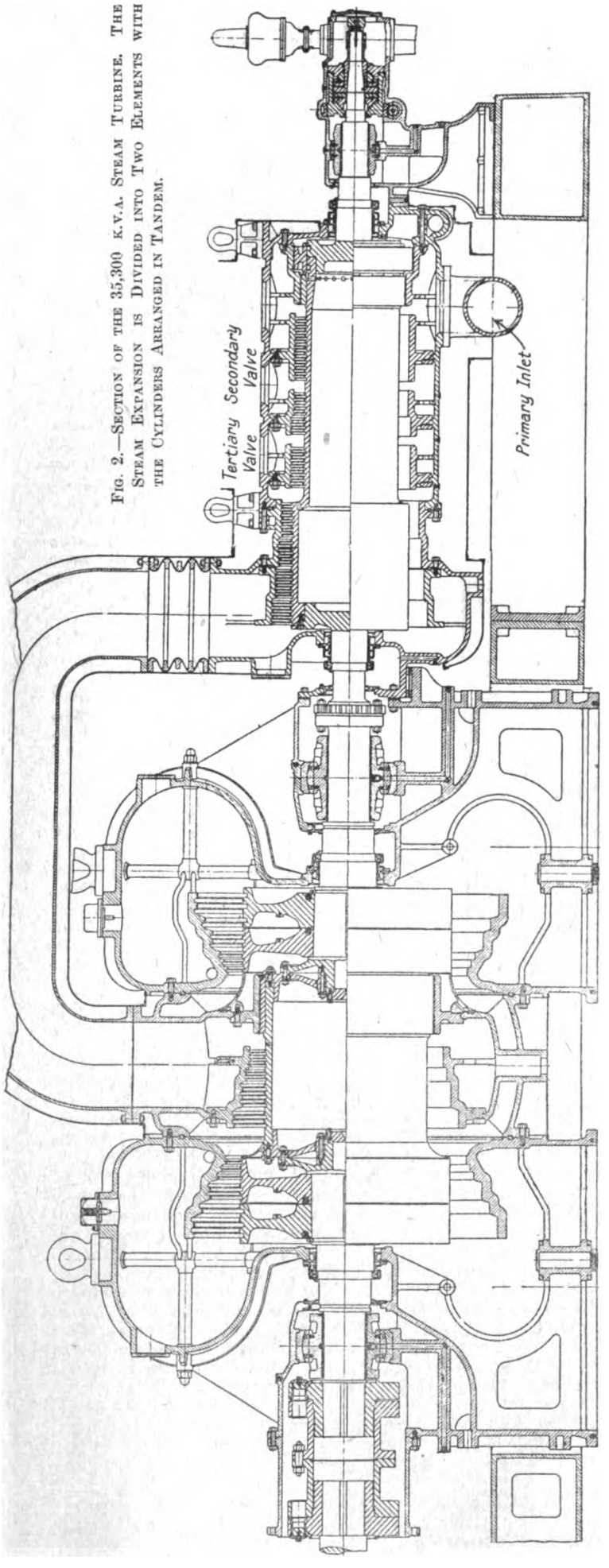

Fig. 2.—Section of the 35,300 k.v.a. Steam Turbine. The Steam Expansion is Divided into Two Elements with the Cylinders Arranged in Tandem.

rotor with reference to its cylinder must, therefore, remain constant under all conditions. Longitudinal expansion of the turbine cylinders is provided for by rigidly attaching the low-pressure cylinder to the bedplate at its generator end only, and leaving the other end free to slide. The movement in changing from cold to normal operating temperature is approximately $\frac{1}{16}$ in.

Main Bearings.

The main bearings are heavy cast-iron shells, split horizontally and lined with babbit. Each bearing is fitted with four large spherically machined pads (one each at top and bottom and either side), which fit a spherical supporting ring in the housing. The bearing, therefore, has perfect freedom to align itself to the journal, and the pressure is equally distributed. Underneath each of the four spherical pads a number of sheet steel liners of various exact thickness are placed to provide an easy, quick and accurate means of changing the alignment of the rotating element. For example, if it is desired to change the alignment of a bearing 0·010 in. either vertically or horizontally, a 0·010 in. liner is removed from underneath one pad and placed underneath the one opposite.

Water cooling in the bearings is not required, as the maximum speed is 95 ft. per second, and the pressure per square inch of projected area 105 lb. The oil leaves the bearings at about 130–150°F. Oil is admitted to the bearing through an opening in the top supplying a groove running the length of the bearing. Only sufficient pressure is required to keep the oil groove in the top of the bearing filled. There is, therefore, no danger of bearing failure from decreasing oil pressure until the oil actually ceases to flow to the bearing.

Glands.

Combination labyrinth and water glands are provided on both high-pressure and low-pressure elements to prevent leakage of steam or air where the rotor shafts pass through the cylinder casings. These constitute an ideal sealing arrangement, being absolutely tight against air leakage into the turbine and steam or vapour leakage into the room. They require no adjustments for varying load conditions, and do not depend on the operation of any automatic devices. There is no mechanical contact between stationary and rotating parts, and therefore no wear. They are extremely simple in design, require no special attention and are as durable as any other part of the machine.

Oiling System.

A complete oil circulation and cooling system of 1,000 gallons normal operating capacity is provided as a part of the turbine unit. The oil is circulated at 150 gallons per minute, and is supplied to the bearings under a pressure of 5 lb. A portion of it, however, is used under a pressure of from 50 lb. to 60 lb. to operate the governor-controlled inlet valves. Besides the necessary piping, valves, &c., the oiling system includes :—

1. A double-pressure reciprocating oil pump driven from the high-pressure turbine rotor.
2. A duplex direct-acting steam-driven auxiliary pump for starting.
3. A surface-type cooler.
4. A reservoir.
5. A strainer box.

A reciprocating plunger pump is used, because it is better adapted for pumping against high pressure, and ready accessibility of the important parts may be had for inspection or repair without complete dismantling.

All of the oil cooling is done in an oil cooler containing 600 sq. ft. of cooling surface, which in design is somewhat similar to an ordinary surface condenser. This cooler is very accessible for cleaning. By simply unbolting and removing the cooler box cover and disconnecting two small unions on the water connections, the entire nest of tubes may be lifted out, the tube plate covers removed and the tubes thoroughly cleaned both inside and out. The tubes being straight, mud or scale can be thoroughly and quickly removed.

The oil reservoir is a rectangular box attached to the side of the bedplate. It has sufficient capacity to take care of reasonable variations in the quantity of oil in the system, and to afford an effective settling chamber for the separation and removal of impurities. It receives the oil from the strainer box at one end and delivers it to the oil pump at the other. The oil velocity through it being very slow, any foreign matter or impurities heavier than oil will settle to the bottom and be prevented from getting into the pump suction. For every gallon of clean oil admitted into the system, a gallon of dirty oil will be discharged from the bottom of the reservoir. The turbine oiling system, although receiving clean oil from and delivering dirty oil to a gravity or partial filtration system, is independent of the operation of that system. An effective oil strainer is also included.

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High-Pressure Turbine.

The high-pressure turbine is of the single-flow type, because the steam volumes are relatively small. It contains 45 rows of rotating blades and an equal number of stationary rows. The shortest blades are 4 in. long, and the width 1 in.; losses are very small, and the net efficiency materially higher than would be obtainable with a two-velocity-stage impulse element. High-pressure steam is admitted to the turbine cylinder by the primary governor-controlled inlet valve, and at all loads up to 25,000 kw. enters the first row of blading, and passes sucessively through all the rows to the exhaust. At loads between 25,000 kw. and 30,000 kw. a secondary valve opens, by-passing the first section of blading and admitting high-pressure steam direct to the 12th stationary row. At loads between 30,000 kw. and 35,000 kw. a tertiary valve also opens, by-passing the first two sections of blading, admitting high-pressure steam direct to the 19th stationary row. At the extreme front end of the spindle body are two balancing pistons provided with labyrinth packing to partially balance the end thrust, caused by the differences of pressure on opposite sides of the rows of rotating blades. The pressure between the balance pistons is maintained equal to that between the two rotor diameters and the pressure against the governor end of the rotor is maintained equal to that against the exhaust end by means of suitable equaliser connections.

The rotor is made in three parts from special high-grade steel castings. The two ends are attached to the body or drum by means of long spigoted press fits reinforced at the exhaust end with specially constructed fillister head tap bolts, and at the governor end with shrink links.

The stator is made of cast steel. It is divided up into a number of assembled parts, so that castings as plain and simple as possible may be used, ensuring the best possible quality of material, and so that the greatest freedom from shrinkage and other distortional stresses may be secured. The joints between the assembled parts are accurately surfaced and bolted up metal to metal, no gasket material or its equivalent being used. Keys or spigoted fits are employed to ensure accurate and positive doweling. The horizontal joint between the upper and lower halves of the cylinder is also accurately surfaced and bolted up, metal to metal, the bolting everywhere being heavy and closely spaced to ensure against distortion and leakage.

Barring-over Device.

A barring-over device, engaging ratchet teeth machined in the circumference of the coupling flange, is provided to facilitate turning the rotor for inspection or for disconnecting the couplings. On the free end of the rotor shaft there is keyed a steel worm which drives a gunmetal wheel, mounted on the governor spindle, at 309 revs. per min. The oil pump is driven from the governor spindle by means of a spur gear and pinion at 169 revs. per min. The worm is held on the spindle by means of a special nut, which contains the overspeed governor. This governor is adjusted to come into operation at approximately 1,320 revs. per min., closing independently both the main throttle valve and the primary inlet valve.

(To be concluded.)

The Labour Outlook.*

(BY OUR LABOUR CORRESPONDENT.)

The serious discontent which has recently come to a head in a series of stoppages of work or prolonged negotiations is due to a variety of causes. Widespread dissatisfaction never comes without reason. Within the past few weeks there has been trouble amongst 'bus girls and tube workers, and a strike on the part of the London Police, followed by events which almost led to a stoppage on the part of the London Fire Brigade. When these were disposed of other municipal strikes occurred, the shipwrights on the Clyde came out, and the agreement arrived at between the railway unions and the Railway Executive was repudiated by the South Wales railwaymen and employees of the Great Western and London & South Western Railway Companies.

The quasi-public servants, such as police and railwaymen, have been in much less favourable position than workers in manufacturing industries. Policemen and engine drivers often live in the same street with girls and youths on munition work who bring home weekly earnings considerably in excess of what these responsible men obtain. Skilled workers in manufacturing industries compare their wages unfavourably with those received by relatively unskilled workers. The real trouble is that the bottom has been knocked out of the old wages system as a result of the re-organisation of industry to meet war needs and of a whole series of new artificial regulations.

Prior to the war, more or less clearly defined relations existed between the wages of different groups of workers and between workers of different grades of skill. These relations were probably not perfectly rational and often inflicted injustice upon the more lowly skilled work-people; but they were established and recognised. The various rates of wages which were paid for different kinds of work were due to a number of causes, of which perhaps the two most important were the degree of skill or responsibility and the strength of organisation amongst the different classes of workers.

Now, when the war broke out there was a rapid development of repetition work and a large demand for labour of a relatively lowly skilled character. It was vital to "produce the goods," and various inducements were put forward to assist increased output. One important result was that lesser skilled men and women earned wages far beyond what even the highly skilled workers had received before the war. The wages of the latter did not keep pace, and, indeed, have not up to the present kept pace. A new relationship has, therefore, been established between the wages of workers of different kinds. The ordinary machinery for wages adjustments has ceased to act. Wages are determined by orders of the Ministry of Munitions and by the awards of the Committee on Production. These methods, however, are not an adequate substitute for the old method of negotiation and so far as the Committee on Production is concerned, its efforts are directed rather towards adjusting wages to the cost of living than to the relations between the wages of different groups of workers.

The matter is complicated by the independent action of the Board of Trade as regards coal mines and railways. The Coal Controller, without fully considering the effects of any steps he might take upon the general wages situation, with which the Committe on Production was grappling, raised the wages of the miners. The Railway Executive has seen fit to negotiate wages agreements into the railway workers without reference to the measures of the Committee on Production.

But the lack of co-ordinated machinery for dealing with wages is not the only trouble. There is a great scarcity of labour, and as a consequence it is being regulated in a way which the inhuman regards as being not unlike "industrial conscription," and for which a rise in wages to keep ahead of rising prices is no compensation.

A further point with an important bearing on the situation is the existence of war profits. It cannot be denied that large fortunes have been made in industry during the war. Although the Excess Profits duty now creams off the greater part of any additional profits made during the war, it does not absorb them all, and workpeople are by no means unfamiliar with the various devices by means of which excess profits are hidden. The old relationship between profits and wages, unstable though it was, is a standard by which existing conditions are measured for large masses of workpeople; wages have advanced, but no real gain has ensued because of the rise of prices. Profits, on the other hand, if we may judge by many annual balance-sheets and by the findings of the Select Committee on National Expenditure, have been large.

The muddle we are in now regarding the whole wages question is extremely serious, and some definite principles of action must be agreed upon if serious trouble is to be averted in the future. Up to the present, labour has not exerted its full economic power to advance wages. It must be remembered that the trade unions, if they chose, could hold up the community to ransom. That must always be borne in mind. The trade union movement will not do that. But there must be a policy which organised labour regards as just and reasonable. It is questionable whether anything less than the extinction of excess profits will be acceptable. If this be conceded a halt may possibly be called to wages advances, except so far as increases are given to meet any further rise in the cost of living, which increases should be automatic. These are large questions, however, which cannot be considered here.

* We do not necessarily endorse the views expressed by our Correspondent, although we are pleased to give space for their publication.—Ed. *E.*

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"Modern Engineering Measuring Tools." By E. Pull (London: Crosby, Lockwood & Son.) Pp. viii.+115. 4s. 6d. net.

"A Small Book on Electric Motors, C.C. and A.C." By W. P. Maycock. (London: Sir Isaac Pitman & Sons, Ltd.) Pp. ix.+192. 5s. net.

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The Disabled Soldier.

THE problem of finding suitable work for the disabled soldier is one that is by no means simple, for it may be regarded from several points of view. The natural tendency is to approach the question in a somewhat charitable attitude. These men have seen the horrors of war, and have not shrunk from the supreme sacrifice for those who remained at home. This fact arouses the natural feeling that when they return in a disabled condition we should do everything possible to render their lives less difficult. Consequently there is a tendency to find jobs for them of an easy kind and not necessarily of a kind that is suitable.

In this connection we notice an interesting short article in the "Proceedings" of the American Institute of Electrical Engineers, by Mr. D. C. McMURTRIE, who is the director of the Red Cross Institute for Crippled and Disabled Men at New York. Mr. McMURTRIE points out that our natural impulses may lead us to a course of action which would not be best for all concerned in the long run. The sort of thing that happens may be described in the supposed deliberations of a local committee, as follows: "Here are a dozen crippled soldiers for whom we must find jobs. Jones, you have a large factory; you should be able to take care of six of them. Brown, can you not find places for four of them in your warehouse? And, Smith, you ought to place at least a couple in your store." This is a very natural line of procedure, but it is one which can have only pernicious results in many cases. One source of weakness is that it depends on a patriotic spirit, which in the course of years may not be maintained; but a more important point is that it savours of charity, and charity has a weakening effect upon the character of most men, who thereby come to expect as a right such gratuitous support. The work that is given should tend to build up the character rather than to weaken it, and we have no right so to place our disabled men that their characters may suffer by reason of their employment. Another difficulty is that a system of this kind takes no account of the men's future. A makeshift job remains a makeshift job, and, therefore, leads to a form of charity, or else to discontent on the part of the employee, who gradually realises that the future holds out very little in the way of advancement.

What is essentially necessary is that the employer should do everything possible to put disabled men into work for which they are fitted. Fortunately, this task has been rendered very much more easy by a number of institutions which have sprung up for training disabled men. Apparently the movement was originated by Mr. EDOUARD HERRIOT, Mayor of Lyons. Looking out, on the one hand, at the great shortage of labour, and, on the other, at the idling of men who had lost an arm or a leg, but who were otherwise strong and well, Mr. HERRIOT induced the Municipal Council to open an industrial school for disabled men; and now similar schools are to be found in hundreds. The important point about training of this character is that it should be sufficiently thorough. It is useless to turn out an adult cripple with such small experience that he has thereafter to follow an apprenticeship. He cannot begin life again like a mere lad. He must, therefore, be sufficiently trained in some branch of work, so that he can immediately earn his living when he leaves the training institution. Fortunately this is generally possible in a comparatively short time, if the previous experience of the man is taken into consideration. It may mean that he has to follow some new line of work, but of a kindred nature; and his previous experience, if this branch of work is properly selected, will enable him to adapt himself to the new line without difficulty. If this re-educational work is taken in hand at the earliest possible moment the disabled man starts in with a will to his new work, and not with distorted ideas of life on a charitable basis.

Consequently, when an employer receives a man from such a training institution, his duty (and it is not altogether an easy one) is to find that suitable work is given to him. It is no good simply to turn him over to a superintendent, with instructions to find some sort of job. It is necessary to find a job which the man can work to advantage. There are many positions that can be filled just as well by a man who has only one leg or one arm as by those who have all their limbs, but they require selection. In the words of Mr. McMURTRIE, the employer should do the returned soldier the honour of offering him real employment rather than proffering him the ignominy of a charity job; and this sentiment we heartily endorse.

Review.

Alternating Current Electricity and Its Applications to Industry. Second Course. By W. H. TIMBIE and H. H. HIGBIE. (London: Chapman & Hall, Ltd.) Pp. ix.+729. 13s. 6d. net.

This is one of the best second-year books which it has been our privilege to review, and it merits a place on the bookshelf of all students and of many electrical engineers. From an advertisement we learn that a "First Course" under the same title has been issued, whilst answers to the problems in both volumes are now in the Press. These problems are a unique feature of the book—they are interspersed throughout the chapters and occur in large numbers at the end of each chapter. In all, there must be a few hundred of such problems, whilst here and there full solutions are given in the form of illustrative examples. The arguments and conclusions of each chapter are also collected and summarised in a useful manner. The book is amply illustrated; indeed, in some places, vector diagrams are given of so many cases that little remains to be done by the student himself, which is perhaps not altogether an advantage. The footlines of the illustrations also are very complete and lucid, but we think it is carrying logic too far to print the type on certain parts of some diagrams upside down.

Without trespassing on the province of the designer, the authors present in a masterly manner information and data of the greatest importance to all connected with the technical side of heavy electrical engineering. The treatment is descriptive rather than mathematical, and though all parts are not equally good, there is not much that could be regarded as shallow.

The first two chapters deal with the regulation and control and with the parallel operation of alternators. Possibly more weight might have been given to turbo-alternators and less to salient-pole alternators, considering their relative importance at the present day. The next two chapters deal with the efficiency and regulation and with the operation of transformers—the latter being particularly good.

Short transmission and distributing lines are discussed in Chapter V., and an actual example is worked out to show the most economical lay-out. In Chapter VI., on long transmission lines, the effect of capacity is introduced. Induction motors are dealt with in Chapter VII.—the authors speak of

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"asynchronous" motors, but we think Steinmetz is right in regarding the commutator machine as the proper asynchronous machine. Single-phase induction and commutator motors are also discussed, but the reader will probably find better descriptions of these machines elsewhere. On the whole, this chapter is among the poorest in the book. Following this is a chapter on the synchronous motor in which the characteristics of this machine are clearly brought out. The last chapter in the book is devoted to converters and rectifiers. One point in this chapter seemed rather disappointing—after telling us that "in order to compare the capacity of a machine as a converter of a particular type with its capacity as a direct-current generator, it is only necessary to compare the respective loads which will produce the same effective currents or the same rate of heating in the *hottest* armature coils," the authors proceed to determine the relative output from the *average* heating effect in the usual text-book style.

At the end of the book are appendices containing tables and data necessary for working out the problems in the chapters.

We are confident that this American book will be appreciated by many readers in this country.

STANLEY PARKER SMITH.

The Snook Apparatus for the Generation of High-Tension Uni-Directional Currents.

By RUSSELL S. WRIGHT, M.I.E.E.

The problem of the satisfactory generation of continuous, or at any rate uni-directional electric currents of the order of 100,000 volts or so is not easy to solve.

The old-fashioned induction coil working from, say, a 12-volt battery and platinum interrupter came as near to solving it as any more modern apparatus, because the necessarily slow magnetisation of the coil with this low primary E.M.F. rendered the corresponding E.M.F. of the secondary

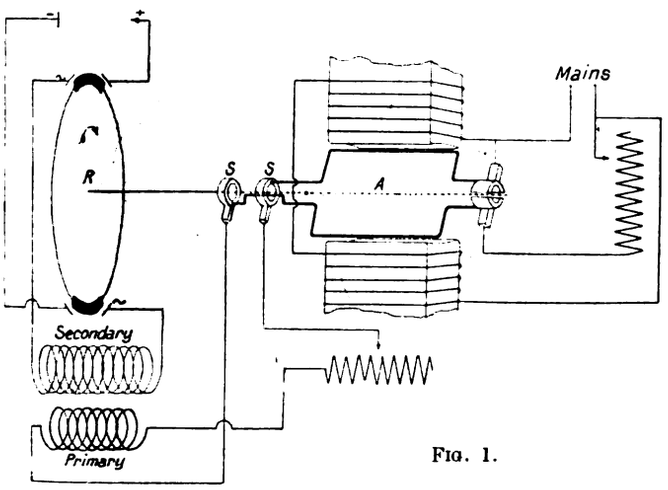

FIG. 1.

at "make" low enough to be negligible, the E.M.F. at "break," which was unaffected by this factor, enormously exceeding it. In other words, there is no difficulty in constructing an apparatus generating uni-directional high-tension currents, if we are prepared to allow a reasonable interval of time between the "peaks," but a modern induction coil is built to work from a main supply of, say, 200 volts with a mercury or electrolytic interrupter breaking the circuit several hundred times per second. Under these circumstances the secondary E.M.F. at "make," usually spoken of as the "closing" current, cannot be disregarded.

More than one attempt has been made to construct a coil free from this inverse or closing current, and some years ago an instrument was demonstrated before the Röntgen Society which was stated by its enthusiastic inventor to have solved the problem, and quite recently an ingenious but quite fallacious idea has been brought to my notice for achieving the same object.

I have more than once pointed out that the problem is of the same nature as the vexed question of perpetual motion: that is to say, it is from its very nature one impossible of complete solution. You *cannot* break a circuit without first making it, and you *cannot* make the circuit in the primary of an induction coil without generating some E.M.F. in the secondary circuit, although the scientific design of the manufacturer may reduce this E.M.F. to a minimum. It being conceded that inverse current must exist, the only remaining question is how to deal with it, and the many types of rectifiers produced from time to time are a tribute to the attention the matter has received. The first of these was the Ball and Point Rectifier, first described, I believe, by myself in a Paper read before the Röntgen Society in 1901, followed by the various types of "Valve" tubes (of which the Kenotron of the General Electric Co., of America, is the latest type), the Mica Disc Valve of Mr. Leslie Miller and other rectifiers too numerous to mention.

Mr. H. Clyde Snook was the first to bring out a practicable instrument on the lines of rectifying and using the inverse current, and his apparatus, patented in 1908, has gradually made its way against the rooted conservatism of the British medical man, but has not even yet been so completely adopted in this country as it has been in America.

The Snook apparatus consists essentially of a high-tension alternating-current transformer, in conjunction with a rotating secondary commutator or rectifier, this latter being driven in exact synchronism with the periodicity of the current.

In cases where the supply from the mains is alternating, the rectifier is rotated by means of a self-starting synchronous motor designed specially for the purpose, but in working from the direct-current mains, a motor converter of the slip-ring type supplies alternating current to the primary winding of the transformer, and at the same time carries the rectifying commutator upon an elongation of its shaft.

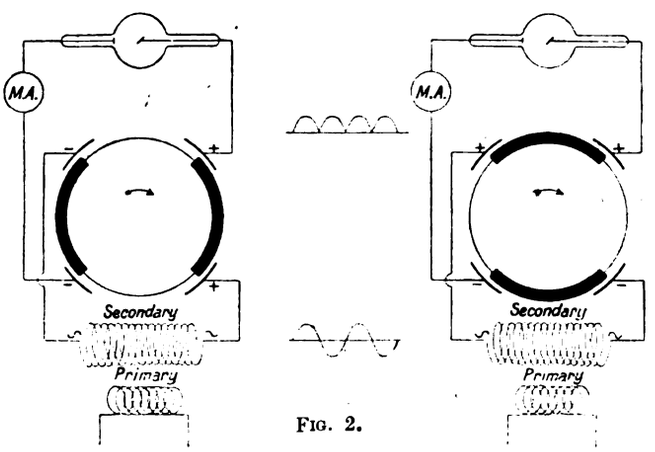

FIG. 2.

Fig. 1 shows the arrangement of the apparatus diagrammatically, *A* representing one turn only of a direct-current motor-converter, *S S* the alternating-current slip-rings, *P* the primary and *S* the secondary of the high-tension transformer, and *R* the rectifier carried upon a prolongation of the armature axle. Fig. 2 illustrates the action of the rectifier in supplying uni-directional current to the X-ray tube and is self-explanatory. Fig. 3 shows the complete apparatus in its portable or mobile form as manufactured for service in the field, and Fig. 4 the larger apparatus for instantaneous radiography in large hospitals.

Recently the Snook machine has also been adapted for work in connection with electro-culture, the Board of Agriculture

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having installed several on their experimental stations, the old fashioned induction coils and valve tubes being found a pretty hopeless proposition where anything like continuous output is required. An absolutely self-contained installation, con-

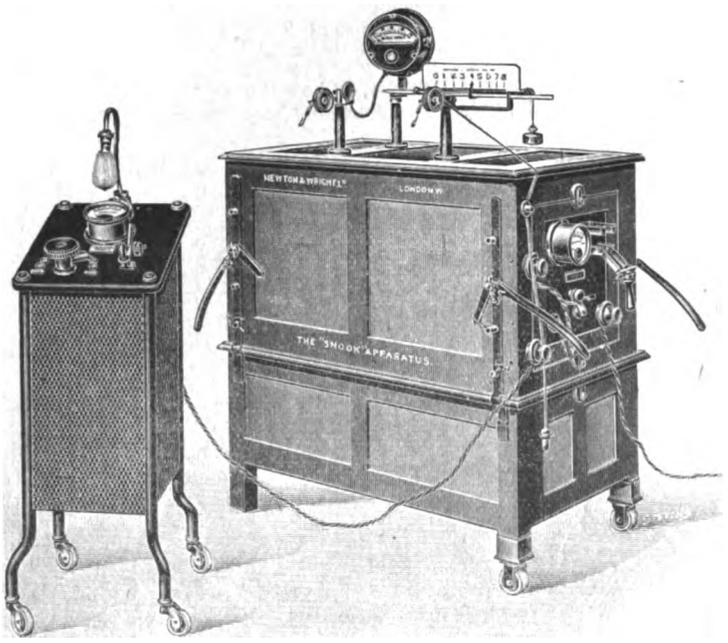


Fig. 3.—Complete Portable Form of Snook Apparatus.

sisting of a petrol engine direct-coupled to a dynamo, this again supplying alternating-current to the primary winding of the Snook transformer, while carrying the rectifier upon a prolongation of its axis has been designed at the invitation of

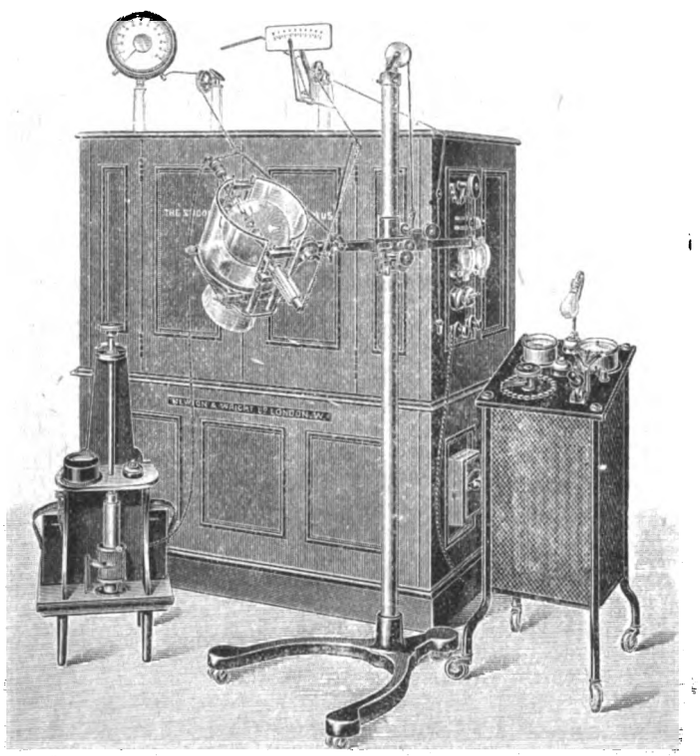


Fig. 4.—Snook Apparatus for Instantaneous Radiography.

the Board of Agriculture, and is at present undergoing its tests at their experimental stations.

This machine may, of course, be improved in detail as time goes on, but at the present moment it undoubtedly represents the last word in apparatus for electro-culture.

Correspondence.

RESISTANCE AND REACTANCE OF IRON TRANSMISSION LINES.

TO THE EDITOR OF THE ELECTRICIAN.

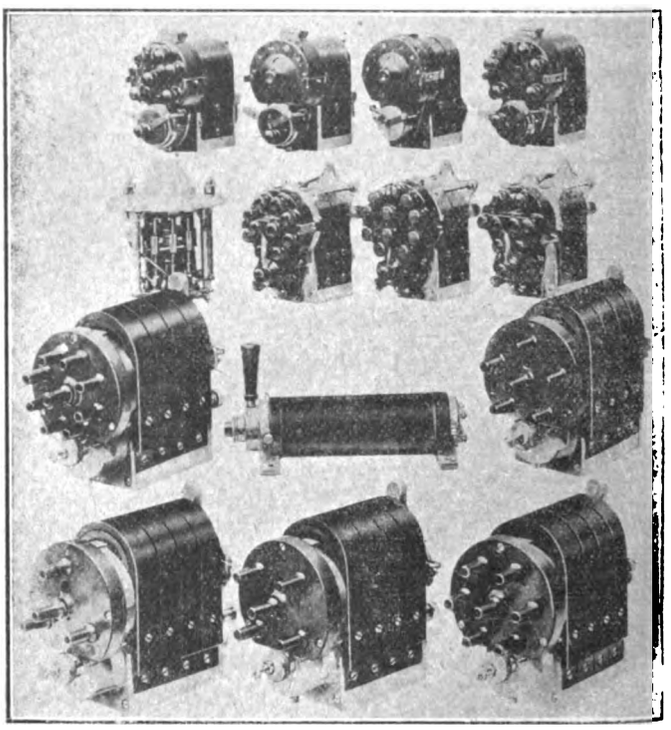
Sir: In his able Paper under the above title, which appeared in July 26th issue of The Electrician, Mr. Press has applied in a very skilful manner the Heaviside mathematical methods to the solution of interesting electrical problem.

The algebra of the Q_m operator that Mr. Press has developed is certainly interesting, and ought to be useful in the solution of other problems. It is to be hoped that Mr. Press will give us shortly a more comprehensive treatment of the subject, and particularly the detail work in applying the Q_m operator algebra to some specific problem.—I am, &c.,

Washington, U.S.A., Sept. 7. Louis Cohen.

The Manufacture of "B.L.I.C." Magnetos.

On Friday last a party of engineering and motor car journalists were given the opportunity of inspecting the works of the British Lighting & Ignition Co., Tottenham Court-road, London, W.C. These premises were originally built by the Bosch Magneto Co., and were the centre of the British business of this firm, whose works, as our readers are doubtless aware, are in Stuttgart. The building was chiefly devoted to the assembly of German-made magnetos. Since the war the entire business has been anglicised and conducted under the proprietorship of Vickers, Ltd., and under the name of the British Lighting & Ignition Co., Ltd. The building has been extended somewhat under the new management, and it has been equipped with modern machine tools for the actual manufacture of magnetos. The object of the visit was to give publicity to



the fact that an entirely British firm is now responsible for the production of Bosch type magnetos and that this organisation is equipped to meet the demands of magneto users of every class and description.

The works in Tottenham Court-road are devoted to the machine tool side of "B.L.I.C." magneto production, the winding of the armatures and the manufacture of condensers being carried on at a separate works in the immediate neighbourhood. The equipment of the factory follows modern lines in general, but there are details in the way of special processes which are, of course, quite distinctive and peculiar to magneto production. In the checking and testing of all detailed parts the utmost care is exercised with a view to ensuring complete interchangeability. The moulded insulating material employed is "Stabilite" (British made), this having been proved the best from the points of view of accuracy of mould and electrical insulating and fireproof properties. The electrical testing department is well equipped.

The adjoining illustration shows 14 different types of "B.L.I.C." magnetos, and it is a collection of products typical of the capacity of the

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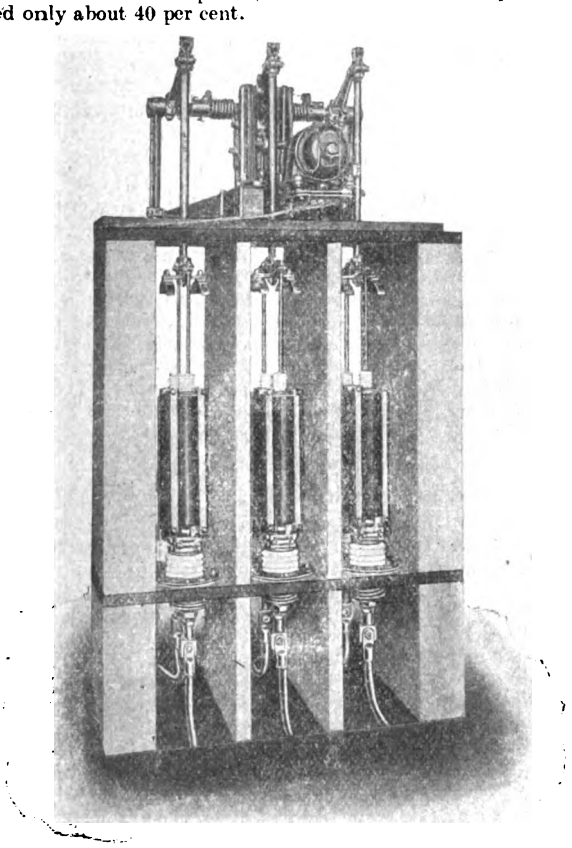
works for turning out not only standardised but also special designs. The illustration does not, however, exhaust the entire list of types and we understand that the Company is always prepared at any time to develop any special requirements of any magneto user. Several of the machines are worthy of special comment, and when the opportunity affords we hope to refer to these in detail. The growth of the high-power multi-cylinder gas engine was exemplified in several special forms of magneto built up by the Company for this class of prime mover. Naturally there is at present a great demand for aero-magnetos, and the works are particularly busy in this direction. The management is, however, not losing sight of post-war requirements.

Mr. B. L. P. Caillard, the managing director, stated at the luncheon that there was no reason why the British manufacturer should not now supply the requirements of British magneto users. There would be no need to turn to Germany for this class of product. His company believed in co-operation between capital and labour, because this policy resulted in an improvement in the product and assisted in the establishing of commerce and industry on a scientific basis. There was now every reason why the Empire should support its own industries. Mr. A. E. Bennett, the general manager, who was formerly associated with the Bosch Magneto Co., attributed the success of the Bosch magneto to the establishment of a specialised factory in a town like Stuttgart, which was in touch with non-specialised labour. He believed that the British manufacturer could do all that the Bosch Co. had done, and in particular he considered that it would be wise to follow the Bosch example in meeting the demand wherever it existed for special magnetos.

Motor-Operated Oil Break Switches.

In modern large power stations the selection of oil break switches is an important matter. In all large distribution schemes calculations of the maximum short circuit current likely to occur at various points in the network are desirable, but the utility of the safeguards imposed against such currents depends entirely on the reliability as regards safe rating of the oil switch employed. A source of electrical energy may momentarily develop current much in excess of its normal capacity, and this the switch must be competent to interrupt. Modern turbo-alternators, for example, may develop instantaneously as much as 12 times their normal current, dropping in about one second to a sustained value of twice normal. Now relays, tripping devices and switches may take 0·2 second to operate, and the initial rush may then have dropped only about 40 per cent.



A 1,200 ampere 15,000 Volt Oil Switch in Stone Cellwork.

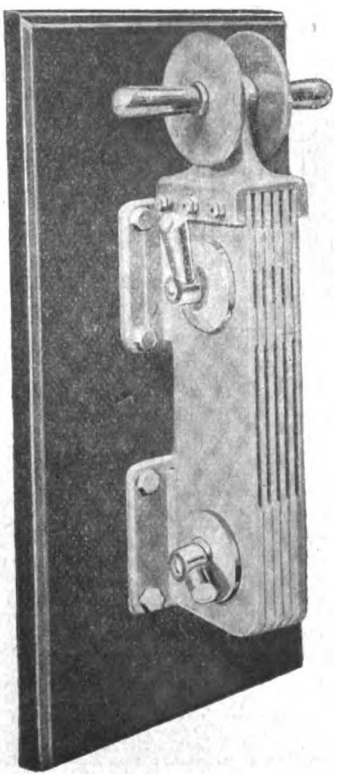
The above considerations are urged in a booklet recently issued by the British-Thomson Houston Co., Ltd., on "Motor-operated Oil Break Switches." The characteristics of such switches are described in detail. Among the many special features may be mentioned: Two long breaks on each phase, giving 32 in. per phase or 64 in. on a single-phase circuit; each break occurs in a separate vessel, and each phase is insulated in a separate concrete or brick compartment; contacts open and close at a speed of 5 ft. per second, and the circuit is not ruptured until this speed is attained; in sizes above 300 amperes main contacts are situated outside the oil vessel and are thus removed from danger of burning and accessible for inspection; the current taken by the operating motor is small, only a few amperes.

The list of ratings covers switches for 15,000 volts (300–4,000 amperes) to 70,000 volts (100 and 300 amperes). The switch utilises a U-shaped contact bridge, and the operating mechanism allows vessels to be mounted either in series or parallel. The vertical travel of the contacts is 20 in. for the 15,000 volt switches and 34 in. for 60–70,000 volt switches. Great care is devoted to proper allocation of space respectively for oil and air tests on a 300 ampere set, show that the contacts part in 0·2 sec., the motion being completed in 0·6 sec., and the time necessary for a cycle of operations, opening and closing, not more than 2 sec.

A general view of a motor-operated switch for 1,200 amperes at 15,000 volts is shown in the illustration.

B.T.H. Lever Switches.

A recent publication of the British Thomson-Houston Co. (Ltd.) deals with switches for main circuits, field breaking, motor starting, &c., on alternating and direct-current circuits. The design of "knife" switches of this type needs care, especially for such large currents as those taken by the switch shown in the illustration. These switches are of laminated construction, of single-pole type, but capable of being fitted with either single or double throw. They are designed for 2,000–10,000 amperes, and can be mounted on 2 in. and 2½ in. panels. The size of blades varies



Main Single-pole Single-throw 10,000 ampere 250-volt Laminated Lever Switch.

according to the current, 4 in. being usual for 2,000 amperes, 4–6 in. for 3,000–5,000 and 6 in. only for 6,000–10,000. The list also contains particulars of field switches and starting switches, of which full dimensional details are given; of interest also are the rotary isolating switches for three-phase systems, the blades being mounted on porcelain insulators on a common shaft, so that a quarter turn of the shaft operates all three blades together. These are specially suitable for isolating the equipment of an oil switch cell.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.
Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.
Orders for the Week.

Captain of the Week.—Capt. W. Hynam.
Next for Duty.—Capt. W. Darley Bentley.
Sunday, Oct. 6.—Annual Musketry Course at Pirbright. Parade Waterloo Station 8.45 a.m. Drill Order. Rifles and side-arms. Mid-day and tea rations to be carried.
Monday, Oct. 7, to Saturday, Oct. 12.—Drills as usual.
Sunday, Oct. 13.—Commandant's Parade at Waterloo Station 8.45 for work at Esher. Drill Order. Mid-day and tea rations to be carried.

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Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 Specifications.

106,482 Malivert. Ignition magnetos for internal-combustion engines. (28/4/16.)
111,096 Feldkamp. Multiple fuse cartridges for electric circuits. (6/11/16.)
114,825 Akt. Ges. Brown, Boveri et Cie. High voltage distributors for electric ignition apparatus. (14/3/17.)
115,627 Landis & Gyr Akt.-Ges. Electricity meters. (19/4/17.)
115,847 Clevenger. Electrolytical production of zinc. (7/5/17.)
118,090 Philips-Brinton Co. Electrical condensers. (20/7/17.)
118,422 Gandolfo. Electric welding machines. (21/3/17.)
118,423 Winterbotham. Electrically-heated cooking stoves. (18/6/17.)
118,425 Berry. Treatment of magnetic material suitable for use in static transformers and other electrical apparatus. (30/6/17.)
118,445 Sturgess. Electric motors coupled with compressors or pumps. (27/8/17.)
118,458 Marks. (Splitdorf Electrical Co.) Ignition devices. (29/8/17.)
118,459 Cox. Electrical switches. (30/8/17.)
118,464 Worsnop. Electrical accumulators. (1/9/17.)
118,478 Stevens. Automatic telephone central station apparatus. (14/9/17.)
118,494 Goldstone. Electromedical coils. (6/10/17.)
118,536 Ellison & Anderson. Electric current controllers. (10/12/17.)
118,546 B.T.-H. Co. (G.E. Co.) Electrical fans. (15/1/18.)
118,578 B.T.-H. Co. (G.E. Co.) Protective devices for electric circuits. (8/5/18.)
118,584 Robinson & Checketts. Electrical fuse carriers. (31/5/18.)
118,587 Bosch Magneto Co. Timing mechanism for ignition systems. (26/9/17.)
118,601 Sumitomo Chukosho (Ltd.). Magnet steel. (15/6/17.)
118,602 Sumitomo Chukosho (Ltd.). Magnet steel. (10/7/17.)
118,603 British Westinghouse Electric & Mfg. Co. Relays. (7/8/17.)
118,613 Smits. Electric heating element. (29/8/17.)
118,615 Gutzwiller. Electric internal tube heaters. (8/8/17.)
118,620 Wolkoff. Magneto-electric machine. (9/8/17.)
118,629 Guess. Process of electrolitically separating nickel from copper. (14/8/17.)
118,630 Remy Electric Co. Regulators for dynamo-electric machines. (10/7/17.)
118,631 Remy Electric Co. Regulating devices for dynamo-electric machines. (18/8/17.)
118,644 Western Electric Co., McBerty & Polinkowsky. Machine switching telephone switches. (10/3/17.)
118,652 Buck. Electric heaters. (16/7/17.)
118,690 Hamilton, Blackwell & Turner. Electrodes for electric furnaces and like purposes. (14/9/17.)
118,691 Stevens. Automatic telephone system. (14/9/17.)
118,694 Jeffcott. Speed controlled electrically operated machines. (19/9/17.)
118,699 Stevens & Sankey & Sons. Electrically transmission arrangements specially applicable for motor vehicles. (24/9/17.)
118,716 Domanico. Telegraphic apparatus. (12/10/17.)
118,720 Pearce & King & Owen. Means for the production and comtrol of current for X-ray tubes. (16/10/17.)
118,726 Kent & Pullman. Electric clocks. (23/10/17.)
118,733 Pritchett & Pritchett & Gold & Electrical Power Storage Co. Electric accumulator boxes. (5/11/17.)
118,734 Rogers. Elevated railways, tramways and the like. (6/11/17. Addition to 14.017/17.)
118,762 Wade. (Mills.) Electric current rectifiers. (15/12/17.)
118,775 Lucas & Breeden. Electric starting apparatus for motor vehicle engines. (10/1/18.)
118,792 Naamlooze Vennootschap Fabriek Van Instrumenten En Electrische Apparatus "Invemtun." Cord connections for electric appliances. (18/10/17.)
118,801 Maudslay & Standard Motor Co. Internal combustion engines having electric ignition. (7/3/18.)
118,805 Stevens. Signalling apparatus for automatic telephone system. (14/9/17.) (Divided application on 13.191/17.)
118,822 Parker & Smith. Trolley heads for electric traction. (10/5/18.)
118,828 Automatic Telephone Mfg. Co. & Remington Co. Electric signalling systems, more particularly for use in mines. (22/2/18.) (Divided application on 12.199/17.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

August 2, 1918.

12,653 Tudor Accumulator Co. & Spencer. Secondary batteries or accumulators.
12,656 Levy. Electrical transmission applicable to radiotelegraphy and telephony, &c. (4/8/17, France.)
12,659 Palin. Apparatus for controlling electric circuits.
12,661 Grylls & Heape. Carbons for arc lamps.
12,664 Collette. Generators and motors.
12,668 Tricoche. Electric machine operating as motor or dynamo.
12,669 S. Smith & Sons, Trier & Martin. Constant-current dynamos.
12,670 Fell. Centre-rail electric traction.
12,672 Murphy. Dynamos and motors for aircraft.

August 3, 1918.

12,709 Sordi. Electric heating apparatus.
12,711 Dixon & Harvey. Production of ammonia gas or hydrate by electro-decomposition of water and air.
12,717 King. Quick-break switch.

August 6, 1918.

12,725 Beresford & McDougall. Cable conduits and their fittings.
12,749 Hutchison. Accumulators, &c.
12,765 Evershed, Nignotes & Clark. Dynamos for production of uniform continuous current.

August 7, 1918.

12,828 B. T.-H. Co. (G.E. Co.) Recording apparatus for electric current impulses.
12,839 Anzani. Magnetos. (7/8/17, France.)

August 8, 1918.

12,869 Automatic Telephone Mfg. Co. Automatic telephone systems. (13/10/17, U.S.).
12,877 B. T.-H. Co. (G.E. Co.) Electric power systems.

August 9, 1918.

12,924 A. West & Co. Lifting magnets.
12,932 Jackson. Incandescent lamp fittings.
12,949 Automatic Telephone Mfg. Co. Automatic telephone systems. (19/9/17, U.S.)
12,959 Mawdsley. Dynamo-electric machinery.
12,960 Marino. Electrolytic method of cleaning iron or steel.
12,963 B. T.-H. Co. (G.E. Co.) Automatic regulators for dynamo electric machines.
12,968 Wolkoff. Magneto-electric machines. (9/8/17, France.)

August 10, 1918.

13,025 & 13,026 Alloy Welding Processes (Ltd.) Manufacture and soldering of electrodes in soldering and depositing metals by electric arc.

Commercial Topics.

Restoration of Trade Union Rules.

The Minister of Labour (Mr. G. H. Roberts) announced on Saturday last that the Government intended that after the war there should be a restoration of trade union rules and customs, and it would shortly be the duty of the Minister of Labour to introduce into the House of Commons a Bill carrying out the Government's pledges in that respect.

* *

Engineering Investigation in Brazil.

The Government, through the Department of Overseas Trade, are embarking upon another investigation abroad. This time they have agreed to share the cost with the British Engineers' Association of an investigation into the prospects for the engineering industry in Brazil.

The investigator, whose name will be announced very shortly, will spend probably 12 months in Brazil, and his reports will cover the whole field open to engineering enterprise. In carrying out this investigation we understand that the Council of the Association is not animated by any hostility towards the merchants and other existing channels through which engineering business has been carried on. They are desirous solely of obtaining for their members information of the requirements of the Brazilian market, the openings for engineering plant and machinery, and particulars of the methods of doing business most likely to suit possible purchasers and users. It will be open to members who receive these reports to do business in any way they like. Some members of the Association are already established in Brazil with branch houses, and others do business through the merchanting and importing houses. Therefore one result of this investigation should be to make manufacturers more willing to adapt their products and methods to local interests, and in this way this investigation should make it easier for merchants to supply their Brazilian demands from British sources. Communications should be sent to the Secretary of the Association, 32, Victoria-street, S.W.1.

* * * *

Progress of Electric Supply in South Africa.

Certain statistics recently compiled for the U.S.A. "Commerce Reports" show that electric lighting and power are making rapid progress in South Africa. It is stated that, apart from the power generated at the Rand mines, 836,437,817 kw.-hours were supplied during 1916 by the various stations of municipal councils and of the public supply companies in the Union. Of the total, 784,847,599 kw.-hours were alternating current, of which 783,689,784 kw.-hours were used for lighting and power, and 1,157,815 kw.-hours were converted into direct current for tramways. In the mines and industries of the Transvaal, Cape Province, Orange Free State, and Natal, there are in use 782 d.c. generators, having a total capacity of 65,039 kw., 240 a.c. generators of an aggregate capacity of 255,697 kw., 4,367 d.c. motors, having a total capacity of 85,347 h.p., and 7,377 a.c. motors, totalling 462,848 h.p. capacity.

In order to develop their trade with South Africa, a "Committee for Dutch Trade in South Africa" recently established in Cape Town a showroom of samples of Netherlands manufactures. The goods exhibited include electrical apparatus, electric lamps, cables and wires, electric cooking and heating apparatus, &c. A similar exhibition has been open for some time at Johannesburg, and is of a permanent character. The latter is organised by the Netherlands Chamber of Commerce in Johannesburg.

* * * *

Electric Traction in the United States.

The Director-General of Railroads in the United States (Mr. W. G. McAdoo) has made an important announcement on the future of American railways, in which he favours the use of electric traction.

Mr. McAdoo states (in the New York "Times") that if the Government were to continue the administration of the railroads of the country for any prolonged period he would be in favour of resorting to the use of electricity just as far as it could be practically employed.

Notwithstanding the great development throughout the country of water-power properties, there remained a tremendous empire of power yet to be harnessed and turned to account in operating industries and for transporting the American people. This power, now almost entirely the property of the United States, could be commandeered at a cost slight in comparison with the advantages to be derived from it. This, in view of the continually troublesome problems connected with the supply and distribution of the coal necessary in manufactures and to heat homes and city apartments, was a consummation that sooner or later would be forced on the country by absolute necessity. For the present nothing could be done toward substituting water-power for coal-produced steam, but it might come as a plain matter of necessity while the war was on. It would first be desirable to keep up the volume of manufacturing power, and then it would be required to relieve terminal needs. Ultimately electricity would be principally employed in moving freight and passengers, and first of all in simplifying terminal problems.

Some of the virgin ground of manufacturing development, such as the south along the Atlantic seaboard, especially invited the consideration of this plan to relieve the country from the thraldom of coal mining and

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shipment. He held that, even if there were no such great necessity to conserve our coal supply, the fact that transportation limits the available power of our coal would of itself justify transforming many railroads to electrical systems. He suggested that probably electrification would be actually undertaken while the Government had control of the railroads, and that the problem would be attacked at the most favourable points in the country where the value of water-power was most obvious and the cost of making the change from steam to electricity would be comparatively slight. The saving in cost of subsequent operation would be such a convincing demonstration that electrification as a general policy would be demanded by public opinion. The incidental economy to be obtained from the use of electricity for manufacturing and transportation by use of water-power would come at first in the saving of labour. Then the fuel-needs of the people could be fully met by the labour released from producing coal for manufacturing plants and the railroads. This in itself, he said, would be a very large justification for embarking in the experiment of electrification, if it could be called an experiment in the face of the numerous private electric plants operated by water-power with such success and such economy.

Electricity Supply.

Extensions.

Bedford.—The Electric Light Committee has received sanction to put in two additional boilers, stokers, induced draught plant, &c., at a cost of £14,396.

A recommendation to increase the salary of the borough electrical engineer (Mr. R. W. L. Phillips) from £400 to £500 per annum has been referred back for further consideration.

Brighton.—Last week the Lighting Committee was authorised to place an order for a 4,000 kw. set at a cost of £30,424.

Councillor Stevens thought the suggestion to pay out of reserve the sum of £10,000 estimated to be the amount of outstanding debt on the old machinery that would be displaced proved the wisdom of those members of the Council who had always been opposed to the profits arising from the electricity undertaking being applied to the reduction of the rates. He pointed out that the Council were now scrapping machinery installed only 14 years ago.

Last week the Lighting Committee recommended the Council to approve an agreement for the supply of electricity to the diamond works in Coombe-road.

Mr. Oppenheimer has agreed to pay the Corporation in advance the cost of the cable and converting plant required for providing a supply of electricity (estimated at £10,000), and will take a supply of electrical energy from the Corporation service exclusively for 10 years and for any further period for which the supply may by agreement be extended. If, owing to the action of the Coal Controller, or some other cause beyond Mr. Oppenheimer's control, the amount of electricity consumed under the agreement shall not amount to 10,000,000 units, Mr. Oppenheimer shall be entitled to an extension of the contract for such further period (not exceeding three years) as will enable him to consume 10,000,000 units. The estimated consumption will be 1,000,000 units per annum, but Mr. Oppenheimer shall be allowed to take power up to the full capacity of the cable if required for the purposes of the factory. The cable and plant will be provided and laid by the Corporation. The charge for the supply is to be 1·25d. per unit, with coal at 40s. per ton as a base price, and this figure to be increased or decreased by 0·03d. per unit per shilling per ton if coal varies above or below this figure.

Fulham (London).—A sum of £1,680 is to be expended on an extension of mains to the Lord Roberts' memorial workshops in Fulham-road.

General.

Bognor.—Electric lighting is to be substituted for gas at the fire station.

City of London.—The Board of Trade have substituted for the rates prescribed for general supply in the City of London Electric Lighting Order, 1899, the rate of 6d. per unit for one year from Oct. 1.

Edinburgh.—Owing to the increasing demand for electric power, the Electric Lighting Committee are anxious to have the new power station at Portobello proceeded with. Therefore the Ministry of Munitions will be asked to sanction the work being proceeded with and to erect two new boilers at the Corporation depot at M'Donald-road.

Electricity in Iron Works.—In the report of the Dalmellington Iron Company it is stated that the plant erected at the works for the transmission of electric power for Loch Doon has been acquired from the War Office.

Fuel and Lighting Order.—It is announced that gas and electric light rationing will begin from the meter readings to be taken for the period ending 30th inst. Coal rationing will start from the day the householder signs his requisition form, provided it is in before Oct. 31.

Leighton Buzzard.—The Urban Council has been informed by the Luton Corporation that there is no immediate prospect of a supply of electrical energy being afforded from Luton, but the matter is under consideration, so that proposals may be submitted after the war.

Light Economy in Munition Works.—Efforts are being made to economise in lighting in the great munition works of the Midlands. Investigation was recently made by an expert on behalf of the Coal Controller, and, in order to obviate preventable waste, an appeal has been made to the workpeople for their co-operation.

The means of saving successfully applied in the Midland works are:

A careful grading of illumination to suit various classes of work.

Abolition of local lighting for separate machines and the substitution of general lighting with suitable reflectors and larger units, such as the half-watt metal filament lamp and mercury vapour lamps.

A systematic patrol of the works to ensure that no unnecessary lights are kept burning.

Appointment of economy engineers whose sole duty is to supervise the operation of plant to secure the most economical results.

Periodical re-lining of shafting to reduce power consumption.

Burning of sawdust in steam boilers.

Keeping down the temperature of workshops.

Mytholmroyd.—The Council will support the proposed application of Halifax Corporation for a provisional order for the district.

Newcastle Chamber of Commerce and the Electrical Industry.—At the meeting of the Newcastle-on-Tyne Chamber of Commerce last week a report on the electrical industry was presented.

The report expressed approval of the recommendations of the Board of Trade Electrical Trades Committee, that the necessity of supporting British electrical industry should be impressed upon the public, and that priority should be given to the industry on demobilisation.

Mr. H. W. Clothier proposed the adoption of the report, but it was pointed out that to approve of recommendations of the Board of Trade Committee would commit the Chamber to Protection.

It was decided to approve the report with the deletion of the portion expressing general approval of the Board of Trade Committee's proposals.

Stirling.—The burgh electrical engineer (Mr. J. W. Papworth) has been instructed to report on a suggestion of the Controller of Coal Mines to install condensing plant at the electric supply station in view of the necessity for economising coal.

Warrington.—The Corporation has secured a fringe order to supply electricity for power and lighting in the rural area to Messrs. W. Mortimer & Co.

Water Power in Ireland.—The Water Power Committee of the Board of Trade has appointed Mr. W. Vaux Graham to examine and report on the available water-power in Ireland and its possibilities in the generation of electricity, &c.

Electric Traction.

Bradford.—The Tramways Committee received 20 applications for the position of tramways manager at a salary of £800 per annum.

The following four applicants have been selected to appear before the Committee on Monday next: Messrs. E. S. Rayner (Doncaster), J. F. Simpson (Preston), J. C. Williams (Erith) and R. H. Wilkinson (Huddersfield).

There were 22 compensation claims arising out of the tramcar accident at Allerton, as a result of which the driver was killed, and these have been settled for £1,236. 14s.

Bristol.—The Corporation has referred to its Docks Committee a suggestion that the railway companies, the Road Board and the Corporation should construct a tunnel suitable for rail and road transport under the River Avon between Portishead and Avonmouth.

Dundee.—The Tramways Committee has reorganised and limited the tramway services in order to meet the Board of Trade requirements. The reduction in the services is 10 per cent.

The Convener (Mr. Johnston) states that by stopping the Sunday services 244 tons of coal (= about £150) would be saved, but it would mean a loss of £10,000 to the department.

Glasgow.—For the purpose of economising power, the Tramways Committee has adopted the skip-stop plan on certain quiet routes.

Leeds.—The Tramways Committee is considering the question of extensions of the tramway lines in the suburban area.

Longridge-Hellefield Light Railway.—The Light Railway Commissioners have conditionally sanctioned the construction of a light railway, 23 miles in length, between Longridge and Hellefield.

The scheme has been approved subject to the promoters reducing the capital cost to about £6,000 a mile, against the estimated cost of £10,000 a mile, or alternatively subject to a subsidy being obtained from some public source to cover the additional cost beyond £6,000 per mile.

Rotherham.—The Corporation took over the electric supply undertaking of the Mexborough & Swinton Tramway Co. on Oct. 1. The purchase price is £46,000.

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Sunday Tramways.—In order to economise coal, the Sunday tramway service has been suspended in several provincial towns, including he following :—

Huddersfield, Sunderland, Preston, Swindon, Torquay, Bournemouth, Ilford, Exeter, Northampton, Nottingham and Ayr.

No tramcars are run on Sunday mornings at Salford, Blackpool, Hartlepool and on the London United Tramways.

Willesden.—The question of purchasing an electrically propelled vehicle for refuse collection is under consideration by the Health Committee, and estimates of cost are being obtained.

Imperial Notes.

Canada.—It is reported that recently a successful test in establishing telephone communication between a train dispatcher's office and a moving train was made by the Canadian Government.

The railway track is used as the conductor, and the electric current reaches the moving train through its wheels. The test was made between Moncton and Humphrey's Station, New Brunswick, on the Canadian Government Railway.

In British Columbia an electric furnace was recently put into successful operation for the manufacture of iron.

Direct Wireless Communication with Australia.—The "Daily Mail" reports that on Sept. 22 direct wireless communication between Great Britain and Australia was established, when two messages from the Premier (Mr. Hughes) and from Sir Joseph Cook were received by the Amalgamated Wireless Company of Australasia from the new station at Carnar. It is stated that the messages received at Sydney were perfectly clear and distinct, despite direct transmission over 12,000 miles.

Johannesburg.—In connection with the extensions of the municipal abattoir, the Council has asked Mr. W. L. Henderson for a tender for the necessary electrical work.

New Zealand Electric Power Boards Bill.—The President of the Southland League recently addressed a conference of the New Zealand Council of Agriculture on the subject of this Bill.

He stated that the Bill, which had already been laid upon the table of the House of Representatives, would make it possible for a Board elected by the ratepayers to generate electric power and distribute it within any district not coming within the scope of any existing or contemplated Government scheme and also to purchase electric energy from the Government or other available source and distribute it within a defined area. Such a measure would make it possible for farming districts to have equal facilities with towns in regard to electric supply.

A resolution was passed urging the necessity for a State hydro-electric scheme.

Papua.—It is proposed to construct a light railway between Port Moresby and Laloki River.

The Minister for Home and Territories has authorised the utilisation of the Rona Falls, on the Laloki River, for generating electric current for mining and industrial purposes.

Research Work in Canada.—The Canadian Industrial Reconstruction Association recommends the various Canadian Universities to establish facilities for industrial and scientific research.

The executive committee of the Association has also decided upon a system of exchanging scholarships between the English Universities outside Quebec and the Universities in Quebec.

Foreign Notes.

A Large Electric Pumping Unit.—The Butte (Mont.) Water Co. recently put in a new electric pumping installation, comprising a Worthington five-stage centrifugal pump with 12 in. single-suction, operating against a head of 875 ft., and with a rated capacity of 6,000,000 gallons per 24 hours.

The pump is driven by a General Electric 1,300 H.P. induction motor (2,200 volts three-phase 60 cycles) and is direct coupled both to the 2-stage suction side and to the 3-stage discharge. The motor speed is 1,180 revs. per min., and the pump has a rated efficiency of 88 per cent. The old pumping units (two steam pumps driven by two 800 H.P. motors) are held in reserve. The power is supplied from the Montana Power Co.'s system.

A Swiss National Trade Mark.—The Swiss Chambers of Commerce propose to establish a Swiss national trade mark under the name of S.P.E.S. (Syndicat pour l'Exportation Suisse).

The mark will be confined to firms two-thirds of whose capital is Swiss and to goods that are made in Switzerland exclusively by the Swiss. The object of the trade mark is to ensure that any articles bearing the mark "Spes" are to be really of Swiss manufacture. In addition, the mark is directed against German penetration, as numerous firms are known to be ostensibly Swiss, but in reality German. No foreign firms are to be prevented from manufacturing in Switzerland, but, not being Swiss, they are to be debarred from using the trade mark.

Italy.—A group of English steel manufacturers has offered to provide the rolling stock for a projected tramway between Rome and Ostia.

Miscellaneous.

Aluminium Prices.—The Minister of Munitions announces that the controlled price of aluminium ingots of 98-99 per cent. purity will be reduced from Jan. 1 next from £225 to £200 per ton. Scrap and swarf ingots will remain as at present.

Breach of Factory Regulations.—At Newcastle-on-Tyne Police Court last week, Messrs. Swan, Hunter and Wigham Richardson, Ltd., were summoned for having failed to take adequate precautions properly to earth an electrically driven punching machine at their Neptune shipyard, and with having failed to protect the live cables.

Mr. W. B. Lauder, H.M. Inspector of Factories, stated that on Aug. 2 a youth named Dunbavin received a fatal electric shock while working at a machine. The machine had become charged with electricity owing to the insulation of the cable becoming bared. Had the machine been properly earthed it would not have become so charged.

Defendants urged that the machine was overhauled in June when it appeared to be quite in order. The machine had been worked night and day, and owing to the excessive vibration and the shortage of labour (half of the electricians having been taken away), the earthing wire had probably worked loose.

The magistrates imposed penalties of £50 and £5 respectively, with costs.

Grimsby Automatic Telephone Exchange.—The new automatic telephone exchange at Grimsby was recently opened.

The contractors for the exchange were Messrs. Siemens Brothers & Co. The work of converting the exchange to automatic working was commenced in October, 1914, but considerable delay was caused by the war. The ultimate capacity of the new station will be 10,000 subscribers, but for the present there is accommodation for only 4,000.

Presentations.—Last week Mr. J. A. Parker, chief clerk of the Belfast Corporation electrical supply department, was presented by the members of the staff and workmen with a cutlery canteen and a cheque on the occasion of his approaching marriage. The presentation was made by the chief engineer, Mr. T. W. Bloxam.

At the meeting of the Municipal Tramways Association at Leicester last week, Mr. C. J. Spencer, manager of the Bradford tramways, who has been secretary of the Association since 1911, was presented by the members with a gold watch, and Mrs. Spencer was presented with a dressing case. Mr. Spencer has now retired from the position of secretary, and is succeeded by Mr. W. Clough, of Bury.

The British Glass Industry.—On the 25th ult. the Glaziers' Company invited those taking a prominent part in the glass industry to a luncheon, as a preliminary to a representative meeting of all interested in the trade which will be held in London during the month for the purpose of bringing about closer relations and co-operation.

The Master (Mr. G. P. Walford) welcomed the guests and stated that the ultimate object was to create a central organisation to promote the production of glass and glassware to supply our own needs, and not only to prevent for ever the competition of German glass in this country but also to compete in foreign markets.

In replying, Prof. Ripper emphasised the need for co-operation and the value of scientific work to industry. He paid a tribute to the work of Dr. Turner and expressed appreciation of the cordial manner in which the glass industry had supported him.

Mr. A. J. Hobson spoke of the establishment of the tungsten industry in Sheffield after the outbreak of war, and referred to the fact that when these works were opened it was necessary to use German glass in the chemical laboratory because none other was obtainable. To-day they could use British glassware. Our enemies, he said, made this war a war of engineering and science. We had accepted the challenge and there was no point in which we had not beaten them.

Dr. Turner emphasised the importance of technical training for craftsmen going hand-in-hand with scientific research.

Tenders Invited and Accepted.

Tramway Stores.

Portsmouth Tramways Committee invite tenders for six months' Tramway Stores, including Overhead Line Material, Castings and Machine Tools, Insulating Materials, Lamps and Motor Windings, Car Repair Stores, Steel Tyres, Lubricating Oils, &c. Specifications from the Engineer (Vivash-road, Fratton), and tenders to Town Clerk by Oct. 15.

Water-Tube Boilers, &c.

Bedford Corporation require tenders by noon Nov. 13 for the supply and erection of two Water-tube Boilers, Mechanical Stokers and Induced Draught Plant. Specifications, &c., from the Engineer, Electricity Works, Cauldwell-road, Bedford.

Electric Railway Stores.

The Mersey Railway Co. require tenders by noon Oct. 10 for supply of asbestos and rubber goods, collector shoes and brackets, electrical sundries, metallic and carbon filament lamps, &c. Forms of tender from the Central Station, Birkenhead.

Tramway Rail Bonds.

Johannesburg (Transvaal) municipality require tenders by noon Nov. 27 for supply of 2,000 copper ribbon bonds and 2,000 copper solid bonds (contract No. 424). Specification, &c., from the Town Clerk.

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Barnsley.—The Council has accepted the tender of Callender's Cable & Construction Co., at £2,676, for supplying and laying a new e.h.t. main in Pontefract road, that of Babcock & Wilcox for an induced draught fan at £294, and that of Stewarts & Lloyds for steam piping at £110.

Colchester.—The Corporation has accepted the tender o Davey, Paxman & Co. for the supply of engines, and that of Crompton & Co. for dynamos.

Government Contracts.—The following tenders were accepted by the British Government departments during August :—

War Office.—Gutta Percha Co., Chatterton's compound and gutta percha ; India Rubber, Gutta Percha & Telegraph Works Co., Chatterton's compound ; Belliss & Morcom, dynamos and engines ; Brush Electrical Engineering Co., Cruikshank, Ltd., Crossley Brcs., Day Motor Co., F. Gilman, Johnson, Hurley & Martin, Lancashire Dynamo & Motor Co., R. A. Lister & Co., and A. Scott & Partners, generating sets, &c. ; Fellows Magneto Co., magnetos ; British Thomson-Houston Co., E. Brook, Ltd., Electric Construction Co., General Electric Co., Igranic Electric Co., Mawdsley's, Ltd., F. Parkinson & Co., and Rhodes Motors, Ltd., motors, &c. ; Brush Electrical Engineering Co., transformers.

H.M. Office of Works.—Pope's Electric Lamp Co., lamps ; Thos. Berry, 15 H.P. motors.

India Office.—Chloride Electrical Co., battery plates ; General Electric Co., cells ; Morgan Crucible Co., crucibles ; Bullers, Ltd., insulator cups ; Tudor Accumulator Co., sections ; R. Johnson & Nephew' Whitecross Co., Shropshire Iron Co., and London Electric Wire Co. & Smiths, wires.

Post Office.—A. W. Gamage, Ltd., India Rubber, Gutta Percha & Telegraph Works Co., and H. White & Co., telegraph apparatus ; British L. M. Ericsson Mfg. Co., Gent & Co., and Western Electric Co., telephone apparatus ; Tyer & Co., boards for telegraph sets ; Siemens Bros. & Co., submarine cable battery boxes and cases for telegraph sets ; Telegraph Construction & Maintenance Co., submarine cable ; General Electric Co., Henley's Telegraph Works Co., Johnson & Phillips, Pirelli-General Cable Works, Siemens Bros. & Co., Union Cable Co., and Western Electric Co., telegraph and telephone cable ; Hart Accumulator Co., secondary cells ; Peel-Conner Telephone Works, retardation coils ; Barker & Co., combiners ; British Insulated & Helsby Cables and Peel-Conner Telephone Works, telephone cards ; India Rubber, Gutta Percha & Telegraph Works Co., galvanometers ; J. Bourne & Son, insulators ; Bullers, Ltd., stay rods ; E. Austin & Sons and British Insulated & Helsby Cables, solder ; Bayliss, Jones & Bayliss and Bullers, Ltd., insulator spindles ; Doulton & Co., troughing ; Peel-Conner Telephone Works, switchboard wire ; Western Electric Co., extension of equipment at Liverpool Bank telephone exchange and povision of exchange equipment at Liverpool central telephone exchange.

Appointments Vacant and Filled.

Paisley Corporation invite applications for the position of manager of the Burgh electricity works. Salary £600 per annum, with free house, &c. Applications to Town Clerk, Paisley, by Oct. 9. *See an advertisement.*

Blackburn Corporation advertise for a switchboard attendant. Salary 65s. per week, inclusive of all awards, plus a sum dependent on conditions. Applications by Oct. 14 to Mr. P. P. Wheelwright, M.I.E.E., borough electrical engineer.

Leeds Education Committee requires a chief instructor and head of the wireless department at the Leeds Technical School. Salary £250 to £300 per annum. Particulars from the Principal, and applications to the director of Education, Mr. James Graham, Calverley-street, Leeds.

Darwen Corporation invite applications for the position of electrical engineer and manager of their electrical undertaking. Salary £300. Applications to the Town Clerk by Oct. 12.

A lecturer is required on the permanent staff in the engineering department of the West Ham Municipal Technical Institute. Salary £250, rising by annual increments of £25 to £300 per annum.

The governing body of the Battersea Polytechnic requires a full time temporary assistant lecturer in electrical engineering. Salary £200 and war bonus. Applications to the Secretary, Battersea Polytechnic, London, S.W.11.

Mr. J. E. Edgecombe, borough electrical engineer, Kingston-on-Thames, has been appointed director of the Tungsten Lamp Association. The Corporation have voted him £500 for extra services in connection with the extensions of their power station.

Mr. T. A. Kingham, chief assistant engineer at Kingston-on-Thames, has been appointed acting borough electrical engineer at a salary of £400 per annum.

Mr. W. G. Moffatt is recommended to Belfast City Council for appointment as mechanical engineer at the electricity station in place of Mr. J. R. Davison, resigned. The Electricity Committee on a former occasion recommended Mr. Moffatt, but the Council appointed Mr. Davison.

Business Items.

Engineering Amalgamation.—The chairman of Messrs. Ruston, Proctor & Co. announces that his company has acquired the old-established business of Messrs. Richard Hornsby & Sons, of Grantham and Stockport. The works of the latter company are extensive, ell equipped with modern plant and machinery and over 3,000 employees. The new combination will be known as Ruston & Hornsby, Ltd.

Heat Treatment of Steel.—Automatic and Electric Furnaces, Ltd. which recently issued a circular dealing with the correct normalising of carbon steel, has now issued its heat treatment bulletin.

The Magnet-Meter.—We have received from Mr. Geo. H. Alexander, engineer, Coleshill-street, Birmingham, a small pamphlet, giving an illuminated description of the magnet-meter.

The magnet-meter has been designed to facilitate the inspection and test of shaped permanent magnets, and determining whether magnets are properly aged. The complete equipment includes a magnet-meter milliammeter, ammeter, three rheostats and two switches.

Bankruptcies and Liquidations.

An application for the discharge of Jas. Brockie, mechanical engineer, 41, London road, Forest Hill, London, S.E., will be heard on Oct. 18 at the Court House, Greenwich.

A meeting to receive an account of the winding up of the Telephone Development Co., Ltd. (in vol. liq.), will be held on Oct. 16 at 22-28, Broad Street-avenue, London, E.C. 2.

Educational.

University of London, University College.—A course of six lectures on "The Scientific Problems of Radiotelegraphy," will be delivered by Prof. J. A. Fleming, F.R.S., on Wednesdays, at 5 p.m., beginning Oct. 30. The course is open to members and non-members of the University.

Technical Education Scholarships.—Messrs. Vickers (Ltd.) recently agreed to give £100 per annum for a "Vickers' scholarship" at the Barrow Technical School, and the Barrow Steel Co. has now offered £100 per annum for another scholarship, preferably for the benefit of children whose parents are in the employ of that concern.

Municipal Accounts.

Aberdeen.—On the Corporation tramways the gross capital expenditure at May 31 was £370,877 (increase £1,484), of which £162,495 has been contributed out of revenue, and the amonut of the sinking fund is £69,173.

Past year's revenue was £116,397 (against £100,073 in 1916-17) and working expenses were £76,997 (£64,026). Interest required £2,735 (£3,475) and sinking fund £5,932 (£5,741) : special expenditure was £4,690 (£4,243), while £13,829 (£13,822) was placed to depreciation and renewals fund, leaving £12,212 (£8,763) profit, £8,141 (£5,842) to reserve, £2,070 (£921) contributed to city improvements and £2,000 (as in previous year) to the Common Good Fund. Depreciation and renewal fund amounts to £189,524 and reserve fund to £57,254. Passengers carried were 34,480,987 (28,623,659), and car-miles run 2,172,792 (2,033,793). Total revenue was 12·86d. per car-mile and working expenses were 8·50d.

Glasgow.—The Corporation tramway accounts for the year ended May 31 show capital expenditure £3,862,934 (increase £16,479), and all the borrowed capital has been repaid.

Revenue was £1,412,635 (compared with £1,260,115 in previous year), working expenses, including war expenditure, were £1,044,183 (£838,065), leaving a net balance of £177,552 (£160,984), which has been handed over to the common good fund. Average total revenue per car mile was 12·91d. (11·728d.) and working expenses, including power and permanent way renewals, were 8·853d. (7·049d.) Average fare charged was 0·44d. per mile. Passengers carried were 430,946,566 (388,294,876), car miles run 26,261,231 (25,786,047) and units used for traction and car lighting 41,054,757 (39,326,948). There are 196 miles of (equivalent) single line open and 862 cars in stock. The percentage of working expenses to receipts was 66·92(55·68), exclusive of payments to employees' dependents and to Paisley Tramways Co., and property and income tax ; total 11·86 per cent.

Norwich.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £381,276 (in addition to £38,927 met out of revenue), of which £66,666 has been repaid, and £39,202 is in the sinking fund.

Income was £72,637 (against £66,760 in previous year), and working expenses were £41,493 (£39,293). Interest and sinking fund required £20,412 (£20,455), leaving £10,731, which, with the balance brought forward from previous year, makes a total of £21,210 in the appropriation account. After writing off £2,000 for cost of transfer of the undertaking and £2,973 expenses of issue and discount on stock, £5,000 is added to depreciation account, and £11,237 carried forward. Working expenses amounted to 0·930d. (0·942d.) per unit.

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Wolverhampton.—The accounts of the tramways department for the year ended March 31 show gross capital expenditure £294,478, of which £75,514 has been repaid. The reserve fund amounts to £56,683.

Revenue was £76,193 (compared with £65,846 in previous year), working expenses were £45,369 (£38,599), war allowances £973 (£1,065), interest required £5,616, repayment of capital £6,218 and income tax £308, leaving net balance £15,545 (trams £13,356 and char-a-bancs £2,189 (compared with £14,997), of which £6,580 is to be devoted to relief of rates. Total revenue per car-mile was 16·671d., and working expenses, including power and renewals, were 13·748d. Passengers carried were 17,126,210 and car-miles run 1,096,868.

Companies' Meetings and Reports.

DIRECT WEST INDIA CABLE CO. (LTD.)—For the year ended June 30 the net result of the working was a balance of £15,225. 8s. 6d., compared with £27,374. 8s. 1d. for the previous year. An interim dividend of 3 per cent. (tax free) has already been paid, and it is now proposed to make a further equal payment (tax free), which will leave £12,525. 8s. 6d. to be carried forward. The balance to credit of revenue account, which was last year £73,029. 15s. 8d., has been debited with £1,350 applied to dividend and with £1,408. 16s. 6d. expended in repairs, and credited with £12,525. 8s. 6d. surplus revenue of past year, and it now stands at £82,796. 7s. 8d., subject to excess profits duty. The company's cable was for a few days interrupted near Turk's Island by a landslide: otherwise the cables have worked efficiently during the year, but the insulation of the Bermuda-Turk's Island section remains low. The increase in amount to credit of spare cable was accounted for by the purchase of new cable sent to Halifax during the past financial year.

The report and accounts were adopted at the meeting on the 26th ult.

GERMAN SUBMARINE CABLE COMPANIES.—According to the "Elektrotechnische Zeitschrift" for Sept. 5, the reports for the year 1917 of the Deutsch-Niederlandische Telegraphengesellschaft, the Deutsch-Sudamerikanische Telegraphengesellschaft, and the Deutsch Atlantische Telegraphengesellschaft were recently issued. A dividend of 6 per cent. was declared by the Deutsch-Niederlandische Co., 5 per cent. by the Sudamerikanische Co., and 3½ per cent. by the Atlantische Co. These dividends are the same as in 1916, except in the case of the last-named company, which paid 4 per cent. in 1916.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—At the annual meeting on the 26th ult., the directors reported that for the year ended June 30 the net result of the working was a balance of £9,696. 11s. 8d., compared with £19,649. 13s. 11d. for the previous year. An interim dividend of 3 per cent. (tax free) had already been paid, and it was proposed to make a further equal payment (tax free) which would leave £6,696. 11s. 8d. to be carried forward. The balance to credit of revenue account, which was last year £23,657. 12s. 3d., has been debited with £1,500 applied to dividend, and with £11,097. 1s. 6d. expended in repairs, and credited with £6,696. 11s. 8d. surplus revenue of past year, and it now stands at £17,757. 2s. 5d. During the year the company's cable has been interrupted on two occasions, by anchor near Halifax and quickly repaired, and on Feb. 17 in deep water. The latter repair has not yet been effected, owing to adverse weather and war conditions. The cable recovered is in a good state of preservation, and the trouble is evidently local and due to chafing. The increase in the amount to credit of spare cable was accounted for by the purchase of new cable sent to Halifax during the past financial year.

LANCASHIRE DYNAMO & MOTOR CO. (LTD.)—The net profit for 1917, after providing for interest, war taxation and depreciation, was £26,314. Including £6,791 brought forward the available sum is £33,106. The directors announce a bonus of 2½ per cent., making 12½ per cent. (tax free) for the year, and the transfer of £10,000 to reserve, leaving £7,193 to be carried forward.

VICKERS (LTD.)—Owing to protracted negotiations with H.M. Government the accounts for 1915 have only recently been made up. The war extensions at work during 1915 were those which the company undertook before the formation of the Ministry of Munitions. The balance of £767,429. 9s. 9d. left after payment of the interim dividends, and after transfer of £250,000 to general reserve, allowed payment of final dividends in March and April, 1916, of 2½ per cent. on the preferred stock and preference shares and of 7½ per cent. (tax free) on the ordinary shares, amounting together to £447,679. 13s. 9d., and leaving £319,749. 16s. to be carried forward to 1916, against £228,876. 10s. 10d. in 1915. After four years of war the company finds itself with an enormously increased plant largely suitable for war material only, and very extensive workshops. The directors have a peace programme under the most careful consideration, and have made extensive preparations. It is clear, however, that much expenditure will have to be incurred in the replacement of machines suitable for war purposes only, and in carrying the higher proportion of stocks and work in progress that peace trades require. The extensive connections that have been formed both by the parent company and by the subsidiary companies will be of the greatest use in increasing the company's old peace trades, and in disposing of their new products. In view of these, and possible further combinations, the directors have every confidence in asking the shareholders for their consent to a further increase of the capital in ordinary shares to the round figure of £12,000,000. It is proposed, subject to Treasury consent being obtained, to issue 1,850,000 new shares at 30s., offering these to the present shareholders at the rate of one share for every three now held. When this issue is taken up, it is intended to pay off the 5 per cent. third mortgage debentures. Of the 4½ per cent. second mortgage debentures there is only a small amount outstanding, which will be paid off next year.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—The net earnings for the year 1917 were £836,301. After providing for interest and premium on debentures (£236,273) and for depreciation and income tax, &c. (£337,261) there remains £262,765, which, with £72,425 brought forward, makes a total of £335,191. Out of this amount the directors have transferred £50,000 to reserve, and out of the balance (£285,191) two dividends, each of 3 per cent. (less tax) have been declared on the preference shares for the year. Out of the surplus of £195,190, the directors on June 20 declared a dividend of 5 per cent. (less tax) on the ordinary shares for the year, and, as the preference shares are entitled to share pro rata, with the ordinary shares in the surplus profits distributed until the preference shares have received a total dividend of 10 per cent. for the year in respect of which the distribution is made, the directors also declared at the same time a further and final dividend of 4 per cent. (less tax) on the preference shares in respect of the year. The above dividends absorbed £97,500, leaving £97,690 to be carried forward.

City Notes.

AMERICAN TELEPHONE & TELEGRAPH CO.—An interim dividend of 2 per cent. ($2 per share), less tax, has been declared for the past quarter.

BOMBAY ELECTRIC SUPPLY & TRAMWAYS CO. (LTD.)—Interim dividend at rate of 14 per cent. per annum has been declared on ordinary shares for half-year ended June 30.

COMPANIES TO BE STRUCK OFF THE REGISTER.—The following companies will be struck off the register of Joint Stock Companies unless cause to the contrary is shown before Dec. 3: Harold Wood Electrical & Engineering Supplies Co., Mea Magneto Co., Taylor & Co. (Hatton-garden).

The following companies are to be struck off before Dec. 13:—Aero Fire Alarm, Anti-Friction, Asbestos & Asbestic Co., British Manganese Co., Curative Electricity Co., "Float" Electric Co., Light Railway & General Construction Co.

The following will be struck off the register unless cause to the contrary is shown before Dec. 20: Harvey Electro-Chemical Co., High-Speed Printing Telegraph Co., Kentish Town Motor and Electrical Engineering Co., Mid-Sussex Electric Light & Power Co., North Eastern Electric Smelting Co., Radium Electro Emanation Co., Telephone Accessories Co.

The following will be struck off the Register unless cause to the contrary is shown before Dec. 27: Alexandra Electrical & Engineering Works, Carleon Electrical Co., Electric Lamp Repairs Co., Printex Accumulator Co., Universal Electric Canoe Co.

DUMBARTON BURGH & COUNTY TRAMWAYS CO. (LTD.)—A dividend of 5 per cent. or 1s. per share, less tax, comparee with 3½ per cent. last year) has been declared on the ordinary shares for the past year and £6,000 has been placed to reserve (against £2,000).

HONG KONG TRAMWAY CO. (LTD.)—The directors intend to redeem all the outstanding debentures on May 31, 1919.

Thirty-Seven Years Ago.

[From The Electrician, October 1, 1881.]

Effect of Heat on the Compass.—It is stated that during the intense heat which has recently been experienced in America the compass was found to stay in any position in which it was placed without reverting to the North.

Electric Lighting by Water Power.—An experiment was made at Godalming on Monday night last to light a portion of the town by electricity, the motive power being obtained from a water wheel. One large Siemens lamp and several of Swan's small incandescent lights were in use, and the results were deemed satisfactory. It is proposed to fix turbines, which the river Wey will drive at considerable velocity, and so to give the necessary power for supplying a number of lights for the Charterhouse Schools, Godalming, and some at Guildford also.

Another Telephonic Concert.—The other day a concert by telephone was given at the Science and Art School, Oldham. The players were stationed at York-street, Manchester, the telephonic despatch office of the "Oldham Evening Express," and the songs and instrumental music were most clearly heard at Oldham, having been transmitted along 12 miles of wire. We noticed the completion of this telephone line some weeks ago. It has been erected by Messrs. D. Moseley & Sons, of Manchester, and the transmitter is one recently patented by them

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THE ELECTRICIAN:

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CONTENTS.

NOTES 487
Arrangements for the Week 489
New Commonwealth Edison Turbine. By J. F. Johnson.—*Concluded* 490
An Automatic Three-Phase Switch. By W. Ernst. Illustrated. 491
The Size and Working Cost of Machines for Continuous-Current Transformation. By Thomas Carter. Illustrated 492
The Reconstruction of Electric Supply in Belgium 494
Electric Winding Engines and Mine Hoists. By H. H. Broughton. Illustrated.—*Continued* 495
Modern Systems of Electric Transmission 497
LABOUR AFTER THE WAR 498
REVIEW 498
CORRESPONDENCE 499
The "Key" Industries Exhibition 500
The Labour Outlook. By Our Labour Correspondent 500
Boiler House and Engine Room Efficiency. Illustrated 501
Patent Record 501
Volunteer Notices 502
Commercial Topics 502
Electricity Supply 503
Tenders Invited and Accepted 505
Companies' Meetings and Reports 506

Notes.

The "Key" Industries Exhibition.

LAST Monday Mr. H. J. MACKINDER, M.P., chairman of the Tariff Reform League, in the absence of Mr. AUSTEN CHAMBERLAIN, opened the "Key" Industries Exhibition at the Central Hall. From its association with the League, one is at first inclined to think that the exhibition must be of a political nature. This, however, is not the case. It is promoted simply with a view to impressing the public with the importance of "key" industries and with our position before the war, as compared with the changed conditions that at present hold. Mr. CHAMBERLAIN, who was to have performed the opening ceremony, was prevented through illness from being present, but a letter from him was read in which he stated that even at the present time this country was far more dependent upon foreign supplies than most people were apt to think. In his view legislation would be necessary to protect "key" industries in the future. Mr. MACKINDER, in his remarks, very naturally suggested that such industries could be protected more easily by tariffs than by any other means. This aspect, however, he was prepared to leave on one side for the moment, and merely to call attention to the fact that new "key" industries were liable to develop from time to time, and, therefore, that no single organisation appropriate for the protection of, say, the dye industry, would be sufficient for all purposes. It was essential that any nation within the League of Nations should ensure its independence, and this necessitated economic independence as well as military. Leaving on one side, however, the political aspects of the question, it may be said that the present exhibition includes some very striking exhibits, and we would call particular attention to the exhibition handbook, which has been so arranged as to give the lay reader a good idea of what is meant by "key" industries and their great importance. Take, for example, tungsten. A simple and very striking diagram shows that 40 per cent. of the tungsten ore is mined in the British Empire and only 2 per cent. in Germany, yet 75 per cent. of the world's production was refined in Germany, and only 6 per cent. in Great Britain. Further, whereas Great Britain uses 50 per cent. of the production and Germany 20 per cent., practically the whole of the metal required by us came from Germany. It may be contended that Germany can refine the ore more cheaply than we can, and that consequently the pre-war position was best for the community at large. We do not know how far Germany was superior in this respect or what led up to this position; but the fact remains that when war broke out this country found itself in an extremely unenviable position owing to the lack of tungsten for high-speed tools. So also in other industries the position is shown in a striking fashion by similar diagrams. In all these matters it is well that the man in the street should understand how things really stand, and then, perhaps, there will be some chance of the Government taking adequate steps, so that we do not find ourselves once again in the old position.

Patent Law Reform.

WE publish in our Correspondence columns this week a letter from Mr. JAMES KEITH supporting the views put forward by Sir ROBERT HADFIELD that we ought to have the same patent laws as America, and to have also an Empire patent. As a deputation is to wait very shortly on the PRESIDENT OF THE BOARD OF TRADE, in order to make suggestions on the proposed two new Bills, it is to be hoped that these suggestions have been given full consideration. In the United States there is no question of compulsory working of a patent. Since the British Act of 1907 was passed we have had some experience of compulsory working in this country, and it has not been altogether advantageous. Undoubtedly it has led to a certain employment of British labour, but it has also led to the introduction of a number of people who are far from desirable. As to an Empire patent, we need say very little. It is obvious that a patent covering the whole Empire would be much more valuable and much less costly than patents covering this country and a number of the overseas dominions. Some temporary inconvenience might, possibly, be caused by the closing of patent offices in these dominions, but any such inconvenience would soon pass away, and it appears to us that the advantages must altogether outweigh the disadvantages. Another strong point in the United States patent law is the very thorough search which a patent carries with it. In the case of the British patent office the search is only concerned with British patent specifications, which, of course, though important, are only a small part of the subject. It is certainly desirable that this search should be extended, though in any case it must always be remembered that the validity of a patent cannot be guaranteed. Then again there is the all-important question of fees. The present scale of fees is quite a disgrace to the country, but it does not depend upon any Act of Parliament. Whether, however, it is true to say that the American system has encouraged invention, and has thus been more successful, is, perhaps, open to criticism.

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By this we do not mean to say that the American system would not encourage inventors more than ours, but whether an inventor is likely to get more out of a patent in America than in this country depends on much more than the patent law, as we have pointed out on previous occasions. It is a well known characteristic of English manufacturers that they look upon any patents except their own with a sceptical eye, and that it is far easier to get a patent taken up in America than in this country. So long as this is the attitude we must not lay all the blame at the door of our patent system, bad as it is.

The E.P.E.A.

Our readers are aware that some little time ago the Electrical Power Engineers' Association was formed as a trade union to look after the interests of staff engineers in electric power stations. Some of us may feel that this movement is undesirable, but it is now generally recognised that it is inevitable, owing to the general recognition of trade unions in the Whitley Report. Thus, the E.P.E.A. has been recognised by the Institution of Electrical Engineers as a desirable body, and one that should deal with the particular side of the question to which it is devoting its energies. It is also known that the trade unions recently enlarged their scope so that their membership might include not merely those who labour with their hands, but equally those who labour with their brain. This being the case, there may be a certain amount of over-lapping between the E.P.E.A. and the Electrical Trades Union in the case of junior members of the staff. Nevertheless, we think it will be felt that the interests of the staff are not necessarily the same as the interests of the men whom they supervise, and consequently it seems highly desirable that there should be a union for both. No union can be successful that embraces conflicting interests. We are therefore surprised to find that the Electrical Trades Union is taking up a very hostile and unreasonable attitude towards the E.P.E.A. This will be seen from a letter which we publish in our Correspondence columns this week from Mr. Arthur Jones, the honorary secretary of the E.P.E.A. Mr. Jones sends us a letter issued by the London district secretary of the Electrical Trades Union, stating that the latter will make it absolutely impossible for any man who is a member of this "bogus trade union (the E.P.E.A.)" to get a living in the electrical industry in the London district. We doubt if this threat can be made effective, but even so this letter displays a most unreasonable attitude on the part of the trade union, and one which we hope will be very speedily dropped. We should have thought that it was quite contrary to the principles of any existing trade union to coerce the members of a new union dealing with different interests.

A U.S.A. Army Engineering School in France.

We observe in the "Engineering News Record" an interesting account of the special army engineer school in France, organised by the United States service. The course appears to be a very thorough one, admirably adapted to the training of officers with special technical duties. There are some sections of the work that practically all engineer officers undertake. Nowadays, for example, gas attacks are so general and the effects may penetrate so far behind the front lines that all officers on their way to the front receive instruction through the "gas school." Elsewhere special courses in mining, pioneering, topography, camouflage, sound ranging and interpretation of aerial photographs—to mention only a few of the specialities—are undertaken, recourse being had to a completely laid out and equipped "model battle sector" to illustrate the work. It is impossible to read the account of the course without realising how directly science enters into nearly all military operations in this war, and comes within the duties of nearly all types of officers. Another reflection that suggests itself is that experience of the war may have a not inconsiderable influence on our methods of education in the future. In technical education, for example, the constant pre-occupation of authorities has been to find the best way of giving practical effect to the desirable union of practice and theory. It has long been recognised by progressive educationists that the key to success in dealing with engineering students is to show them, as quickly as possible, the direct practical bearing of what they learn. Indeed, some would go so far as to say that a knowledge of applications should precede theory. In the stern school of war, practice and theory go closely hand in hand. The officer in training soon recognises that his life and the lives of others depend on his recognition of this relation. In the war school we find, on a huge scale, much that educationists have sought in vain to reproduce in our technical courses. The lecture room, the experimental ground and the school of practical experience in the trenches are never far removed from each other; and the constant insertion of new problems and methods, which must be dealt with, forbids stagnation. We cannot help hoping that some of the more gifted men who graduate in such war engineering schools will afterwards apply their experience in training to the home educational problems of the future.

The Benjamin Electric Works.—Erratum.—In a short article which appeared in our last issue describing the new works of the Benjamin Electric, Ltd., we stated that the works covered an area of 2,000 sq. ft., and that ground was available at the back to the extent of 3,000 sq. ft. We regret that these figures were incorrect, and should have been 20,000 and 30,000 respectively.

Electrical Power Engineers' Association.—We are informed that the membership of the Midland Division of this Association is still rapidly increasing, new members having been admitted during the past few months at the rate of about one per day. A smoking concert will be held at the Imperial Hotel, Temple-street, Birmingham, on Wednesday the 16th inst., at 7.30 p.m., when all engineers interested in the movement will be cordially welcomed.

The Ramsay Memorial Fund.—H.R.H. the Prince of Wales has become patron of this Fund, which was founded in November, 1916, in order to raise £100,000 as a memorial to the late Sir William Ramsay. About £37,000 has been raised, and subscriptions, expected from Overseas committees, will probably bring the total to £50,000. It is now proposed to raise the remaining £50,000 in the form of a Million Shilling Fund.

The Industrial Reconstruction Council.—The second lecture of the series arranged by the Industrial Reconstruction Council will be held in the Saddlers' Hall, Cheapside, E.C. 2, on Wednesday, Oct. 16. The chair will be taken at 4.30 by the Rt. Hon. the Lord Mayor of London, and an address on "Principles of Reconstruction" will be given by the Rt. Hon. Christopher Addison, M.D., M.P., Minister of Reconstruction. Applications for tickets should be made well in advance to the Secretary, I.R.C., 2 and 4, Tudor-street, E.C. 4.

Glasgow Corporation Electricity Department Engineering Society.—The first meeting of this new Society, which has been formed in consequence of the success of last winter's series of experimental lectures, was held on the 7th inst., when office bearers were elected. Mr. W. W. Lackie, chief engineer and manager, delivered an address, in the course of which he showed by a series of diagrams and tables the effects of the war on generation costs. The meetings are to be held fort-

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nightly during the winter months, and with an attendance of 102 at the first meeting there is a prospect of a successful session.

German Scientific Men and the War.—During the past week a series of articles has been appearing in "The Times" by Prof. G. F. Nicolai, a German physician, who was professor of medicine at the University of Berlin at the outbreak of war. The notorious "Appeal by German Men of Learning," which was issued in October, 1914, will be remembered by our readers, and it is interesting to note that Prof. Nicolai published jointly with Prof. F. W. Foerster, Prof. Einstein and Dr. Buek a protest against this appeal. On account of this protest Prof. Nicolai was removed from his position of chief physician to a military hospital, and was transferred to the small fortress of Graudenz.

The Peat Industry in the United States.—A recent review by Mr. C. C. Osborn, of the U.S.A. Geological Survey, shows that the peat industry in the United States enjoyed exceptional prosperity during 1917, nearly 100,000 tons, approximately twice that in the previous year, being produced. The total number of producing plants increased from 13 to 18 in 1917, and many new companies organised, but did not complete, their plant in time to contribute to the year's output. The areas worked appear to be widely distributed, but the largest number of plants operated in the State of New Jersey. There is general agreement that the demand for peat exceeded the supply, the chief difficulty being limitations in regard to labour and railway transport.

Solution of Flood-Lighting Problems.—The so-called "flood-lighting," which has found many special applications in the United States, will no doubt become more familiar in this country when the present lighting restrictions are removed. From a recent article in the "General Electric Review" (U.S.A.), by Mr. J. H. E. Butler, it is evident that such methods are already becoming standardised, and with the data available for any particular projector, it is easy to determine the resultant illumination on an object at a given distance, or the number of projectors necessary to cover a given area. We notice that the illumination considered necessarily varies according to the surface of the building or other object illuminated and its surroundings. This, no doubt, is quite natural, as one would expect a higher illumination to be necessary in order to make an object "stand out" in a brightly lit thoroughfare than would be needed if it stands alone amidst dark surroundings.

A Useful Record of Boiler Operations.—In a recent issue of the "Electrical World," a useful device for checking extravagance in the use of boilers in supply stations was described. A record chart is prepared on which both the load in kilowatts and the number of boilers in service are plotted against time. The boiler curve should fall very close to the load-curve, and the coincidence can be accentuated by the proper choice of scale on the ordinates. Any variation from normal operation is immediately detected by a wide divergence between the two records, and in such cases an explanation is sought. The data from which the curves are plotted are collected separately by the man in charge in the boiler room and the man in charge of the engine room, and the records are assembled by the chief. This precludes any possibility of "doctored" figures. The device has been found very helpful in checking any tendency to use more boilers than are necessary for the load.

Obituary.

Wm. Warren.—The death occurred in July last, at Sydney (N.S.W.), of Mr. William Warren, for many years superintendent and general manager in Australia of the Eastern Extension, Australasia & China Telegraph Co.

Mr. Warren, who was 82 years of age, entered the Electric Telegraph Company's service in 1852, and was in the Egyptian Government service from 1856 to 1959. In December, 1861, he joined Messrs. Glass & Elliott (now the Telegraph Construction & Maintenance Co.), and was sent to Genoa (Italy) for a year, and thence to Benghazi for three years Subsequently he returned to Suez for three years, and was superintendent there during the Abyssinian war. With Admiral Sherard Osborn's permission, he acted as Government agent for receiving and forwarding telegrams from and to Lord Napier of Magdala, and also for several papers. Mr. Warren was transferred to Tasmania in 1869, and assisted in the laying of the 1869 and 1885 cables, and also the New Zealand duplicate cable of 1890. In 1889 Mr. Warren was appointed manager in Australia by the Eastern Extension Telegraph Co., a position he retained until a few years ago, when he retired upon pension.

Thos. Davies.—On Sept. 20 the death occurred at Penmaenmawr of Mr. Thomas Davies, A.M.I.C.E., A.M.I.E.E., late lieut. R.E.

Deaths on Active Service.—The following deaths are reported:

Pte. H. J. Smith (County of London Regt.), formerly in the secretarial department of the County of London Electric Supply Co., was killed in action on Aug. 22. He was in his 19th year.

Lieut. P. M. Chadwick (R.E.), M.Sc. (Eng.), who was killed on Sept. 22, was a former student at the Imperial College of science and Technology, lecturer at the City and Guilds Technical College, Finsbury, and subsequently a lecturer in engineering at Birmingham University. He won a James Forrest medal and a Miller prize awarded by the Institution of Civil Engineers.

Rfmn. E. T. S. Morris (London Irish), formerly in the India Rubber Company's general office, has been killed in action.

Sec.-Lieut. A. Hinder (R.A.F., Ind. Force), aged 22, was killed while flying on Sept. 16. Before joining the Army in 1917 he was employed by the Electric & Ordnance Accessories Co. (Ltd.).

Personal.

Mr. Albert McKinstry, general manager in Australia of the British Westinghouse Electric & Mfg. Co., has been appointed to the Australian directorate of munitions. The British Westinghouse Co. has placed Mr. McKinstry's services at the disposal of the Department free of charge to the Government.

Mr. Alexander Richardson was entertained to dinner on the 3rd inst. at the Savoy Hotel, London, by a distinguished company of engineers on the occasion of his election as M.P. for Gravesend.

Sir Alfred Yarrow, Bart., presided, and among others present were Sir Wm. Beardmore, Bart., Sir E. Tennyson d'Eyncourt, K.C.B., Sir A. Trevor Dawson, Sir Charles Parsons, K.C.B., Mr. J. T. Milton (chief engineer surveyor to Lloyds Registry), Mr. W. H. Allen, D.L., Sir James McKocknie, K.B.E., Mr. W. H. Maw, LL.D., Sir John E. Thornycroft, K.B.E., Mr. G. Mure Ritchie, &c.

Arrangements for the Week.

FRIDAY, Oct. 11th (to-day).

University College Engineering Society.

5.15 p.m. In the Society's Rooms, University College, Gower-street, London, W.C. Presidential Address by Prof. E. G. Coker, F.R.S., on "Determination of Stresses by the Use of Polarised Light."

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. General Discussion and Social Evening.

Electro-Harmonic Society.

8.0 p.m. At the Holborn Restaurant, London, W.C. First Smoking Concert of the Season.

SATURDAY, Oct. 12th.

Manchester Association of Engineers.

6.30 p.m. At the Grand Hotel, Manchester. Inaugural Address by the President, Mr. J. Butterworth, M.I.Mech.E.

Birmingham and District Electric Club.

7.0 p.m. At the Swan Hotel, New-street, Birmingham. Paper on "Some Modern Applications of the Gyroscope," by Mr. H. F. Steventon.

Association of Engineers-in-Charge.

7.30 p.m. At St. Bride Institute, Bride-lane, Fleet-street, London, E.C. Address on "Fuel Economy," by Mr. D. Wilson, A.M.I.E.E.

MONDAY, Oct 14th.

Institution of Electrical Engineers, Western Local Section.

7.0 p.m. At the Merchant Venturers' Technical College, Bristol. Address by the Chairman, Mr. H. I. Rogers.

WEDNESDAY, Oct. 16th.

Electrical Power Engineers' Association, Midland Section.

7.30 p.m. At the Imperial Hotel, Temple-street, Birmingham. Smoking Concert.

FRIDAY, Oct. 18th.

Institution of Mechanical Engineers.

6.0 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Papers to be read on "A Law Governing the Resistance to Penetration of Metals which are Capable of Plastic Deformation, and a New Hardness Scale in Fundamental Units," by Prof. C. A. Edwards and F. W. Willis; "The Value of the Indentation Method in the Determination of Hardness," by R. G. C. Batson; and "The Ludwik Hardness Test," by Dr. W. C. Unwin, F.R.S.

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New Commonwealth Edison Turbine.*

By J. F. JOHNSON.

(*Concluded from page* 477.)

Governing Mechanism.

The governing mechanism is the most important feature of the unit. It is extremely sensitive, positive and quick to adjust itself to small or large changes in load. In order to ensure that changing temperature conditions will not impose heavy stresses on the turbine, the secondary and tertiary valves have been separated from the primary and mounted on top of the cylinder, where the pipe connections can be shortest and variations in stresses will be a minimum.

The primary valve, steam strainer and throttle valve are mounted on coil spring supports attached to the bedplate. The valves are all of the double-seated balanced type with renewable monel seats and rings. The three valves are operated in series by means of a high-pressure oil relay mechanism, the secondary valve being adjusted to begin opening when the primary inlet pressure reaches its maximum, and the tertiary to begin opening when the secondary inlet pressure reaches its maximum.

The governor is of the fly-ball type. In practice, governor linkages are never frictionless, nor absolutely free from lost motion, and multiport relay control valves will never have their ports absolutely accurate; consequently there will have to be sufficient change in speed to overcome these imperfections before there will be a movement of the valves. Furthermore, the oil in a long pipe has considerable inertia even when under high pressure, and does not instantly respond, to the opening of the control valve. In this governing mechanism the linkage adjacent to the governor is given a small, positive, oscillating motion, sufficient to overcome any lost motion in the linkage and error in the accuracy of the relay control valve, and still cause a very slight oscillation of the main inlet valves; consequently the slightest change in speed will be responded to by the valves. The sluggishness caused by the inertia of the oil is overcome by installing a high-pressure by-pass relief valve as close to the oil operating cylinder as possible, and employing a positive oil pump, so that the oil in the supply and discharge lines is flowing continuously, except in the short connections between the by-pass valve and the operating cylinder.

Low-pressure Turbine.

The low-pressure turbine is of the single-double-flow type, because the change in steam volume taking place within it is very large. The volume of the entering steam at average load is 13 cubic ft. per lb., and at exhaust is 585 cubic ft. per lb. Steam from the high-pressure element enters through the overhead connection and passes through 10 stationary and 10 rotating rows of single-flow blading. It then divides, half going straight on through the eight stationary and eight rotating low-pressure rows to one exhaust, and the other half passing around the intermediate section between the inner and outer cylinder, and through a similar low-pressure section to the other exhaust. A labyrinth packing is interposed between the inlet chamber and the low-pressure section opposite to the intermediate section to prevent entering steam from passing directly to the low-pressure stage. The length of the blades ranges from 6 in. to 18 in.

The rotor is of steel, and is designed to secure maximum rigidity with minimum weight. It is built up of a hollow drum carrying the single-flow section blading and labyrinth packing rigidly attached to two shaft ends. On each shaft end are mounted two discs carrying the double flow section of blading.

The stator is made entirely of cast iron, the stresses being sufficiently low for steel not to be required. It is made up of a central section and two end sections keyed and bolted together. Each section is split horizontally, the top half of all three being handled as one piece. The intermediate stage blading is carried on one inner cylinder, which is separated from the outer cylinder sufficiently to provide space for passage of the steam to one of the double-flow sections. Owing to the great size of the end sections, bracing is used to secure absolute rigidity against collapsing stresses due to the vacuum, and to maintain the position of the blade carrying elements fixed with reference to the bearing supports. An auxiliary steam inlet enables exhaust steam at atmospheric pressure, not required for feed water heating, to be admitted direct to the low-pressure stages. For every 2·5 lb. of steam admitted through this connection 1 lb. of high-pressure steam will be saved.

Condensing Equipment.

The 56,000 sq. ft. surface condenser is built in two separate shells, each directly connected to one of the low-pressure turbine exhausts without the medium of an expansion joint. Nearly the entire weight of the condensers is carried on helical spring supports. Rubber expansion joints are provided in the water and air lines, so that the condensers may be free to move with the turbine without causing excessive stresses in it. Each shell contains 6,486 1 in. tubes 16·5 ft. long, and in addition a primary heater containing 750 sq. ft. of heating surface located in the top of the shell. The temperature of the condensate is 10°F. to 15°F. lower than that of the steam entering the condensers. The primary heater raises the temperature of the condensate passing through to within 2 deg. or 3 deg. of the temperature of the exhaust steam entering the condenser.

Circulating water to the two condensers is supplied by one 60,000 gallon per minute motor-driven centrifugal pump. A very small portion of this water is taken from the pump discharge for the turbine oil cooler. There are two turbine-driven combination air and condensate pump units, each connected to both condensers. Under normal conditions only one need be operated.

The Generator.

The main generator is unusual only on account of its size; otherwise it is of standard construction. It is rated at 35,300 k.v.a. (30,000 kw. at 85 per cent. power factor), three phase, 60 cycles, 12,000 volts, 1,200 revs. per min., and is capable of delivering its rated vilovolt-amp. output at any voltage between 11,500 and 12,600.

The axial ventilation system is used for the stator. Cooling air is passed through openings in the iron parallel to the shaft, and discharged from an annular central duct into the frame casing. This arrangement allows the use of the shortest possible rotor, increasing the stiffness of construction, and hence ensuring freedom from vibration. It also permits intimate contact of the air with the iron, and since the heat conduction is greatest along the plane of the laminations any tendency toward hot spots in the iron is reduced to a minimum.

Cooling air is supplied by a ventilating fan capable of delivering 110,000 cubic ft. of air per minute, against 5·5 in. water head, and driven by a 200 H.P. three-phase 60-cycle 440-volt 500 revs. per min. wound secondary induction motor. A separate fan for cooling gives somewhat better fan efficiency and material reduction of noise in the station, and facilitates higher air velocities in the intake ducts and through the turbine. A reduction of approximately 2 ft. in the over-all dimensions of the generator proper can also be made.

The rotor construction is of the plate type. Discs approximately 2 in. thick are rabbeted into each other and strung upon through-bolts at their outer periphery. This construction insures the working of the metal in a tangential direction, as well as uniformity of steel throughout the whole body, and eliminates internal stresses due to unequal heat treatment, which are liable to occur with large diameter steel forgings.

The insulation of both stator and rotor is good for a continuous temperature of 150°C. (measured on the stator by means of embedded detectors located in the windings and on the rotor by the increase in resistance of the field coils). Such a high temperature involves the use of the best grade insulation, and also acts as a guide to the operator or emergency overloads, indicating the margin of safety on the machine. Mica insulation is good for temperatures considerably in excess of 150 deg., and in this particular unit a maximum temperature of 114 deg. has been secured at full-rated load with 25 deg. air. Mica insulation will also withstand without injury corona or static discharges, which exist in practically all machines wound for 10,000 volts and higher. Such effects lead to the formation of nitrous oxide and similar chemical compounds, which attack all insulating materials of fibrous nature with disastrous results.

These machines are guaranteed to withstand direct short-circuits without injury to the stator winding. This necessitates a very rigid bracing of the stator coil. Movement of any coil is prevented by supporting the coil in a series of clamping devices which restrictits motion in all directions.

The direct-connected exciter for this unit is of more than sufficient capacity to provide an ample safety factor. The rating is 160 kw., 230 volts, 1,200 revs. per min., shunt wound. The full-load excitation of the main turbine is less than 500 amperes. A special condition of operation is that no rheostat is used in the main generator field, and the shunt-wound exciter will deliver steady voltage at any point in the range of 100 to 230 volts. This condition is satisfactorily met by special proportioning of the magnetic circuit of the exciter, so as to secure a certain degree of saturation throughout the entire voltage range.

* Abstract of an article in the "Electric Journal."

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An Automatic Three-Phase Switch.*

By W. ERNST.

Automatic switches are used for intermittent work, such as pumps and compressors, or in cases where some sort of distant control of the motors is used. In installations of considerable size there are complications owing to the necessity of bringing the rotor starter out of the short-circuit position. This means some difficulty with special reversing relays if the design is such that the auxiliary motor, which is generally used, changes its direction of rotation. A simplification has, however, been effected in the following plan, by which the auxiliary motor always rotates in the same direction. Figs. 1 to 4 give four characteristic positions of the apparatus. Fig. 1 shows the apparatus in its position of rest. The stator switch m is open; the rotor starter f is in the short-circuit position, which corresponds to the final contact *II*. If the motor q is to be started, the contact piece a is brought into the position shown in dotted lines. The relay b comes into action, and closes the circuit for the auxiliary motor d, which then starts. At the same time the relay b closes another contact, which leads to the auxiliary motor d, by a circuit independent of a. The motor d drives the spindle r and the disc g, which, by means of the cam h, displaces the lever i. The spring s stretches until the starting switch for the stator m is locked, as shown in Fig. 2. Meanwhile the brushes on f are moved from the short-circuit position *II* to the starting position *I*. The motor q is now ready to be started. The cam h is now about to slide past i, while the brushes f are on the first starting contact. In the next instant the lever i is free, and the spring s then closes the stator switch, as shown in Fig. 3. The motor q then starts. The auxiliary motor d then moves the brushes f over the various contacts, short-circuiting the various sections, till finally the motor q reaches full speed. As soon as the rotor switch reaches the position *II* the tip of the contact lever o falls into the notch of the interrupting disc e, and the contact at o breaks the circuit of the auxiliary motor, which consequently comes to rest. The rotor switch remains in the short-circuit position, and is consequently in the same position as at the start. The motor q is stopped by the no-voltage device n. If the voltage falls below a certain amount, or if it is cut off altogether, the armature u falls away and strikes against the end of the level l, whereby the stator switch is unlocked. The spring t then opens the switch. Apart from its use as a protective device, the no-voltage cut-out is useful as a means of cutting out the motor. In this case the contact piece a is put into the other position, as shown in Fig. 4. The cut-out relay c is excited, and opens the circuit of the no-voltage coil n; the armature u falls and causes the stator switch m to open. The relays b and c are protected by the reversing switch p. As soon as one of the relays has done its work the circuit of this relay is opened and that of the other is closed; it is, therefore, impossible for the relays to act irregularly.

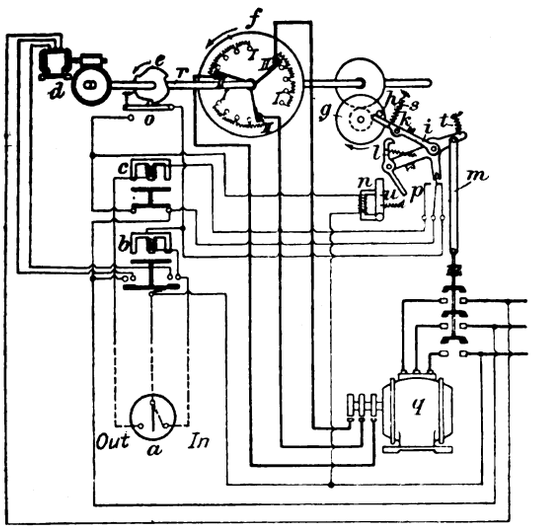

Fig. 1.—Apparatus After Stator-Switch has been Opened.

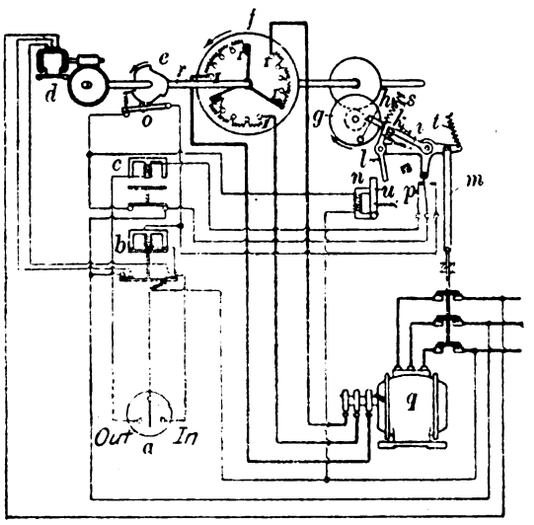

Fig. 3.—Second Stage, Stator-Switch Closed.

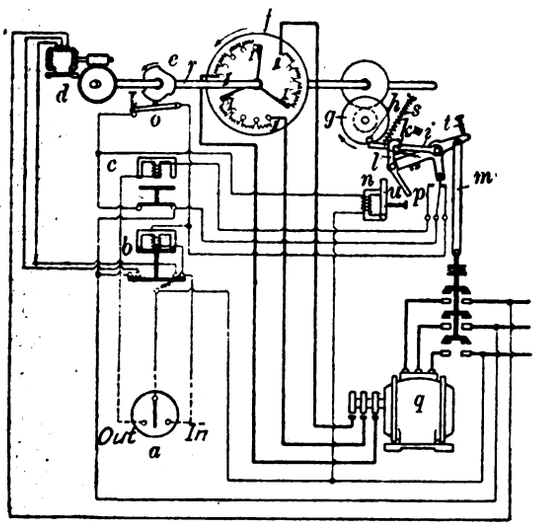

Fig. 2.—First Stage of Starting Operation.

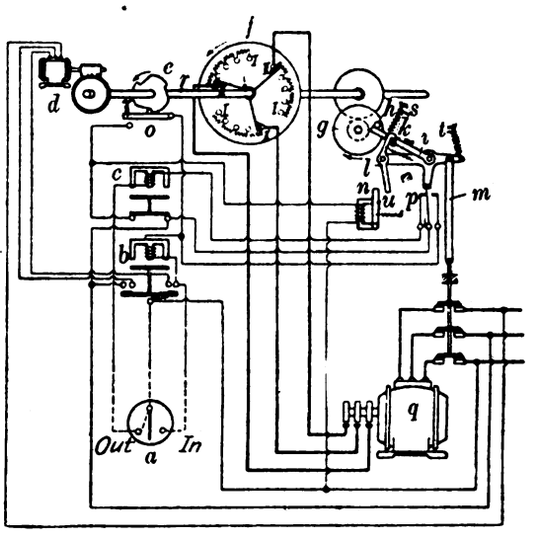

Fig. 4.—Third Stage, Motor Running at Full Speed.

This apparatus is made by Voigt & Haeffner; a photograph is given of an automatic three-phase starter for loads up to 40 kw. and for voltages up to 500. With the exception of the starting resistances, everything is contained in a dustproof cast-iron case. The cover can be opened on a hinge, and there is an aperture through which the interior can be inspected. For chemical work the apparatus is immersed in oil, and consequently, owing to increased insulation, voltages can be used up to 1,000.

* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 4, 1918.

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The Size and Working Cost of Machines for Continuous-Current Transformation.

By THOMAS CARTER.

Summary.—The article discusses various methods of continuous-current transformation (I.); considers the differences existing between three schemes using a motor-generator, and arrives at expressions for the relative sizes of these machines, which are plotted in curves based on an assumed 100 per cent. efficiency (II.); draws certain conclusions from these expressions and curves in regard to the first cost of the machines and their method of operation (III.); introduces corrections for the actual case when efficiency is not 100 per cent., and deduces curves of overall efficiency of transformation, which show that the cheapest set to buy is also the cheapest set to run (IV.); and concludes by comparing a machine having a double-wound armature with a motor-generator as regards voltage regulation, and by mentioning briefly certain well-known schemes for variable-speed motors which may be simply dealt with on the principles set out (V.).

I.

When a supply of continuous current is required at a voltage different from that of the general supply available from the mains of a public or private power station, some means must be adopted to produce the new voltage efficiently, and to ensure that it will remain reasonably constant under the full range of working conditions. In some special cases, where a reduction of voltage is required, a resistance is used to absorb the surplus. Such a method is adopted for arc lighting, or for welding, and in the special case of a cinematograph arc, generally fed from a motor-generator transforming from the supply voltage down to something under 100 volts, a resistance is used in addition to the motor-generator. In all these kindred cases, the resistance has the specific purpose of steadying the arc, and the power absorbed by the resistance has to be paid for as a necessary part of the scheme for getting certain desired results. For other cases, where a small temporary reduction in voltage is required, the loss of efficiency due to a resistance may be endured, and, if the current required is constant, the voltage at the user's terminals will remain constant; but if the load be variable, the variation in voltage

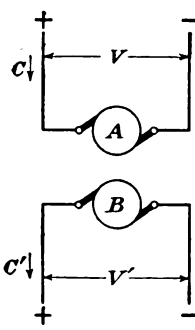

Fig. 1.
Scheme No. 1.
Motor-Generator Principle.

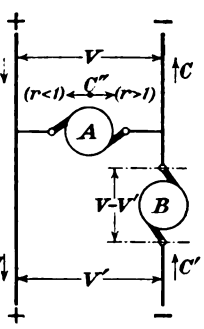

Fig. 2.
Scheme No. 2.
Booster Principle.

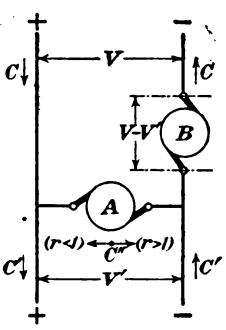

Fig. 3.
Scheme No. 3.
Balancer Principle.

will probably be inadmissible, ranging, as it would, from full supply volts at no-load to some minimum value at the maximum current, and, consequently, some other means of producing the required voltage must be adopted.

A battery might be used, with its cells charged from the main supply, and then re-arranged to give the new voltage, either by recoupling the whole battery in sections, or by tapping suitable points, or by both methods. But such an arrangement, unless the required voltage bears some simple numerical relation to the supply voltage, such as double, or one-third, or the like, which would allow the whole of the battery to be recoupled suitably, is not very economical, as certain cells would, with tappings, have to be used more than others, unless special, and probably complicated, provision were made for using all the cells in turn. The fact that some cells are out of action altogether would involve undesirably increased capital expenditure, and a battery cannot be used except under definitely favourable circumstances.

The usual practice is to use a motor-generator to deal with the transformation, and there are three principal ways of arranging the two machines composing the set. These are shown diagrammatically in Figs. 1, 2 and 3. Fig. 1 shows the most obvious way of dealing with the problem, namely, to have a straightforward motor-generator set, of which each machine is capable of dealing with the whole power to be transformed. Figs. 2 and 3 show two other ways of making the transformation; in each of them one of the pair of machines is put in series with one of the mains of the general system, while the other is connected across the mains. The difference between scheme 2 and scheme 3 is that in scheme 2 the machine across the mains, *A*, is nearer the supply than the machine in series with the main, *B*, while in scheme 3 *A* is further from the supply than *B*. In scheme 1, the two machines have no electrical connection with each other, but in the other two cases they have such a connection. One main is, in fact, common to the two parts of the system, and hence if it be undesirable that the user's apparatus should be in any way connected to the supply, say for reasons of insulation, scheme 1 must necessarily be used. A case where this is essential is one where the main supply is generated for traction, with, therefore, one outer main earthed, and where it is necessary, in addition, to supply some lighting on a three-wire system, with earthed neutral. If it were desired to supply the lighting from the traction system, a motor-generator would be installed, on the plan of scheme 1, and the specified main could then be earthed without disturbance in each system. In some cases, a one-to-one transformation of voltage might have to be used for this reason.

When, however, there is not any such restriction, scheme 2 or scheme 3 would be used. In scheme 2, the two machines, *A* and *B*, are in series across the user's side of the system, and the principle is that of a booster, which, if the transformation be to a lower voltage, becomes a back-booster. The best-known use of this scheme is to charge and discharge a battery by hand regulation, or by automatic means of various sorts. In scheme 3, the two machines are in series across the supply side of the system, and, as the user's second main is taken off between the two machines, the principle is similar to that of a balancer, and the motor-generator, when the transformation is to a lower voltage, is sometimes called a reducer set.

II.

Consider, now, the size of the motor-generator required in each of these three cases, and assume, as a basis of comparison that one definite secondary voltage only is to be produced. Further, let it be given that a certain current, C, at a supply voltage V, is to be taken from the mains in order that some other current, C', may be used at some other voltage, V', after transformation, so that the same number of watts is dealt with in each scheme. For simplicity, let the motor-generator efficiency be assumed, meantime, to be 100 per cent.; an efficiency correction is introduced later, and the present assumption affects the comparative results only quantitatively. Let the ratio of voltage transformation, V'/V, be r in each case.

In all three cases, the user draws all his supply from the mains, as the intermediate motor-generator, however arranged, does not contribute new power, but merely alters the voltage at which the power originally taken is finally delivered. Therefore, the watts used must, in every case, be the same as the watts taken from the supply, which means that

$$VC = V'C'.$$

Now, $V' = rV$, and hence

$$VC = rVC',$$

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from which it is clear that

$$C'=\frac{1}{r}C,$$

and this relation is true throughout. As the efficiency of the motor-generator is 100 per cent., the two machines, A and B, are of equal size, and thus the relative amount of machinery required is measured by the size of each of the two machines. In scheme 1, each machine is large enough to deal with VC watts, so that the machinery for this arrangement may be denoted, for comparative purposes, by

$$VC. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In schemes 2 and 3, the basic difference from scheme 1 is that the motor-generator does not deal directly with the whole of the energy drawn from the supply, but allows some of the current to flow from the mains through the whole system. Looking at the left-hand main in Figs. 2 and 3, it is clear that in each case

$$C'=C+C'',$$

when proper signs are given to the various currents, a point which is further dealt with later. Hence

$$\begin{aligned} C''&=C'-C \\ &=\frac{1}{r}C-C \\ &=\frac{1}{r}(1-r)C. \end{aligned}$$

Further, in each case machine B deals with $V-V'$ volts, that is, with

$$(1-r)V \text{ volts.}$$

In Fig. 2, therefore, where the output of machine A is VC'' watts, and that of machine B is $(V-V')C'$ watts, this is, in each case, equal to

$$\frac{1}{r}(1-r)VC, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

which is, therefore, the expression for the amount of machinery for this scheme. In Fig. 3, where the output of machine A is $V'C''$ watts, and that of machine B is $(V-V')C$ watts, the corresponding expression for the amount of machinery is

$$(1-r)VC. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Equations (1), (2) and (3) thus give, in terms of VC, which is the same for all three, a means of estimating which scheme will lead to the smallest amount of machinery in any given case. In scheme 1, the amount is fixed, whatever be the value of r, but in the other two, the amounts depend on r in a very definite way. It will be noted that, for a one-to-one transformation, the amount of machinery in scheme 2 or scheme 3 is zero: this is as might be expected, as then the power can be taken straight from the supply mains without any transformation. Further, the ratio of the amount of machinery for scheme 3 to that for scheme 2 is always

$$(1-r)/\frac{1}{r}(1-r)=r,$$

which means that, for a transformation to a lower voltage than V, giving $r<1$, scheme 3 needs less machinery than scheme 2, while when r becomes >1, scheme 2 is cheaper than scheme 3. This is clear on general principles, for in scheme 2 the current dealt with at $V-V'$ volts is C', while in scheme 3 it is C, and when r is <1, C is $<C'$, while when r is >1, C is $>C'$. Further, it will be noted that when r changes from <1 to >1, the amount of machinery in schemes 2 and 3 becomes negative, as the formulæ are written, which means, in fact, that the machines reverse their functions, that which was a motor becoming a generator, and vice versa. It is necessary, in order to keep the expressions positive, as denoting an amount of machinery, to write $(r-1)$ instead of $(1-r)$, so that the three expressions become—

$$+VC, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$\frac{1}{r}(\pm 1\mp r)VC, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and

$$(\pm 1\mp r)VC, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

the top signs being used for values of r up to unity, and the bottom signs for values above unity.

Putting V and C each equal to unity, which gives VC also equal to unity, the relative amounts of machinery become

$$+1, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1a)$$

$$\frac{1}{r}(\pm 1\mp r), \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2a)$$

and

$$(\pm 1\mp r) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3a)$$

for the three schemes respectively, and these are plotted, against r, in Fig. 4.

III.

The differential of $\frac{1}{r}(\pm 1\mp r)$ with respect to r is $\mp\frac{1}{r^2}$. The tangent to the curve of scheme 2 at the point whose co-ordinates are 1, 0, has thus the slope ∓ 1, which means that the equation to the tangent at this point is of the form

$$y=\mp x+a,$$

and, since the point 1, 0 is also on this line, $a=\pm 1$, so that the tangent is

$$y=\mp x\pm 1,$$

which means that the straight lines forming the curves for scheme 3 are tangential to the curves for scheme 2 at the point where they meet, namely, at $r=1$.

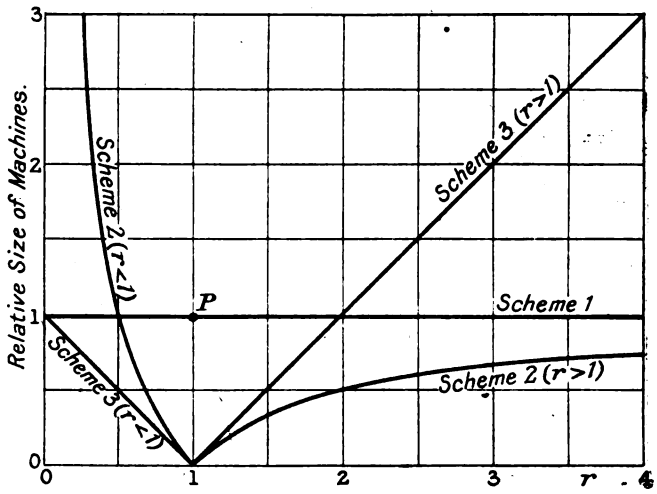

Fig. 4.—Relative Sizes of Motor-Generators for the Three Schemes.

Fig. 4 shows that the amount of machinery for either scheme 3 or scheme 2, according as r is $<$ or $>$ unity, is always less than that for scheme 1, so that unless some of the special reasons already mentioned make scheme 1 a necessity, either scheme 2 or scheme 3 should be used.

From a well-known rule of co-ordinate geometry, the lines forming the two parts of the curve for scheme 3, whose equations are of the form $y=-x+1$ and $y=+x-1$, are at right angles to one another. Further, if the origin be moved to P, in Fig. 4, and the axes be turned clockwise through 90 deg., that is, through -90 deg., the equation of curve 2, for $r>1$, which now has the form

$$y=\frac{1}{x}(x-1),$$

is transposed into the form

$$1-x=\frac{1}{1+y}\cdot y,$$

which simplifies to the form

$$y=\frac{1}{x}(1-x).$$

which is the form of the equation of curve 2 for $r<1$, referred to the original axes. This means that curves 2 and 3, for $r>1$, are simply curves 2 and 3, for $r<1$, rotated clockwise through 90 deg.

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The conclusion from Fig. 4 is that the cheapest scheme is the balancer, or scheme 3, when r is <1, while for $r>1$ the cheapest is the booster, or scheme 2.

It has already been pointed out that at $r=1$ the two machines A and B, in schemes 2 and 3, reverse their functions. For $r<1$, V' is $<V$, and machine B, in Fig. 3, say, has its lower terminal in the diagram at a higher potential than its upper terminal. The current is thus going through it from its positive to its negative terminal, which means it is a motor, and will thus absorb $V-V'$ volts in being driven. Thus, when no current is passing, machine A is giving V' volts with zero current, while machine B is taking $V-V'$ volts, also with zero current. When some current is taken, it passes through machine B, and accelerates it, which consequently increases the voltage of machine A, and causes it to give out current of an amount which increases until the watts of the two machines are the same, and the set gives back to the system just what it absorbs, so letting the user get just the amount of power he wants, with an exactly equivalent amount taken from the mains. When $r=1$, machine A is generating zero current at V volts, no matter what current is being used in the main circuit, and machine B is carrying C amperes, and is not generating any volts. When r becomes >1, V' is $>V$, and the terminal polarity of machine B is reversed as compared with the conditions just described. But the current is travelling in the same direction as before, and the machine begins to generate, causing the set to slow down, and so making machine A act as a motor, and take just enough current to drive machine B. In all these conditions, the ordinary laws of the electric circuit are fulfilled, and consequently

$$C'=C\pm C''.$$

The negative sign now introduced simply means that the current C'', of which it was previously written that $C'=C+C''$, may become intrinsically negative, and thus in the diagrams it is shown with two arrows, one pointing to the left for $r<1$, and one pointing to the right for $r>1$, while for $r=1$ the current C'' is zero.

(To be concluded.)

The Reconstruction of Electric Supply in Belgium.

A contribution on the above subject to "Le Génie Civil," by Mr. J. Carlier, raises a number of points of interest. Even before the war inter-connection of the various systems of supply was in contemplation in Belgium. As an instance, Genck, in Campine, is mentioned, which was fed by three distinct systems of supply, a combination of which was actually effected in this region before war broke out. Mr. Courtoy, engineer to the Société anonyme d'Ougrée-Marihaye, has likewise made a study of the conditions in this area, which appeared in the "Revue Universelle des Mines" in 1914. The results anticipated from combination in this case were most interesting.

The war has radically altered conceptions of electricity supply, such factors as increased working costs, scarcity of coal, &c., having affected all countries, even America. In this connection reference is made to the recommendations in the recently issued Interim Report on Electric Power Supply in Great Britain prescribed by the Coal Conservation Sub-Committee under the Ministry of Reconstruction. In a note (No. 4) of the "Comité d'Etudes," on the centralisation of supply in Belgium, it is stated that the average power to be mobilised for the complete electrification of the transport industries would be about 250,000 kw. The figure is much below the power required for steam, but centralisation, by averaging the demands at any moment, would permit important economies. The average demand of the industries of Belgium is placed at 500,000 kw. It is calculated that by an adequate general system of electric supply 1,000,000 tons of coal might be saved per annum on the railways, and an additional 4,000,000 in industry, making a total of 5,000,000 tons, valued at about 83,000,000 fr. The price per unit could also be substantially reduced.

In order to get the most economical results in this respect, it is not desirable to rely exclusively on the inter-locking of existing sources of supply. Ultimately new central stations for bulk-supply will be needed. The chief advantages of such concentration are (1) diminution in coal consumption per unit generated, and (2) diminution in financial charges for production. Assuming that in Belgium high-tension lines aerial lines (60,000–100,000 volts) are used, and that central stations furnishing each from 150,000–250,000 kw. are installed, the areas where such stations are erected might be as follows:—

1. The carboniferous region of Belgian Limbourg.
2. The area round Liége
3. The area round Charleroi
4. The area round Mons.
5. At the ports of Ostend, Ghent and Antwerp, according to the cost of coal available by importation at these centres.

On this basis a total of about 1,200,000 kw. would be secured. Through the agency of a National Association for Electric Supply, the inter-connection of central stations, and the federation of producers of electricity, should be encouraged. In Belgium stations existing at present are of relatively small production, 2,000–3,000 kw. being usual, and 6,000 kw. the limit. The cost per unit (with coal at 15 fr. per ton at the mine) is not less, even in the best stations, than 10 centimes (1d.). These charges must not be confounded with those available where exceptional conditions prevail, *e.g.*, where by-products of industry are used for generating power in place of coal, a condition that not infrequently is met with in Belgium. As regards the bulk-supply of power, the most favourable rates prevailing are 2·5 centimes (¼d.) where by-products are used as fuel, and 3·5–5 centimes (¼d.–½d.) where the load is of an exceptional even character. Such prices are, however, quite exceptional, and for moderate demands the rates are frequently 10 centimes (1d.) per unit, and for small demands 15–25 centimes (1½d.–2½d.), or even 50 centimes (5d.) per unit.

It is suggested that by the aid of super-central stations the rates might be diminished by 50 per cent., so that for domestic requirements it might be 9–10 centimes (1d.) per unit; for moderate demands 4–5 centimes (½d.), and for large power demands 2–2·5 centimes (*i.e.*, about ¼d. only).

The author does not advocate the sole control of electric power production by the State, which has in general shown itself inefficient in industrial operations, nor even by towns and communes, but rather by a body representative of industry itself. On the other hand public authorities should be represented on the National Electric Supply Association (Société Nationale d'Electricité) because—

1. They have freedom and power to take measures necessary to ensure the most economical and efficient methods and supply, and a corresponding diminution in the price per unit.
2. Municipalities and public bodies would be clients of this body, or themselves producers, or both; cities are thus interested in the central stations, and it is to their benefit to associate them, one with another.
3. There would thus be beneficial emulation between all those concerned with electrical supply, but on a co-ordinated plan.

The federation could be constituted in the form of a Belgian co-operative association, the capital necessary for the erection or linking up of stations being provided by the affiliated electrical concerns, as well as the public authorities represented. Eventually central super-power stations would be erected by this association. By this method we secure the representation of public bodies concerned with electricity supply not merely as commissioners but as sharers in the enterprise. We have, in fact, an amalgamation of all the interests concerned, representing the public as a whole, and working for the benefit of the entire country.

The Electrical Industry in Japan.—According to the "Board of Trade Journal," the Japanese electrical industry is making vigorous efforts to replace German interests in China, and a number of leading Chinese business men and journalists recently arrived in Tokyo to inspect the Electrical Exhibition in the Uyeno Park. There are now more than 700 power supply concerns in Japan, with a total capital of 600,000,000 yen (1 yen approx. 2s.), and over 1,000,000 H.P. is being generated. While Japan was entirely dependent upon foreign electrical supplies only a few years ago, the value of the electrical exports now reaches over 7,000,000 yen per year. The Tokyo Exhibition, referred to above, appears to have been a great success, over 200 exhibitors taking part.

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Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

(*Continued from page* 474.)

Summary.—In this article the author deals with the mechanics of the cylindro-conical drum winder, and gives as an example a 10,000 lb. machine winding 114 tons per hour from a depth of 4,170 ft. The static torque diagram is determined by two methods, one of which is graphical and the other arithmetical.

Cylindro-conical Drums.

Should a pure conical drum be too wide in a given case, then it is necessary to make part of the drum—the part of large diameter—cylindrical in form, and to arrange for this to carry two layers of rope. Such a drum is called a cylindro-conical drum.

When the diameters are chosen with such a ratio that the static torque at the beginning of the wind is equal to that at the end, then this torque will gradually increase to about the middle of the wind and decrease again towards the end, as shown in Fig. 39.

The form of the static torque diagram depends on the ratio of the number of turns on the cylindrical portion to the number on the conical portion, as well as on the ratio of the diameters. The several diagrams, Fig. 40 (*a*), (*b*) and (*c*), have been drawn for winders having cylindro-conical drums with an equal number of turns on the cylindrical and conical parts.

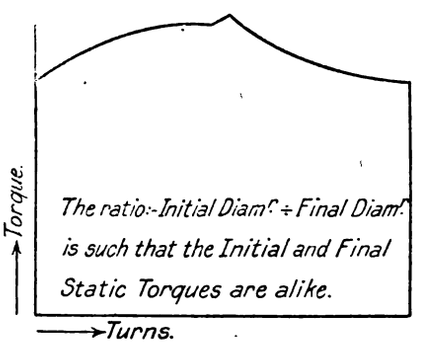

Fig. 39.—Static Torque Diagram of a Cylindro-Conical Drum Winder.

Fig. 40 (*a*) is the static torque diagram for a winder having a drum in which the diameters have been taken so as to make the torque at the beginning equal to that at the end of the wind. In the diagram, Fig. 40 (*b*), the lesser diameter of the drum is too small, so that the torque variations are more than equalised or are over-compensated. Fig. 40 (*c*) shows the torque diagram for a winder, in which the lesser diameter of the drums is too large completely to equalise the variation due to the rope. In this case the torque variations are said to be under-compensated.

The data assumed in drawing these diagrams are :—

Depth of shaft	4,000 ft.
Weight of rock	10,000 lb.
Weight of skip	6,500 lb.
Weight of rope	3 lb. per ft.
Friction	10 per cent.

In the section dealing with conical drums an expression was found, equation (33), for the ratio of the diameters in order to equalise the torque. For the cylindro-conical drum winder the pull, P, on the loaded side is $(10{,}000+6{,}500)1{\cdot}1=18{,}150$ lb.; and the pull, Q, on the unloaded side is $6{,}500\times0{\cdot}9=5{,}850$ lb. The weight of a 4,000-ft. length of rope is 12,000 lb. Inserting these values into equation (33) we get—

$$\frac{R_2}{R_1}=\frac{18{,}150+5{,}850+(2\times12{,}000)}{18{,}150+5{,}850}$$
$$=2.$$

The smaller diameter is assumed to be 10 ft. Hence, the larger diameter is 20 ft. These values have been used in Fig. 40 (*a*). In Fig. 40 (*b*) the smaller diameter has been reduced to 8 ft., and in Fig. 40 (*c*) it has been increased to 12 ft.

Static torque diagrams for winders with cylindro-conical drums having an unequal number of turns on the cylindrical and conical portions of the drum are depicted in Fig. 41 (*a*) and (*b*).

Fig. 41 (*a*) is the diagram for a drum having the greater number of turns on the cylindrical portion. The section of

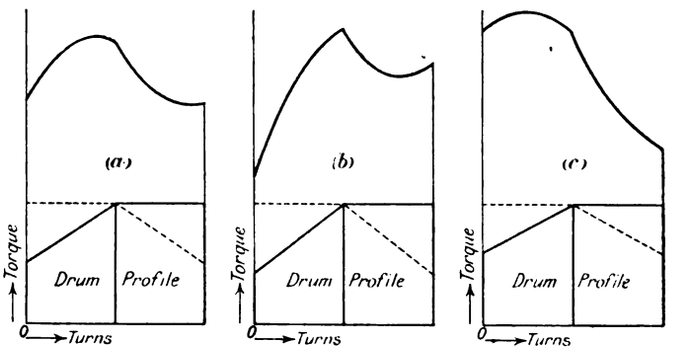

Fig. 40.—Static Torque Diagrams for Cylindro-Conical Drum Winders.

the diagram between B and C shows the resultant torque during the portion of the wind when both the ascending and descending ropes are working on the cylindrical parts of the drums. During this period the torque due to rope-pull is not compensated.

The diagram of static torque for a drum having most of the turns on the conical part is shown in Fig. 41 (*b*). The part of the diagram between B and C shows that the rope torque is over-compensated.

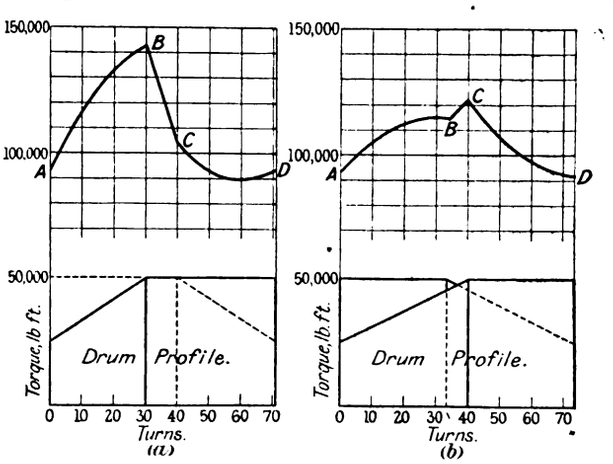

Fig. 41.—Static Torque Diagrams for Cylindro-Conical Drum Winders.

(*a*) When most of the turns are in the cylindrical portion of the drum.
(*b*) When most of the turns are in the conical portion of the drum.

In both diagrams the parts AB show the torque variation when the ascending rope is winding on the conical portion, and the descending rope is unwinding from the cylindrical portion of the drum. The parts CD of both diagrams show the torque variation when the ascending rope is being wound on the cylindrical portion and the descending rope is being unwound from the conical portion.

An example will now be given in order to show how the torque diagrams for cylindro-conical drums are constructed.

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Example 5.—The particulars given below relate to a cylindro-conical drum winder, which was designed to operate on the minimum number of kilowatt-hours per ton hoisted. The winder, although generally operated in balance, must be capable of making an occasional unbalanced trip. It is

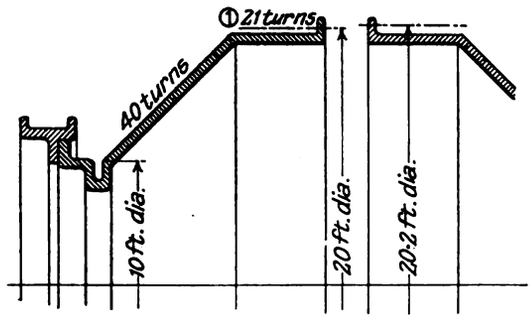

Fig. 42.—Cylindro Conical Drum.

required to draw the torque diagrams for both kinds of operation.

The particulars referred to are :—

Weight of ore	10,000 lb.
Weight of skip	6,500 lb.
Depth of shaft	4,170 ft.
Rope, 1⅜ in. dia.	3lb. per foot.
Max. winding speed	3,500 ft. per min.
Accelerating period	28 seconds.
Full-speed period	52 seconds.
Retarding speed	30 seconds.
Loading period	30 seconds.
Output	114 tons per hour.
Drums, cylindro-conical	10 ft. dia. to 20 ft. dia.
Drum speed	55 revs. per min.
Inertia of drums, &c.	250,000
Inertia of motor	27,000
Inertia of sheaves	4,000
Sheaves	12 ft. dia.
Friction	10 per cent. of load and skips.

The drum is depicted in Fig. 42.

Balanced Winding.

Graphical Method of Determining Static Torque.—From the given data the length and weight of rope coiled on each section of the drum can be determined. For easy reference, these are tabulated below :—

Section.	Turns.	Length of rope.	Weight of rope.
Completing cone	40	630 ft.	1,890 lb. w
Cone	40	1,890 ft.	5,670 lb. w_1
Cylinder, First layer	21	1,325 ft.	3,975 lb. w_2
,, Second layer	15	950 ft.	2,850 lb. w_3
Turns per wind	76	Ideal rope	14,385 lb.

The torque diagram will be drawn by the methods used for cylindrical and conical drums.*

The drum profiles are superposed and plotted to a turn base, as shown in Fig. 43, and the apex 0_1 of the completing cone determined.

Considering the loaded, or ascending, side. For the conical part of the drum the static moments are determined in precisely the same manner as that described in Example 5.† The line $0_3 0_1$ is drawn as a base at a distance representing, to a convenient scale, the torque due to the loaded skip and ideal rope, as well as that required to overcome the friction of this side. This torque, denoted by—

$$R_2(W+W_s+F+w_3+w_2+w_1+w_c)$$

in Fig. 43, is equal to—

$$10\{1{\cdot}1(10{,}000+6.500)+14{,}385\}=325{,}350 \text{ lb. ft.},$$

the friction on this side being taken as 10 per cent. of the weight of the loaded skip. Taking into account the varying load, due to the winding-up of the rope, and the varying radius of the drum, as described in Example 4, we get the curve *fe* for the conical part of the drum.

* The Electrician, pp. 354 and 433.
† Ibid, p. 434.

After 40 turns the rope begins to coil on the cylindrical portion of the drum and the torque follows the stepped sloping line *ehg*. The step at *h* is due to the rope beginning to coil on the second layer. At the end of the wind—*i.e.*, after 76 turns—the torque $d_1 g = R_3(W+W_s+F) = 10{\cdot}1 \times 1{\cdot}1 \times 16{,}500 = 183{,}315$ lb. ft. If desired, the two points at *h* are calculated, but, as a rule, it is sufficiently accurate to join *e* and *g*.

At the beginning of the wind, on the descending side, the rope is on the second layer of the cylindrical portion, and the torque $a_1 j$, therefore, is :—$R_3(W_s-F) = 10{\cdot}1 \times 0{\cdot}9 \times 6{,}500 = 59{,}085$ lb. ft. During the 36 turns the rope is on the cylindrical portion of the drum, the torque follows the sloping line *jkl*, and when the drum has made 36 turns the torque is

$$R_2(W_s-F+w_3+w_2) = 10\{(0{\cdot}9 \times 6{,}500)+2{,}850+3{,}975\} = 126{,}750 \text{ lb. ft.}$$

When the rope is on the conical portion, the torque is determined by a construction similar to that used for the ascending side, using the pole 0_4, and transferring the divided line *te* to *sl*. This gives the line *lm*.

Hence, for the ascending side, the torque is represented by

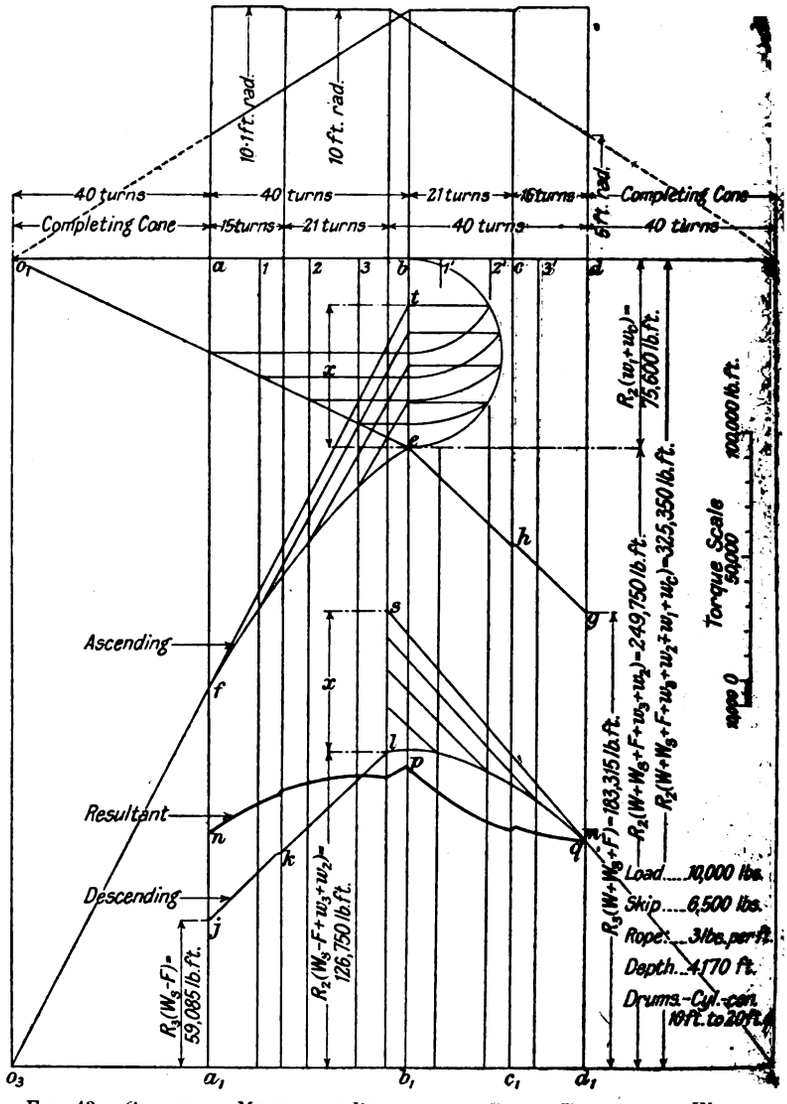

Fig. 43.—Graphical Method of Determining Static Torque of a Winder having Cylindro-Conical Drums.

fehg, and for the descending side by *jklm*. By subtraction the resultant static torque *npq* is found.

Arithmetical Method of Determining Static Torque.

It is possible that some readers may prefer to plot the static-torque diagram without recourse to the rather elaborate graphical method described above. The four curves depicted in Fig. 44 have been found by the arithmetical method, and combined to give the resultant static torque.

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Loaded Skip.—Allowing 10 per cent. for friction, the torque line *abc* for the loaded skip is drawn by determining two, or at most three, points on the curve. The key point is the commencement of the wind, when the drum radius is 5 ft. At this point the torque is—

Rock. Skip. Friction. Radius.
$$(10{,}000+6{,}500+1{,}650)\times 5 = 90{,}750 \text{ lb. ft.}$$

When the drum has made 40 turns the rope begins to wind on the cylindrical portion of the drum, and during the next 21 turns the drum radius is constant and equal to 10 ft. During this period, therefore, the torque is constant and equal to $18{,}150\times 10=181{,}500$ lb. ft. After 61 turns of the drum the rope begins to coil in a second layer on the cylindrical portion of 10·07 ft. radius. Hence, the torque is slightly increased to $18{,}150\times 10{\cdot}07=182{,}500$ lb. ft.

Unloaded Skip.—The effective load is $0{\cdot}9\times 6{,}500=5{,}850$ lb., and at the beginning the torque is $5{,}850\times 10{\cdot}07=58{,}800$ lb. ft. After 36 turns the torque is $5{,}850\times 10=58{,}500$ lb. ft., and after 76 turns—that is, when the unloaded skip has reached the bottom of the shaft—the torque is $5{,}850\times 5=29{,}250$ lb. ft. These points when plotted below the axis give the torque line *def* (Fig. 44).

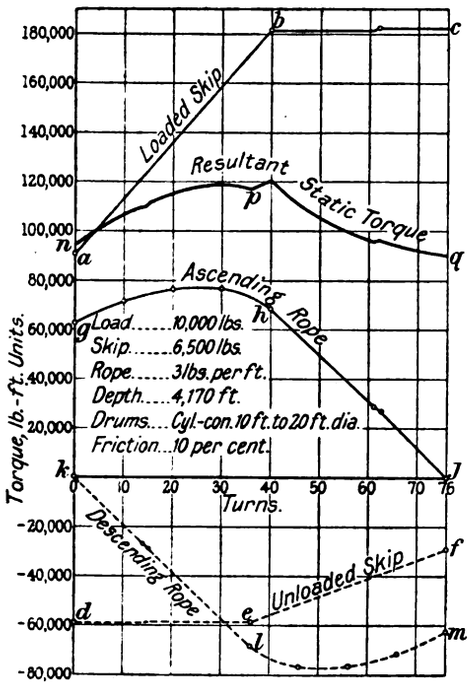

Fig. 44.—Static Torque Diagram determined by the Arithmetical Method.

Ascending Rope.—The weight of rope depending from the drum at a given instant can be found without difficulty, as also can the drum radius, and the torque is the product of the two. During the first 40 turns both the rope weight and drum radius vary: the next 21 turns of rope are coiled on the drum at a constant radius—namely, 10 ft. During the sixty-second turn the drum radius is increased to 10·07 ft., at which value it remains constant till the end of the wind. The calculations are set out in the accompanying table:—

Determination of Rope Torque (Ascending Side).

Instant.	Rope weight w. lb.	Drum radius R ft.	Torque wR. lb. ft.
Beginning of wind.....	12,510	5·00	62,600
After 10 turns	11,451	6·25	71,500
,, 20 ,, ...	10,155	7·50	76,200
,, 30 ,, ...	8,766	8·75	76,700
,, 40 ,, ...	6,840	10·00	68,400
,, 61 ,, ...	2,865	10·00	28,650
,, 62 ,, ...	2,676	10·07	26,947
,, 76 ,, ... (End of wind).	0	10·07	0

The figures in the last column when plotted give the curve *ghj*, Fig. 44.

Descending Rope.—It is evident that the figures for the ascending rope, if plotted below the axis and with the origin at the right instead of the left, can be used for finding the torque line, *klm*, due to the descending rope.

Resultant Static Torque.—By subtracting the negative moments from the positive moments the resultant static torque at any instant can be found. The curve *npq*, Fig. 44, shows the variation of the static torque throughout the wind.

(To be continued.)

Modern Systems of Electric Transmission.

In an article in the "Electrical News," Dr. E. P. Driver and Mr. E. V. Pannell review some of the most extensive transmission systems in different parts of the world. Among those briefly dealt with are the installations of the Mississippi River Power Co., the Cedars Rapids Line, the Tennessee Power Co. and the Pacific Light & Power Corpn. (U.S.A.); the Tata Hydro-Electric Co. (India); Victoria Falls & Transvaal Power Co. (S. Africa); the Lauchammer Co. (Saxony); the Lake Coleridge Development (New Zealand); the Inawashiro Hydro-Electric Co. (Japan). A feature of interest is the variety in practice in these different localities, which is affected to a great extent by local conditions—*e.g.*, the available coal and water-power, the proximity of industrial works, and the necessity in some cases of importing materials, such as structural steel. It will be noted that in the installations studied the pressure varies from 100 kv. to 150 kv., and the kilovolts per mile from 0·57 to 2·32. The data are assembled in the following table, which is of considerable general interest:—

System.	Kilo-volts.	Dis-tance, Miles.	Kv. per Mile.	Conductors. Material.	Conductors. Equiv. C.M.	K.v.a. per circuit.	Amps. per sq. in.	Insulators. No. Units.	Insulators. Kv. per Unit.	Spacing. Inches.	Spacing. Min. per kv.
Pacific Light & Power ...	150	241	0·62	Aluminium-steel	368,000	30,000	400	9–11	16·7–13·6	210	1·40
Southern Sierras Power...	140	238	0·59	,, ,,	211,000	4,200	104	6	23·4	134	0·96
Commonwealth Power ...	140	245	0·57	Copper	105,600	15,000	750	10	14·0	144	1·03
Utah Power & Light	130	136	0·96	,, ...	250,000	12,000	270	9–11	14·5–11·8	156	1·20
Tennessee Power	125	140	0·89	,, ...	133,100	10,000	440	7–8	18·0–15·6	126	1·01
Inawashiro Power	115	144	0·80	,, ...	198,000	28,000	600	7–8	16·4–14·4	120	1·04
Pacific Gas & Electric ...	110	110	1·00	Alum.-Copper ...	167,800	13,000	525	7–8	15·7–13·7	120	1·09
Mississippi River Power .	110	144	0·76	Copper	300,000	36,000	810	7–8	15·7–13·7	120	1·09
Hydro-Elec. Power Com.	110	229	0·48	Al.-steel-copper	212,000	22,000	700	8–10	13·7–11·0	128	1·16
Chile Exploration	110	86	1·28	Copper	167,800	20,000	810	4–5	27·5–22·0	155	1·41
Alabama Power.....	110	150	0·73	,, ...	133,100	18,000	900	6–7	18·3–15·7	120	1·09
Georgia Ry. & Power ...	110	90	1·22	,, ...	212,000	25,000	790	5–5	22·0	103	0·98
Cedars Rapids Mfg.	110	70	1·57	Aluminium-steel	300,000	36,000	810	8–8	13·8	120	1·09
Mexican Northern.....	110	158	0·70	Aluminium	212,000	11,000	350	7–9	15·7–12·0	120	1·09
Sierra & San Francisco...	104	138	0·75	Copper	133,100	14,000	740	5–5	20·8	96	0·92
Great Western Power ...	100	154	0·65	,, ...	167,800	25,000	1,100	5	20·0	120	1·20
Tata Hydroelectric	100	43	2·32	,, ...	121,000	20,000	1,360	6–7	16·6–14·3	126	1·26

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The Electrician.
FRIDAY, OCTOBER 11th, 1918.
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Labour After the War.

Those who attended Sir Albert Stanley's Address to the Industrial Reconstruction Council last week had the advantage of hearing a remarkable pronouncement by Mr. G. N. Barnes, M.P. As is well known, Mr. Barnes, who is a member of the War Cabinet, has always taken a broad-minded view of Labour questions and of the relations that ought to exist between Capital and Labour. In the course of a few minutes he dealt with a series of points which are of such importance to Labour that we feel they should receive more than a casual reference.

Mr. Barnes dealt with three important aspects. The first may be described as the attitude of the workman. In the future it is desirable that he should have a greater interest in his work than hitherto. With the means by which this may be secured we cannot deal in the present article, as the question is far too elaborate; but, briefly, it may be said that the Whitley Report is a step in this direction, and there is a strong movement at the present time to enable the worker to have a greater interest and a larger say in his employment. The great desideratum is that the worker should adopt a different attitude of mind, and realise that he can, in conjunction with his employer, serve the community at large. This national service is impossible if the "ca' canny" frame of mind is adopted, which, as stated by Mr. Barnes, can only be bad for both employer and employed.

The second point is the absolute necessity for increased production. It is quite impossible to put back the hands of the clock. The state of affairs at the present time is entirely different from what it was four years ago, and we agree with Mr. Barnes that, even if it were possible to go back to the old order, it would be bad even for trade unionists to revert to the policy of restriction of output. If that is so, however, what is to be said about the Trade Union conditions, which the Government have undertaken to reinstate? The promise was definitely made, and cannot lightly be set on one side. The view of Mr. Barnes is that, since it is undesirable to revert to the former state of things, the trade unions should strike a bargain with the Government over the matter, and that this bargain should be based on three demands. The first would be for a shorter working day. With this view we are entirely in agreement. It is well known that the 54 hours week, which means starting at six o'clock in the morning, leads to inefficient work before breakfast. The worker starts work on an empty stomach, and, during the winter, generally under bad conditions; and he then stops work for an uncomfortable breakfast at, say, eight o'clock. Work carried out under these conditions can only be inefficient, and yet the employer is content not only to pay for time which is not well spent, but which has a bad effect upon the mental attitude of the worker for the rest of the day. A number of firms now realise that it is far better to have a 48-hour week and to start work after breakfast, with only one break in the day; but this attitude is by no means universal. The second point made by Mr. Barnes was that unfair competition between employers by means of different rates of wages should be stopped; and, lastly, that there should be standard rates of wages. These two points really go together. There is no great difficulty in fixing standard rates of wages for a town, or for a district; but it is a much more difficult matter to fix standard rates for a country as a whole, or for town and country alike. The cost of living in towns is higher than in the country, and consequently in towns higher wages are expected. For this reason it is possible for country firms to quote lower prices than firms in towns, and it is difficult to see how this can be avoided.

The third point to which Mr. Barnes referred was security of employment. The feeling that a week's notice may be served at any time, and that the worker may find himself out of employment through variations in the state of trade, must necessarily cause a feeling of anxiety, and it is highly desirable that this should be avoided. At the same time, it is difficult to know what remedy to propose. Mr. Barnes is in favour of the view that when a man cannot be employed for lack of work the Government should provide either work or alimony. We do not know that this is really a good solution, for it means that when trade is bad taxation must be heavier in order to provide the necessary alimony, and consequently the effect of bad trade must be still more acutely felt. We think it would be better for the various industries concerned to provide in times of prosperity a fund (possibly as an excess profits tax) which might be used for the workers in days of adversity. This might, if necessary, be supplemented by the Government, though we are far from anxious to suggest a general extension of Government control.

These are all very important questions, and we are glad that Mr. Barnes has the courage to express his opinions. We believe they are shared by most of the more responsible Labour leaders. What we very much fear, however, is that they are not shared by the rank and file. For example, Mr. Barnes is the late secretary of the Amalgamated Society of Engineers. Will the rank and file of that union subscribe to his views? We fear not. Yet the only reason, so far as we are aware, why his views should not carry conviction is that the rank and file are not sufficiently educated in these economic questions. That being so, we feel that the Councils of the various Trade Unions should carry out an educational campaign. It is not sufficient for the rank and file to protest that the leaders are out of touch with them. If the leaders have come to see things differently, this is due to their more intimate contact with the various conditions that control industry. That being so, let these conditions be made better known to the rank and file; let the Trade Union Councils realise their responsibilities, and let them provide this very necessary education.

Review.

Mathematics for Engineers. Part I. By W. N. Rose, B.Sc. (London: Chapman & Hall.) Pp. xiv.+510. 8s. 6d. net.

It must require considerable courage in these days to place a book of the above type on the market, for there are many excellent books of a similar nature there already. The author has given it the title "Mathematics for Engineers," instead of the more usual "Practical Mathematics." If engineers are to be taught mathematics at all, or if they are to make intelligent application of the subject to engineering, then the best method seems to be to undergo a thorough training in pure mathematics from professional mathematicians. Although much excellent work is done and much mathematical encouragement has been given to students who would otherwise, perhaps, have become fainthearted on the way, by the introduction of the so-called "Practical Mathematics," yet from our experience of some years' teaching, the foundations laid seem to be insecure and the student's judgment not reliable. After

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all, technique is required in mathematics, as in other things, and the technique acquired from this kind of teaching is often faulty.

In the particular book before us, we must say that the subject is excellently done. The examples are exceedingly numerous and of a very practical nature, and the book work is sound without erring on the side of over-elaboration. Many types of engineering applications are given here, which one does not usually come across in books of a similar nature published before. There is a very good chapter on the calculation of earthwork volumes, and another on the plotting of difficult curve equations, included in the latter being temperature entropy diagrams and the construction of these for engines other than steam. There is also a very useful chapter giving the construction of practical charts, a thing very convenient for the design or drawing office, we should imagine. The remainder of the book is on more or less conventional lines as far as the treatment is concerned. The usual amount of algebra, trigonometry and mensuration is done, and sufficient for the student to commence studies in the calculus. This, and the higher portions of the work generally, the author proposes to do in a second volume, though the fundamental idea of differentiation is introduced here in the work on limiting values of algebraic expressions. In finding the constants from a curve which is supposed to be of the form $y=a+bc^x$, or $y=b(x+a)^n$, &c., we think that it is better to make use of the calculus, and hence such curves would find a better place in the next volume. The examples throughout are of an eminently practical character, and the use of this book would well repay even one who has had a good training in mathematics of the more orthodox type.

H. C. K.

Correspondence.

PATENT LAW REFORM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR:

"We ought to have the same Patent Laws as America. We ought also to have an Empire Patent. With all the Overseas Representatives here, this could easily be arranged."—*Vide Sir Robert Hadfield, Bart., in Morning Press, Sept.* 26, 1918.

Returning once more to this subject, might I ask your support in impressing upon the deputation, which is to wait on the President of the Board of Trade almost directly, to make the above suggestions its principal text, when there is a possibility of some practical good being accomplished. In addition, a comprehensive and sound report by the Institution of Electrical Engineers has been accepted by the conferences which have been held as forming the basis for the criticism of proposed two new Bills coming before Parliament.

The report justly points out by inference that patents are granted to reward inventors and that they should not be subject to conditions which simply amount to the legalisation of robbery.

The requirement of compulsory working is, of course, not a modern requirement at all. I believe it is found in Letters Patent, granted in the reign of Charles I., if not earlier. The philosophy of the subject is at least as old as the French Revolution, but surely by this time we ought to have got a long way from that? The whole doctrine is, however, in my opinion, based on a fallacy. It is enough to point out that when the Act of 1907 was passed, Mr. Lloyd George and others exulted over the circumstance that Germans were going to be compelled to put up factories in Great Britain. In actual fact, the Act did not have anything like the effect that it was alleged to have. The point is, however, that in so far as the Act may have led to the establishment of factories by Germans in this country, it simply led to the introduction of a number of very highly undesirable people. It will probably take us a long time to eliminate the undesirable element for which we have to thank the Act of 1907. Do we want to compel the Germans to come over here? If we do, then let us have compulsory working or for that matter compulsory immigration. If we do not want them, then for Heaven's sake don't let us invite them, as most certainly those compulsory working clauses in the proposed new Bills do. As regards the present obnoxious Renewal Fees, these ought in any case to be materially reduced; but, beyond all that, there is no provision in the proposed new Patent Bill for the establishment of an official search through prior literature *other than British Patent Specifications*, which, of course, after all, leaves any so-called official search a mere farce.

What is the matter with the American patent system? Under it, these objections are eliminated, there are no renewal fees, no compulsory working, but no patent is granted unless it can stand a world's search: in comparison, the existing American system *has stood the test of nearly a century, has encouraged invention*, and *has been eminently successful*, and possibly its only objection is that *it is anything but German!!*

In the same period of time we in Britain have had numerous Patent Acts, mostly on German lines, and not one of them has been worth a cent. so far as the encouragement of invention and progress is concerned, as the report of the Electrical Institution for the guidance of the deputation and the Board of Trade clearly shows.

I therefore continue to be in full agreement with Sir Robert Hadfield in advocating the adoption of similar patent laws as the United States, under a democratic British Empire patent system, and in abjuring anything approaching German lines of procedure.—I am, &c.,

Leigh-on-Sea, Oct. 3. JAMES KEITH.

THE ELECTRICAL TRADES UNION AND THE E.P.E.A.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I shall be obliged if you will allow me the hospitality of your columns to draw the attention of all technical staff engineers engaged in the electricity supply industry, or in the generation, transmission, distribution or utilisation of electrical energy in private plants to the enclosed letter.

To safeguard their own interests, I suggest that these engineers should support the E.P.E.A. and should write out, sign, and send to me the following memorial, whether they are members of the E.P.E.A. or not:—

I, the undersigned, holding the position of in the desire to register a protest against the outrageous attitude of the Electrical Trades Union as evidenced by a letter of the London District Secretary of the E.T.U., dated Oct. 2, 1918, and their claim to represent the interests of the executive and supervisory officers of the electricity supply industry.

It is my emphatic desire that any matters affecting the interests of technical staff engineers in the industry should be negotiated with the Government and all other authorities by the Electrical Power Engineers' Association.

I am, &c.,

W. ARTHUR JONES.

Hon. General Secretary Electrical Power

London, Oct. 7. Engineers' Association.

The following is the letter to which reference is made:—

ELECTRICAL TRADES UNION.

London District Committee. District Office,
76, Grays' Inn-road, London, E.C. 1.

To Mr. Oct. 2, 1918.

DEAR SIR AND BROTHER,

It has been brought to my notice that you intend running out of the Electrical Trades Union, and joining this bogus organisation, the E.P.E.A.

Before you do this should like to draw your attention to the position. We have been for a considerable period—and at considerable expense—drawing up working conditions for men employed in electricity undertakings in the London area. You, in addition to every other man in the industry, will materially benefit through our efforts.

Altogether apart from this you have up till now benefited to the extent of 23s. 6d. plus 12½ per cent. on all wages earned, got simply through the efforts of the Electrical Trades Union, and if you run out of this Electrical Trades Union then you will go out of the electrical industry as far as London is concerned.

We are going to make it absolutely impossible for any man who is a member of this bogus Trade Union (the E.P.E.A.) to get a living in our industry in the London district.

Sincerely trust, therefore, that you will re-consider your position.

Yours fraternally,

(Signed) W. J. WEBB,
London District Secretary,
pp. I.F.W.

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The "Key" Industries Exhibition.

Last Monday the "Key" Industries Exhibition, promoted by the Tariff Reform League, was opened, in the absence of Mr. Austen Chamberlain, by Mr. H. J. Mackinder, M.P., chairman of the League. The exhibition, which is free from the ordinary political programme of the League, has been organised with a view to calling popular attention to the importance of "key" industries, so that it may be more generally realised how important such industries are to the good of the country. The exhibition will remain open until the 22nd inst., when it will be taken to Manchester, Birmingham and other provincial centres.

Quite as instructive as the exhibition itself is the handbook, which contains a number of articles. The first is on "The Keys of Industry," by Mr. H. J. Mackinder, and deals with the subject in a general way. The second is by Dr. E. F. Ehrhardt and Mr. A. Edge, on the subject of "Coal Tar Dyes." It is shown how enormously the dye industry has developed in Germany, and that it was lost to this country through lack of research. Whatever may be the position at the present day, in those days research was not appreciated in this country as it was in Germany. Other articles deal with various "key" industries, many of these being connected with minerals. For example, there is tungsten. In a remarkable diagram, of which there are many similar in the handbook, it is shown how largely we depended upon Germany for this metal, although 40 per cent. of it is mined in the British Empire. At the outbreak of war we had only three months' supply of an article which was indispensable to the manufacture of armour plates and projectiles. On the other hand, it is estimated that Germany entered the war with 10 years' supply of wolfram ore on hand. The position is now very much altered, and in 1916 we controlled and acquired over two-thirds of the world's supply of the ore. In the case of spelter we were also dependent upon Germany owing to the German Zinc Trust. Similarly the Canadian nickel mines were worked by the International Nickel Co., an off-shoot of the German metal combine. For manganese and lead we were similarly dependent upon German supplies. In the case of monazite sand the principal deposits are in Brazil and at Travancore. The latter deposits were handled by an apparently English Co., but there was a predominant German control, so that the whole of the output was taken by the German thorium manufacturers. The position of the magneto industry is well known to our readers, as also that of chemical and optical glass and electric light carbons. Other articles deal with carbon, rubber, and hot metal pressings.

There are a number of striking exhibits, and among the exhibitors we notice the following: Abbott, Anderson & Abbott, British Aluminium Co., British Ever Ready Co., British Ignition Apparatus Association, British Laboratory Ware Association, British Lighting & Ignition Co., Duram, Ltd., Erinoid, Ltd., General Electric Co., Hadfields, Ltd., London Electric Wire Co. & Smiths, Micanite and Insulators Co., Newton & Wright, Silica Syndicate, Thermo Electric Ore Reduction Corpn., Thermal Syndicate, Thermit, Ltd., Vickers, Ltd., Vulco Dry Battery Co., and Henry Wiggin & Co.

The Tariff Reform League are to be congratulated upon organising an exhibition which should be of marked educational value.

The Labour Outlook.*

(BY OUR LABOUR CORRESPONDENT.)

A short time ago I alluded to the Report of the Adult Education Committee, and promised to return to the question of the education of adults. It is becoming more and more widely appreciated amongst the organised workers that the realisation of their aspirations depend upon education; not primary, it should be observed, upon *technical* education, but upon that broader education which gives power and understanding.

The modern movement may be conveniently described as taking its rise with the foundation of the Workers' Educational Association in 1903, though pioneer movements have done much to break up the ground during the 19th century. The Association was started by a small group of working people for the promotion of higher education amongst the working classes. It is now a large organisation, consisting of affiliated societies, such as trade unions, other working class organisations and educational bodies on the one hand, and individual members on the other. The W.E.A., as it is called, is governed by a Central Council representative of national organisations and the constituent districts of the Association. The majority of the districts have full time secretaries. The district is governed by a Council, representative of affiliated organisations, branches and individuals. The branches, which are now widely scattered over the country, are governed in the same democratic fashion by the trade union branches, co-operative and other bodies and individual members who compose it. The Parliamentary Committee of the Trade Union Congress and the Co-operative Union, representing the trade union and co-operative movements, are affiliated to the Association.

The Association carries on educational work by organising and providing classes, study circles, lectures and conferences; but it has gone beyond this, and has induced every university in the country to set up a Joint Committee, composed of members of the university on the one side and working class representatives on the other. These Joint Committees organise and provide what are called University Tutorial Classes. The teachers are approved by both the university and the classes themselves, who, in co-operation with the tutors, decide their own programme of study. The classes are inspected by the Board of Education and receive Government grant. The subjects studied are for the most part industrial history, economics, political science and philosophy, though there are classes in literature and national science. The classes run for three years, and students are required to do written work. These classes in the aggregate are in the nature of a great working class university, and represent the higher water mark of working-class education.

But this does not by any means exhaust the educational work which is being carried on in working class circles. In 1899 Ruskin College was founded in Oxford, and thither went before the war trade unionists and co-operators, often provided with scholarships by their organisations. They lived in the college usually for a year, and, in addition to lecturers and assistance from the staff of the college, the students obtained great help from prominent Oxford dons. In 1909 there was a schism in the college, and a number of reactionary spirits broke away and founded the Central Labour College. This labour institution has extended its work, and now arranges classes in economic and social subjects in the provinces. Its outlook is definitely Socialistic, and it has carried on a campaign against the Workers' Educational Association on the ground that "impartial" education is capitalist education. The C.L.C. stands for class-conscious education. It is supported by the South Wales Miners' Federation and the National Union of Railwaymen.

The Adult Schools and Co-operative bodies also carry on a good deal of educational work, and many of them are affiliated to the Workers' Educational Association, which, amongst other activities, provides lecturers and teachers for other organisations. The war has in some degree interfered with the educational movement. The young men have for the most part joined the colours. The keenest students, however, have carried their enthusiasm into the Army, and in Y.M.C.A. huts and elsewhere reading and discussion has been carried on. Now that the War Office is undertaking a large educational scheme, with a view to education during the period prior to demobilisation, a considerable development may be expected. In spite of difficulties, the movement at home has gained in many ways, and the number of classes has fallen less than proportionately to the loss of members. In some areas the members of non-educational classes has actually increased during the period of the war. A very significant development was the summer school held at Oxford during the past summer, under the auspices of Ruskin College, when over 70 organisers of the Workers' Union went into residence for a fortnight to study political science and industrial problems.

The educational movement is young as yet, and its influence has hardly begun to be felt. The younger men, who are gaining most from it, have not yet entered into their heritage. But working class movements are realising the importance of education, and those who have given up their evenings to study are, by force of superior knowledge, their wider outlook and developed capacity, gradually winning for themselves places of responsibility. Instead of desiring that they themselves should advance personally, these students are more concerned that the working classes should advance. There is a growing desire to understand political, social and economic questions in order that what is evil in society may be cast out, and so that democracy may be fully realised. It is the social impulse behind the educational movement which renders its success inevitable in the long run. As yet the movement touches but a minority, though a growing minority. After the war it will undoubtedly develop, with results which will be at once profound and far reaching.

* We do not necessarily endorse the views expressed by our Correspondent, although we are pleased to give space for their publication.—Ed. *E.*

Books Received.

(Copies of the undermentioned works can be had from The Electrician Office, on receipt of published price plus postage.)

"Applications of Electrolysis in Chemical Industry," by A. J. Hale, B.Sc. (London: Longmans, Green & Co.) Pp. ix.+148. 7*s*; 6d. net.

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Boiler House and Engine Room Efficiency.

It is frequently suggested that there is as much to be saved in the engine room as in the boiler house of a modern power plant. In both cases improved thermal efficiency is assured by increasing the temperature range, irrespective of the size of the units. Even with war-time, low-grade coals, high in ash, boiler-house efficiency may be raised to the maximum and manual labour eliminated, with resulting savings, by merely adopting fully automatic stokers with furnace settings suited for continuous high-temperature combustion. On the other hand, any

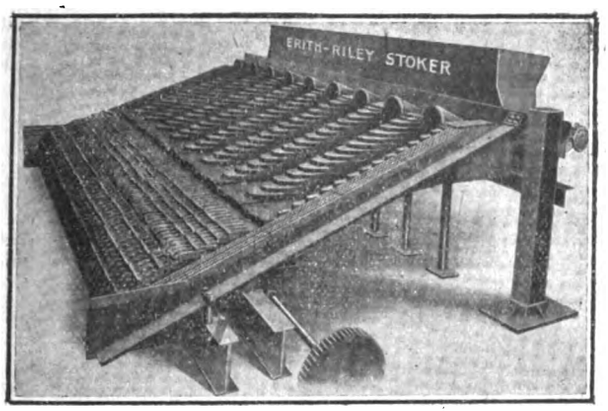

FIG. 1.—VIEW OF ERITH-RILEY STOKER, SHOWING CONSTRUCTION.

material increase of steam temperature involves entirely new plant of very costly construction; such plant is unprocurable under war conditions, whereby output is limited to boiler plant, turbo-generators, &c., of standardised types.

Some electricity stations, under favourable condensing conditions and with high load factors due to bulk supply, are able to maintain in practice 12 lb. steam on 1½ lb. good coal—say 20,000 B.Th.U. per kilowatt-hour, or 17 per cent. thermal efficiency. Here steam is used at normal

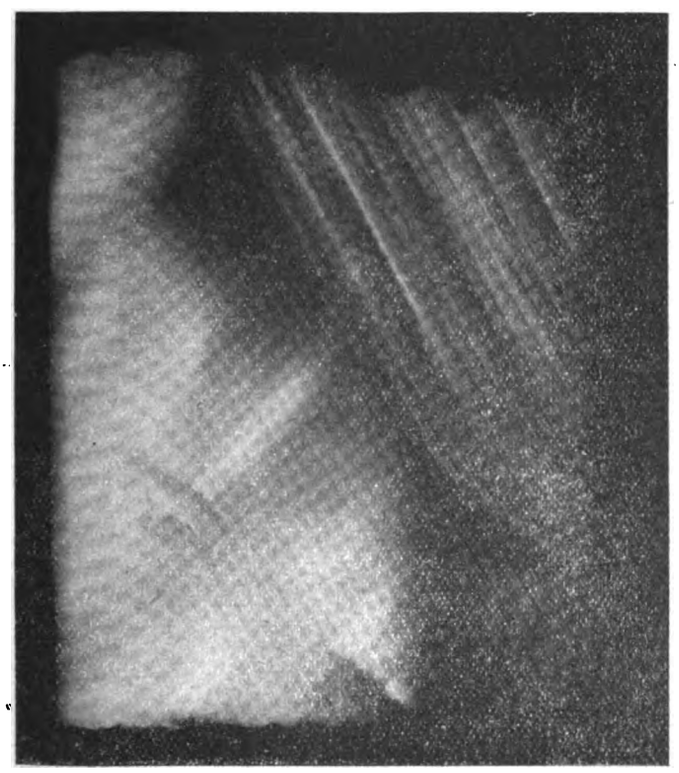

FIG. 2.—PHOTOGRAPH SHOWING SHORT FLAME COMBUSTION WITH ERITH-RILEY STOKER.

pressure and superheat not exceeding 600°F. total temperature. Standardised plant is employed, and thus the pre-war installation cost was only about £12 per kilowatt installed. Allowing for differences in load factor and in condensing conditions, there is no reason why corresponding thermal efficiency should not be maintained in any central station having modern turbo-generators and water-tube boilers; but undoubtedly small units involve larger capital charges and higher upkeep and wages charges than a few large units of same total output capacity. To take an extreme case, a 100 kw. locomobile set, comprising a cylindrical loco-type boiler with two-stage superheater and a compound condensing engine, can give a thermal efficiency leaving very small scope for improvement; but for commercial reasons such small units could not be seriously considered. An interesting case is the small boiler, 3,180 sq. ft. heating surface, with stoker, superheater, economiser and induced draught fan, supplying a 1,500 kw. turbo-generator at Rugby, with steam at 350 lb. pressure with superheat to 700 deg. With 28½ in. vacuum, a 10-hour full-load test showed 1·83 lb. 11,000 B.T.U. coal, 20,000 B.T.U. or 11·2 lb. steam per kilowatt-hour, or 17 per cent. overall efficiency; but this test figure excludes the power for auxiliaries. With the same steam pressure of 350 lb., but with still higher superheat to 750°F., a 5,000 kw. plant of same type is guaranteed for 10·2 lb. steam per kilowatt-hour. But it is doubtful if the high cost and high upkeep of such plants will prove commercially justified.

As regards boiler plant, high thermal efficiency is consistent with low capital costs and low upkeep. The first essential for maintaining 12 to 14 per cent. CO_2—viz., continuous high-temperature combustion—is to eliminate perishable brick arches. These are never used with self-cleaning multiple-retort underfeed stokers, wherein the fuel is coked in the lower layer of the thick fire bed, while the high-temperature zone of combustion is not in contact with metal; but in the upper layer of incandescent fuel, which forms its own combustion arch, smokelessly completing combustion at about 3,000°F. in the upper part of the fuel bed, so that the products of complete combustion impart much of their heat by direct radiation to the boiler tubes, thereby assuring excellent circulation. Such self-cleaning multiple-retort underfeed stokers feed the coal, clean the fires and discharge the incombustible ash in a regular stream without any manual labour. They are assembled from standardised retort units, and thus identical results are assured with a given surface area, irrespective of the size and number of boilers employed to secure it.

The photograph reproduced herewith shows the luminous, intense, short-flame combustion at Hull Corporation electricity works; this photograph was taken through the side-wall furnace-inspection door. Two tons of 9,500 B.T.U. low-grade slack are consumed per hour on their nine-retort Erith-Riley stoker on Stirling boiler; they have seven-retort Erith-Riley stokers on other boilers. Their fourth order is for a new nine-retort high-duty Erith-Riley stoker for a large new boiler, having 33 per cent. extra capacity in all sizes, with 2½ ft. extra depth of furnace, but equally devoid of arches. This added stoker capacity assures full boiler rating with the very poor grades of coals now delivered to most electricity stations; for such fuels the continuous, automatic cleaning is invaluable. Fig 1 shows the stoker itself.

Four 12-retort Erith-Riley stokers, each 20 ft. wide, and equally requiring no arches, are being supplied to the Bow power station of the Charing Cross Electricity Supply Co. Both at Hull and at Bow the feed water is heated by auxiliary exhaust. As the efficient combustion minimises the waste heat in exit gases, the chimney suffices for suction draught, and the cost and upkeep of economiser and induced draught fan is eliminated. The same practice is followed in many other plants using multiple-retort stokers with archless furnace settings, although the economiser could save 5 per cent. under such conditions of maximum boiler efficiency, and is therefore justified where the price of fuel is high.

Patent Record.

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses, are those of communicators of inventions.*

August 12, 1918.

13,038 & 13,045 FARTHING, RAILING & WINSTANLEYS. Electrical heating apparatus.
13,049 B. T.-H. CO. (G.E. Co.) Controlling alternating currents.
13,050 ARMSTRONG, WHITWORTH & CO., CRICKON & THAIN. Electric signalling apparatus.
13,080 W. T. HENLEY'S TELEGRAPH WORKS CO. & GROVER. Distribution of electrical energy.
13,090 SOC. ANON. DES ETAB. L. BLERIOT. Electric installations. (23 11 17, France.)

August 13, 1918.

13,104 COLLIE. Means for making temporary connections with electric supply cables.
13,105 FEARNLEY & WILKINSON. Current collectors for electric vehicles.
13,120 KING. Junction box for armoured cables.
13,125 FULLER ACCUMULATOR CO. & WELCH. Vents for electric accumulators.
13,151 SARRAMEA. Bath for electrolytic tinning. (27 9 17, Switzerland.)
13,156 BIOXAM. (Russische A.G. L. M. Ericsson & Co.) Electrically operating mechanisms from a distance.
13,167 BROWN. Variable electric resistances, &c.

August 14, 1918.

13,187 JOEL. Batteries.
13,203 LATOUR. Rectifying alternating currents. (14 8 17, France.)
13,207 & 13,208 B. T.-H. CO., HASTINGS & MARTIN. Starting devices for a.c. machines.
13,235 EISENSTEIN. High-frequency alternators.
13,231 CUBAS. Electrically separating nickel from copper.

August 15, 1918.

13,232 BENARD-BARBEIR ET TURBINE & GRANAT. Electrically operated device for laying artillery projectors, &c.
13,234 BROUGHAM. (Deutsch.) X-ray apparatus.

August 16, 1918.

13,314 HOWARTH & JEPSON. Measuring average maximum demand in k.v.a. from a.c. supply.
13,321 WESTERN ELECTRIC CO. High-frequency signalling.
13,325 SMITH. Cooling armatures.
13,340 B.T.-H. CO. (G.E. Co.) Electrically-operated fuel valves.
13,369 ELECTROLYTIC ZINC CO. Treatment of zinc solutions preparatory to recovery by electro deposition. (17 8 17, Australia.)
13,371 ACCUMULATORS (LTD.) & HUNTER. Portable batteries.

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August 17, 1918.

13,389 Fuller Accumulator Co. & Welch. Vents for electric accumulators.
13,390 Fuller Accumulator Co. & Welch. Electric safety lamps.
13,411 Elphick. Electrically ignited lighting device.
13,417 Latour. Telephone apparatus. (18 8 17, France.)

August 19, 1918.

13,455 Svenska Aktiebolaget Gasaccumulator. Hammer interrupters for radio-telegraphy. (14 9 17, Sweden.)
13,459 T. Gunn (Ltd.) & Tibbles. Electric burglar alarms.
13,473 & 13,474 Remy Electric Co. Regulators for dynamo electric machines. (19 7 17, U.S.)
13,476 Press. Electrical ignition systems.
13,477 Press. Energiser circuits.

August 20, 1918.

13,493 Pedder & Perry. Combined electric switch and starter panels.
13,499 Clarke. Directive wireless telegraphy.
13,510 Ritter. Signalling on primaries of telegraph or telephone phantom circuits
13,518 Wall. Alternating-current generators.
13,520 Jorgensen. Combination light and electrical heating apparatus. (20 8 17, Norway).
13,521 Marks. (Schlitdorf Electrical Co.) Ignition devices.
13,534 Breeze. Vibrating decelerating relays.
13,536 Ellis. (Adcock.) Determining direction of distant sources of electric magnetic wireless radiation.
13,539 King. (Chkliar & Theodor.) Portable electric lamps.

August 21, 1918.

13,544 Gibbons. Dynamos for arc welding.
13,549 Norton & Robinson. Fuse distribution box.
13,556 Bruce. Production of radiographic photos kinematographically.
13,578 Taylor. Automatic telephone systems.
13,583 British L.M. Ericsson Mfg. Co. & Brookes. Magneto-electric machines for ignition in internal combustion engines.
13,607 Hoofnagle. Treating gases and vapours electrically.
13,614 Bloxam. (Russische A.G. L.M. Ericsson & Co.) Operating distant devices by electromagnetic waves.

August 22, 1918.

13,633 Rodney Engineering Co. & Andrews. Apparatus for sending messages in Morse alphabet.
13,642 Jascowitz & Rosenbaum. Cleaning metals by electrolysis.
13,653 Meek & Turquand. Electrically-heated balloons.
13,698 Alexander, Imbery & Vint. Electrical device for indicating temperature of electrically-heated steel before quenching to obtain correct hardening.

August 23, 1918.

13,717 McLean. Electric adapters, &c.
13,722 Brook & Hirst. Trip switches for controlling electric circuits.
13,733 & 13,734 Quain. Electric heaters.
13,747 Westinghouse Electric & Mfg. Co. Turbine. (18 10 17, U.S.)
13,752 B.T.-H. Co., Clough, Taylor & Whitaker. Alternating-current dynamo-electric machines.
13,756 Tyer & Co. & Leake. Electrical instruments for signalling on railways.
13,767 Harlow. Electrical relays. (28 8 17, U.S.)

August 24, 1918.

13,791 Automatic Telephone Mfg. Co. & Savin. Selecting switches for automatic telephone systems, &c.
13,810 Penty. Electrical synchronising gear for aeroplane guns, &c.

August 26, 1918.

13,870 Fessenden. Means for receiving impulses and ascertaining their direction. (16 8 17, U.S.)
13,880 Fessenden. Submarine signalling. (20 7 17, U.S.)

August 27, 1918.

13,907 Roberts. Electric cigar or pipe lighter.
13,923 Ferranti. Transformers.
13,934 Wilson. Standards or supports for electric lamps
13,936 Wilson. Means for supporting electrical conductors.
13,940 Suchostawer. Magneto motor.

August 28, 1918.

13,961 Virr. Motor starters, rheostats, &c.
13,975 Dowsen & Samuelson. Trolley heads of electrically propelled vehicles.
13,984 Soc. Talco Grafiti Val Chisone & Redoni. Manufacture of natural graphite electrodes. (5 3 18, Italy.)
13,986 Lyster, Russ, Newton & Wright. Electric switches.
13,988 Piatti. Edison lamp holders. (28 8 17, Italy.)

August 29, 1918.

14,020 Levi. Reflector and heat accumulator for gas and electric lighting and heating.
14,038 Alloy Welding Processes, Ltd. Choking coils.
14,040 Garrard, Railing & Wilson. Cut-outs.
14,043 & 10,404 Eggington & Lucas. Electric signalling lamps.
14,045 Edwards & Lucas. Electric switches.
14,058 Wade. (Sullivan Machinery Co.) Coal-cutting machines.

August 30, 1918.

14,078 British Thomson-Houston Co. & Taylor. Dynamo-electric machines.
14,079 Keene. Electric furnaces. (5 9 17, U.S.)
14,087 Cardwell. Printing telegraphs.
14,106 Jungner. Primary galvanic batteries with unalterable electrolyte. (4 9 17, Sweden.)
14,114 Edwards & Lucas. Plug and socket connections for electric circuits.

August 31, 1918.

14,144 Rundle & Walton. Utilisation of currents produced in the earth.
14,148 Bodman. Electric lamp holders.
14,154 Brooks & Holt. Controlling switches of combined ammeters and voltmeters.
14,155 Simmonds. Appliance for engaging conductor with trolley sheave.
14,160 Stell. Apparatus for detecting h.t. or e.h.t. sparks or discharges.
14,165 M-L. Magneto Syndr. & Watson. Safety gaps of ignition magnetos.
14,184 Lewis. Variable speed a.c. motors.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.
Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.
Orders for the Week.

Captain of the Week.—Capt. W. Darley Bentley.
Next for Duty.—Capt. E. G. Fleming.
Sunday, Oct. 13.—Commandant's Parade at Waterloo Station, 8.45 a.m., for work "pontooning" at Esher. Drill order. Great-coats to be worn. Mid-day and tea rations to be taken.
Monday, Oct. 14, to Friday, Oct. 18.—Drills as usual.
Sunday, Oct. 20.—Annual Musketry Course at Pirbright. Parade Waterloo Station 8.45 a.m. Drill order with pouches. Rifles and side-arms to be carried. Mid-day and tea rations to be carried.

Band.—Recruits are still needed for the Band. Novices instructed free.

Commercial Topics.

Reconstruction Problems.

The Association of Chambers of Commerce is taking steps to bring under review the recommendations of various Government Committees which have been dealing with industrial and trade policy after the war.

Owing to the resulting increase in its work, a system of quarterly meetings is being inaugurated by the association in London. The first quarterly meeting will be held in London on the 15th inst., when the recommendations of five Government Committees will be reviewed. These deal with commercial and industrial policy after the war, and with the iron and steel, the textile, the electrical and the engineering trades.

* * * *

State Help for Key Industries.

On the 2nd inst. the President of the Board of Trade (Sir Albert Stanley) delivered at the Saddlers' Hall, London, the first of a series of lectures arranged by the Industrial Reconstruction Council. His subject was "Commerce and Industry After the War," and the chair was taken by Mr. G. N. Barnes, M.P.

Mr. Barnes, in opening the meeting said Government would restore trade union conditions as far as possible after the war, but in certain respects it would be impossible to do so, and therefore there should be a shorter working day, a standard rate of wages and more security for continuity of employment.

Sir A. Stanley said that British industry and commerce would have to meet not only the competition of Germany, but also that of neutral countries. It was essential that sweeping improvements in our methods of production should be made and in the organisation of oversea trade. One of the first problems to be solved was such an organisation of industry as would make possible the complete overhauling of our industrial equipment and the establishment of large-scale production. Further, there must be more systematic attention given to securing and increasing supplies of raw materials. In some cases Government co-operation and assistance would be necessary, as in the development of mineral resources. Our manufacturers had not hitherto been so conscious of the importance of scientific research as some of our foreign competitors. The Department of Research was promoting the formation of trade associations for the purpose; but no amount of improvement in organisation or attention to research would give what was aimed at unless workers also were raised to the highest level of efficiency, and unless there was complete co-operation between employers and employed. He hoped, also, that there would be greater readiness among workers to welcome new processes and to realise the need for the largest possible individual and collective output.

The Government was not capable of telling manufacturers and merchants how they should conduct their businesses. There was necessity for Government action in certain directions. It must furnish our traders with the fullest possible information as to foreign markets, and take a more active interest than hitherto in British enterprises abroad. Particularly it must be prepared to give special assistance towards the maintenance and development of "key" industries. In other directions the Government might lead, and especially in regard to transport. In regard to railways, it was essential that we should not merely return to the condition which prevailed before the war, but that the lesson of united working during the war should not be forgotten. The canals also must be considered an integral and effective part of transport organisation with roads and port facilities.

Three other matters in relation to development were engaging the attention of the Government. One was the conservation of the coal supplies, and another was the question of electric power supply. If electric power was to be sufficiently cheap for wide use industrially, there must be large generating stations serving wide areas. Thirdly, attention must be given to the utilisation of the water-power of the country.

It was of importance that there should be no attempt at Government control of industry and trade after the war, except in so far as such control might be necessary during the transition from a war to a peace basis. It would be impracticable to revert suddenly to a state of complete freedom for individual action; but it should be for the shortest possible period, and should, as far as possible, be limited to definite purposes, such as the securing of food and material supplies, the prevention of a scramble for materials and plant, and the equitable allocation of materials among competing industries.

* * * *

New Capital for Callender's Company.

It is proposed to increase the capital of Callender's Cable & Construction Co. to £900,000. During the past three years the company's business has largely increased, and this growth has been financed by using a portion of the annual profits as working capital. The recent conversion of £175,000 of the reserve into ordinary shares merely brought the nominal capital more into accord with existing conditions, but did not increase the company's monetary resources

The directors of the company, like the boards of other manufacturing companies, have recently had under review the financial requirements of the company, which have been affected by the great alteration in values since the war commenced. Prices of raw materials have risen enormously and wages have been substantially advanced, so that manufacturing costs have been greatly increased. To carry on a given amount of business requires, therefore, considerably more capital than was necessary a few years ago, and the directors are unanimously of opinion

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that the future operations render it imperative that further capital should be introduced. So far as can be ascertained, the amount which will meet present requirements is £250,000, and they propose to raise this sum at an early date by the issue of 40,000 £5 cumulative preference shares and 10,000 £5 ordinary shares. It is proposed that the rate of interest on new preference shares shall be 6½ per cent., and it is intended to increase the interest on the existing preference shares to the same rate. It is proposed to issue the ordinary shares of £5 each at a premium of £2 per share. The sanction of the Treasury to the proposed issue has been obtained, and meetings to sanction the plan will be held on Wednesday next.

Electricity Supply.

Bangor (Co. Down).—The Urban Council has appointed a committee to ascertain whether Belfast Corporation will shortly be in a position to supply electrical energy to the district.

Barnes.—The Urban Council will expend £1,220 on additional plant at the destructor works.

Belfast.—In submitting the Electricity Committee's minutes to the Council last week, Councillor Duff said good progress was being made with the extensions. Already the first supply to the shipyards was available and had been connected.

Hackney (London).—Owing to the depleted stock of coal, the Electric Supply Committee has appealed to the shopkeepers to reduce the inside lighting of their shops to an amount only sufficient to enable them to serve customers, and to refrain from using electricity for display purposes.

Hammersmith (London).—The Electric Lighting Committee recommends the purchase of three condensers, at a cost of £1,875.

Increased Charges.—The charges for electric current have been increased in the following places:—

Grimsby Corporation has increased its charges by 15 per cent. from Sept. 30.

The City of London Electric Lighting Co. is increasing its charges by a further 10 per cent., making a total of 60 per cent. over pre-war charges.

Lowestoft Corporation has increased the charge for lighting by 1d. per unit and for power by 10 per cent.

Greenock Corporation's charges have been increased by 7½ per cent. further.

At Keighley the charges are being increased by 1d. per unit for lighting and ½d. per unit for power.

At Leyton the charges to all classes of consumers are being increased to 50 per cent. over pre-war rates.

At Walsall the charges have been increased by 10 per cent. from Sept. 30.

Manchester Electricity Committee proposes to increase the price by 30 to 40 per cent. over pre-war charges to general consumers, 15 per cent. for industrial power and 7½ per cent. to large power consumers.

The Notting Hill Electric Lighting Co. has increased the rate for lighting from 7d. to 8d. per unit.

Ilford.—The Electricity and Tramways Committees have decided that current supplied for traction purposes for the year ended March 31 last be charged at 1⅜d. net per unit.

Negotiations are proceeding upon an application from Messrs. Hughes & Sons for an extension of the electricity supply to their works at Hainault. The scheme will involve a considerable capital expenditure.

Leek.—The Urban Council has decided to install new generating plant at a cost of £4,000.

Luton.—Ald. Wilkinson reported at the last meeting of the Council that the New Industries Committee had induced the James Keith & Blackman Co. to decide to establish works at Luton.

Manchester.—On the recommendation of the Electricity Committee, the Corporation has agreed to insert a clause in the Bill to be promoted in the next session to enable the Electricity Committee to enter into an agreement for the use of water from the Manchester Ship Canal.

The chairman of the Committee (Councillor Dagnall) stated that the demands for electric current were growing so rapidly that it might be necessary to begin work on the Barton site earlier than had been intended, and hence the necessity for the clause.

Ald. Walker stated that the capital expenditure of the electricity undertaking, which was £2,959,804 in 1914, was now £3,325,530: the revenue had increased from £513,589 to £861,078, and the maximum demand from 46,500 kw. to 65,600 kw. In 1914 they consumed 195,718 tons of coal and last year the amount was 302,296 tons.

Marylebone (London).—The operation of the Fuel and Lighting Order is expected to cause a decrease in revenue of the electric supply department of £45,000, and it is proposed to apply to the Board of Trade for liberty to increase the charges for current. Application will also be made to the London County Council for power to postpone repayments due in 1919 and 1920.

Ald. Beaumont, chairman of the Electric Supply Committee, pointed out to the Council last week that generation expenses were 20 per cent. higher than last year and 150 higher than 1915-16. Rent, rates and taxes had also gone up, and of course they felt seriously the effect of the heavily increased wages bill. The sum total of the electricity situation was that in March they would be left with a net deficit of £3,689, which, in view of the more favourable position they would be in next year, they could very well afford to carry over.

Ald. Walford moved that they apply to the London County Council for an extension of their loans, and this was agreed to.

Skelmanthorpe.—The Council has asquiesced in the application of the Yorkshire Electric Power Co. for a provisional order for the district.

Tonbridge.—The Urban Council has increased the salary of the electrical engineer, Mr. M. P. Plunkett, by £25 per annum.

Weybridge.—The Urban Electric Supply Co. recently applied to the Board of Trade for an order to authorise an increase in the maximum price of electricity from 7d. to 8d. per unit, but the Council will oppose the application.

Willesden.—There are 200 houses to which the electricity department have been unable to obtain access for reading the meters. A new condition of supply is to be framed, providing for a minimum charge of 13s. 4d. per quarter in such cases.

The accountant reported that in the course of his audit of the accounts, pursuant to the agreement with the power company for the supply of electricity in bulk, two important points of principle had arisen—namely, as to the high grade labour employed by the company in unloading coal and the interpretation placed by them on the coal clause (6). The Electricity Committee have authorised the accountant to inform the company that the charge must not be varied unless and until the price of coal has increased or decreased by a definite 3d. per ton, and that the employment of high-grade labour in the unloading of coal should not continue.

Worcester.—Last week the Council adopted the Electrical Engineer's suggestion that he be empowered to accept the option given by Mr. Arthur Hicks for the purchase of the site, &c., of Bransford Mill, with the water rights, at £355.

Mr. Hill said the purchase of these rights would enable them to develop, when desired, the water power at Powick. The Council also desired to acquire Nut Island in the same locality, for £75.

Electric Traction.

Barrow.—The Council has decided, "in view of the failure of the Barrow tramway system," to ask the Parliamentary Committee to take into immediate consideration the question of promoting a Bill to authorise the running of motor omnibuses in the borough and district.

Electric Vehicle Costs.—At Chester two Edison tipping wagons have been employed in collecting house refuse since the summer of 1915.

Up to the end of December, 1917, the wagons had travelled 13,688 miles, collected and carried 5,974 tons of house refuse, delivered 217 tons of fuel to the electricity works, and conveyed 167 tons of shell and 256 tons of scrap steel to the railway station. According to the report of the electrical engineer (Mr. S. E. Britton), the working expenses were as follow:—

	Per mile.	Total.
Driver's wages	4·50d.	£256 13 0
Repairs	0·24d.	13 13 9
Materials	0·60d.	34 4 0
Insurance	0·20d.	11 8 1
Electrical energy	2·65d.	151 3 2
Maintenance of tyres	1·00d.	57 0 8
	9·19d.	£524 2 8

There was received for the cartage of the fuel, &c., a sum of £48. 2s., so that the net cost for the cartage of the refuse was £476. 0s. 8d. The two vehicles performed the work of six horses and men, which would have cost for hiring £1,506. 14s. It is pointed out that, in order to get a fair comparison, the drivers employed with the horses and carts also assist in filling them, so that their wages should be deducted from the hiring. After allocating the driver's wages in equal amounts to collecting and driving, the hiring figure is reduced by £256. 16s., viz.: Six horses and carts, £1,259. 18s.; two electric vehicles, £471. 3s.; or a balance in favour of the latter of £788. 15s.

Mr. W. Greig, cleansing superintendent at Glasgow, reports that for the year ended May 31 last that the two Edison 2-ton vehicles put into commission in December, 1916, and May, 1917, respectively, have given satisfaction. A comparison with horse haulage derived from the figures for the past year shows the following: For electric vehicles, 3s. 5½d. per ton; for horse traction, 4s. 1½d. per ton. The Cleansing Committee have advised the purchase of two further 2-ton battery wagons, at £1,168 each, and two 3½-ton battery wagons, at £1,432 each.

L.C.C. Tramways.—The Board of Trade has extended by one year from Aug. 11, 1918, the time limited by the L.C.C. (Tramways and Improvements) Act, 1913, for the completion of certain tramways authorised by the L.C.C. (Tramways and Improvements) Act, 1903.

An extension of one year from Aug. 16, 1918, has also been granted

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for the widenings at Farringdon-road and Clerkenwell-road, and for the completion of certain tramways authorised by the L.C.C. (Tramways and Improvements) Act, 1909.

St. Helens.—The Corporation is negotiating with the new St. Helens & District Tramways Co. for an extension of the tramways lease for five years.

York.—The Tramways Committee recommend that the Board of Trade be asked permission to increase the maximum fares permitted on the tramways by 50 per cent.

Imperial Notes.

Australasia.—The "Industrial Australian and Mining Standard" says Sydney Electric Lighting Committee has decided to invite offers for the sale to the City Council of a coal mine capable of supplying the requirements of the electric supply and other departments.

The report of the Electric Light & Power Corpn. (Balmain, Sydney) states that consumers increased from 2,911 in 1915 to 5,299 in May, 1918. Connections can now be made only to existing mains, owing to the difficulty of obtaining copper. The proposed new generating plant, for which capital has been raised, has not yet been purchased, owing to the prohibitive prices prevailing. Net profit for half-year to April 30, 1918, was £16,274 (increase over corresponding half of previous year, £5,800), part of which was due to conversion of debentures into shares, and the year's profit was £31,998 (compared with £23,902). The dividend proposed is 8 per cent., as in previous year.

In the Queensland Legislative Assembly recently, Mr. Huxham introduced a Bill to provide for the purchase of the Brisbane tramways, the compensation of the shareholders and the placing of the lines under the control of local authorities.

The Victorian Premier, Mr. Lawson, defining recently the Government's attitude towards the power problem, said an ample supply of cheap power must be made available as early as possible. There were natural sources of power which could be made national assets of the first magnitude for a multitude of productive purposes. A special committee of experts had investigated the brown coal proposition at Morwell, and reported favourably. The water power of the Kiewa River had also been discussed. The Government had determined to introduce legislation designed to control such projects in the future. It was essential that the main sources of electrical energy should be co-ordinated. They would begin with a controlling body created by Act of Parliament, and consisting of technical and business men. There would be no unnecessary delay. The Government did not intend to allow private capital to exploit for its own advantage the brown coal deposits, but with respect to water power schemes they were open to consider proposals that were economically and financially sound, and properly conserved the public interest and provided for resumption by the State.

George Town (Penang).—The 1917 accounts of the municipal electricity department show gross capital expenditure $1,056,878, and the total written off for depreciation amounts to $190,566.

Revenue was $383,269 ($335,611), works costs were $139,169 ($106,832 total costs $168,473 ($134,472) and capital charges $106,616). Gross profit was 20·3 per cent. on total expended capital, and net profit 10·3 per cent. Units sold were 1,925,694 (increase 13·4 per cent.).

Capital expenditure on the tramways amounts to $572,304 and amount written off $223,931. Revenue was $153,707 (against $151,498 in previous year), working and general expenses were $93,046 ($91,735), and capital charges, depreciation and renewals required $54,949, leaving a balance of $5,642. Gross profit was 10·6 per cent. Passengers carried were 5,597,667 (5,560,398), and car-miles run 439,318 (498,570).

Indian Science Congress.—The 6th annual meeting of the Indian Science Congress will be held in Bombay from Jan. 13 to 18, 1919, and Sir Leonard Rogers will preside.

Dr. D. N. Mallik will be president of the physics and mathematics section and Mr. F. L. Usher of the chemistry section. Particulars of the meeting may be obtained from the hon. secretary, Dr J. L. Simonson, Indian Munitions Board, Simla.

Foreign Notes.

Exports to China.—The Foreign Trade Department (Foreign Office) announces that Gaston Williams & Wigmore, Electrical Engineering Corpn., Shanghai, has been re-included in the list of firms in China to which articles may be exported from the United Kingdom. The firm had been previously removed from the list because it was understood to be identical with Gaston Williams & Wigmore Far Eastern Division, Ltd.

Krupp Works for the Ukraine.—According to "Engineering," the firm of Fried. Krupp has formed a concern under its leadership with a capital of 20,000,000 marks and an additional guaranteed capital of 80,000,000 marks for the purpose of exploiting Ukraine industrially.

A number of undertakings in the iron and steel industry, in machinery and electrical engineering are also interested in the venture. At the same time a number of banks and financiers have formed another syndicate for the exploitation of Ukraine financially, and, it is added, in the matter of railway construction. The latter concern so far has only a capital of 5,000,000 marks, and its work, in the first instance, will probably be confined to a study of the country and the possibilities it offers. The fact that the two concerns have not joined hands has caused some surprise, but the reason is stated to be that the banks wanted a concern which comprised all industries and did not find it expedient to co-operate with one which only represented a limited number.

New Swedish Electrical Association.—On Aug. 28 representatives of the Swedish electrical industry met and decided to form the Sveriges Elektroindustriförening for promoting the generation and use of electrical energy in Sweden, and to watch the commercial interests of the electrical industry. The board consists of J. S. Edström (president), F. Jäger (vice-president), R. Amelin, K. B. Henke, Axel Hultman, G. Piltz, E. Sievert and K. Ostlund.

Norway.—The total estimate of expenditure in the extraordinary Budget is 281,226,856 kroner, of which over 21,000,000 kroner will be for railway enterprises, 6,327,150 kroner for telephones and telegraphs, and for the purchase of waterfalls 22,261,500 kroner, including the purchase of Glomfjord power station. Various sums are also to be allocated for the purchase of mines and other industrial enterprises.

Spanish Hydro-Electric Power Development.—The shortage of coal and other fuel has led to a boom in Spanish hydro-electric projects, and at present many schemes for the utilisation of water power are being prepared. Among these may be mentioned the following:—

A company has been formed in Barcelona to utilise the power of the Seros waterfall on the river Segre (which is estimated to yield 60,000 H.P.) and that of Noguera-Pallerese, with a possible total of 110,000 H.P. The company will instal also works on the Ebro where only 15,000 H.P. will be generated at the outset, but later the plant capacity will be increased to 3,000,000 H.P.

The Sociedad Productora de Fuerzas Motrices, with a capital of 6,100,000 pesetas, has been formed in Bilbao, for exploiting the falls of the river Flemisol en Poble de Segur (Lerida).

It is also stated that a company proposes to exploit a waterfall of the Duoro, about 90 metres high and estimated to yield 350,000 H.P. Electric current would be transmitted to Madrid, Bilbao and Galicia, and would serve for the electrification of the Northern Spanish railways.

The Chamber of Commerce of Valencia has ordered an investigation into the advisability of utilising a waterfall on the river Jucar, in the Province of Albacete, which is estimated to yield over 6,000 H.P.

A French company has been granted water power rights on the Eseta and the Cinca, Aragon, where it proposes to erect works for the production of fertilisers.

Miscellaneous.

Enemy Firms Wound Up.—The controller of (1) the Union Electric Co. (Ltd.) and (2) the United Berlin-Frankfort India Rubber Co. (Ltd.) has applied to the Board of Trade for a release.

Gas Coke Order.—The Board of Trade have made an Order fixing the price of gas coke and breeze used for industrial purposes as from the 7th inst.

The Order contains provisions authorising the Controller of Coal Mines to suspend any of its provisions in any district, or to vary the maximum prices in any cases of hardship.

From the 7th inst. the price of gas coke for household and industrial purposes will be controlled throughout England, Wales and Scotland by a new Order of the Board of Trade. Hitherto, in the metropolitan area, there was an agreed price with the gas companies, and in other parts of the country, although recognised prices prevailed, there was nothing to prevent gas companies or dealers charging higher prices.

The effect of the Order is that the price of gas coke shall not exceed in any district the price of the second list of house coal, but industries which use 50 tons of gas coke per month on a yearly contract will obtain a discount of 10 per cent. The maximum price of unscreened coke breeze will be 60 per cent. cheaper than that of ordinary large coke, but industrial users of over 600 tons a year will get a 10 per cent. discount. The prices of second list coal, on which the prices of coke are based, are fixed by the Local Coal Committees in each district.

Municipal Industrial Councils.—Arrangements are being made by the Ministry of Labour for the formation of joint industrial councils for the four large trading services of municipalities—*i.e.*, electricity supply, tramways, gas and water works. It is probable that separate industrial councils will be established for the other municipal (non-trading) services.

New Naval Rating.—The Admiralty has instituted the rating of electrical artificer, with rank as corporal, in the Royal Marine submarine liners.

The pay is 2s. 6d. per day with 1s. 8d. per day engineering pay. Some knowledge of mechanical engineering is an advantage, but the chief qualification is a general knowledge in regard to the operation of small isolated electrical plants. It will be a recommendation if candidates can dismantle and assemble small generators and motors, make connections, read voltmeters and ammeters, make sweated joints on copper cables, trace and locate faults, &c. Candidates, who should be between 21 and 45 years of age, should apply to the Department of Naval Recruiting, 20, Cranbourn-street, Leicester-square, London, W.C. 2.

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Popular Science Lectures.—Under the auspices of the Coventry Higher Education Committee a series of 10 popular science lectures will be delivered in the Hippodrome fortnightly, on Sunday evenings, commencing Oct. 13, at 6.30 p.m.

The lecturers include Dr. C. W. Salesby, Prof. W. Stirling, M.D., Prof. H. H. Turner, Dr. W. Rosenhain and Mr. A. P. Young. The latter will discourse upon "The Romance of Electricity," on Dec. 8, and the lecture will be illustrated by lantern views and experiments.

Scottish Valuation Appeals.—Last week the Lanark Valuation Appeal Court heard appeals by the Etna Iron & Steel Co. (Craigneuk) and the Dalziel Motor Co. (Motherwell), against the valuation placed upon certain motors by the Assessor, whose contention was that the motors were used for "first motive power" as mentioned by the Act. Appellants, however, contended that the electricity, being supplied by the Clyde Valley Electric Power Co. was first motive power in the Clyde Valley Works, but not in the works of appellants, to which it was mechanically conducted. The Court unanimously came to the conclusion, so far as the particular work was concerned, that the motors were first motive power, and upheld the contention of the Assessor.

Wireless Telegraphy on Australian Ships.—The Commonwealth war precautions include a regulation requiring that all vessels over 1,600 tons shall have a wireless installation.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during August, 1918, and (*b*) the aggregate figures from Jan. 1 to Aug. 31, with increase or decrease compared with corresponding periods of 1917 :—

Electrical machinery, (*a*) £49,732 (decrease £32,944), (*b*) £493,162 (decrease £438,444); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £27,697 (increase £3,548), (*b*) £108,663 (decrease £67,381); and electrical machinery unenumerated, (*a*) £22,635 (decrease £36,492), (*b*) £385,099 (decrease £371,063); telegraph and telephone cables other than submarine, (*a*) nil (decrease £1,154), (*b*) £1,936 (decrease £48,498); telegraph and telephone apparatus, (*a*) £1,270 (decrease £711) (*b*) £34,277 (increase £12,911); other electrical wires and cables rubber insulated, (*a*) nil (decrease £1,729) (*b*) £657 (decrease £29,797); with other insulations (*a*) nil (decrease £1,598), (*b*) £760 decrease £7,770); carbons (*a*) £1,693 (decrease £1,510) (*b*) £27,032 (decrease £27,361); glow lamps, (*a*) £2,643 (increase £1,838), (*b*) £86,887 (increase £15,240); parts of arc lamps and searchlights (other than carbons) (*a*) nil (decrease £17,175), (*b*) £62,991 (decrease £23,188); primary and secondary batteries, (*a*) £8,320 (decrease £15,586), (*b*) £108,044 (decrease £104,529); meters and measuring instruments (*a*) £750 (decrease £40), (*b*) £17,488 (decrease £5,209); switchboards, (*a*) nil, (*b*) £2,131 (increase £1,650); electrical goods and apparatus unenumerated, (*a*) £52,248 (increase £7,310), (*b*) £362,361 (increase £8,917). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £16,924 (decrease £30,394), (*b*) £698,564 (decrease £207,731).

Exports.—The exports of electrical machinery, material, &c., (*a*) during August, 1918, and (*b*) from Jan. 1 to Aug. 31, with increase or decrease compared with corresponding periods of 1917, were as follows :—

Electrical machinery, (*a*) £80,049 (decrease £56,661), (*b*) £700,162 (decrease £306 433); including railway and tramway motors, (*a*) £3,070 (decrease £1,534), (*b*) £26,061 (increase £3,214); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £36,880 (decrease £50,306), (*b*) £418,683 (decrease £181,015); and electrical machinery unenumerated, (*a*) £40,099 (decrease £4,821), (*b*) £255,418 (decrease £128,632 telegraph and telephone cables, submarine, (*a*) £34,225 (increase £18,678), (*b*) £399,756 (increase £270,668); other than submarine, (*a*) £22,139 (decrease £6,828), (*b*) £195,088 (decrease £325,999); telegraph and telephone apparatus, (*a*) £13,450 (decrease £15,086), (*b*) £129,660 (decrease £50,861); other electrical wires and cables, rubber insulated, (*a*) £8,654 (increase £4,032), (*b*) £46,290 (decrease £117,929); with other insulations, (*a*) £7,792 (decrease £21,967), (*b*) £59,586 (decrease £169,729); carbons, (*a*) £1,080 (decrease £3,212), (*b*) £4,386 (decrease £15,787); glow lamps, (*a*) £7,818 (decrease £3,505), (*b*) £56,773 (decrease £36,225); arc lamps and searchlights, (*a*) £2,137 (decrease £3,950), (*b*) £15,973 (decrease £1,544); parts of arc lamps and searchlights (other than carbons), (*a*) £2,020 (decrease £7,016), (*b*) £13,326 (decrease £41,480); primary and secondary batteries, (*a*) £19,025 (increase £3,919), (*b*) £79,879 (decrease £28,298); meters and measuring implements, (*a*) £8,131 (decrease £5,425), (*b*) £78,846 (decrease £26,700); transformers (*a*) £4,366 (decrease £1,022), (*b*) £21,004 (decrease £27,949); switchboards, (*a*) £2,129 (decrease £3,881), (*b*) £21,996 (decrease £5,594); electrical goods and apparatus unenumerated, (*a*) £33,065 (decrease £45,877), (*b*) £279,946 (decrease £5,594). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £166,031 (decrease £91,141), (*b*) £1,402,509 (decrease £749,490).

Tenders Invited and Accepted.

Water-Tube Boilers, &c.

Bedford Corporation require tenders by noon Nov. 13 for the supply and erection of two Water-tube Boilers, Mechanical Stokers and Induced Draught Plant. Specifications, &c., from the Engineer, Electricity Works, Cauldwell-road, Bedford.

Tramway Stores.

Portsmouth Tramways Committee invite tenders for six months' Tramway Stores, including Overhead Line Material, Castings and Machine Tools, Insulating Materials, Lamps and Motor Windings, Car Repair Stores, Steel Tyres, Lubricating Oils, &c. Specifications from the Engineer and tenders to Town Clerk by Oct. 15.

Tramway Rail Bonds

Johannesburg (Transvaal) municipality require tenders by noon Nov. 27 for supply of 2,000 copper ribbon bonds and 2,000 copper solid bonds (contract No.424). Specification, &c., from the Town Clerk.

Barnes.—For the supply of e.h.t. cable, an order has been placed with Siemens Bros. & Co. at £885.

Bedford.—The Council has accepted the tender of the British Electric Transformer Co., for a 350 k.v.a. transformer, at £435.

Belfast.—The corporation has accepted the following tenders for electrical plant.

British Thomson-Houston Co., two 6,000 kw. turbo-generators, condensing plant, &c., and one 300 kw. balancer booster, £74,839; Stirling Boiler Co., four 48,000 lb. water-tube boilers, four fuel economisers, two steel chimneys, &c., £82,516; Holden & Brook, two electrically-driven boiler feed pumps, £1,565; Tudor Accumulator Co., accumulators, £4,414; Vickers Limited, rotary converters, £30,613; Siemens Bros. Dynamo Works, static transformers, £9,162.

Glasgow.—The Tramways Committee has accepted the following tenders: Carron Co., brake blocks; T. Bolton & Sons, trolley wire; British Insulated & Helsby Cables, lead-covered cable; Robinson & Hunter, pitch.

Walsall.—The Council has accepted the following tenders: Brush Electrical Engineering Co., consumers' transformers; British Westinghouse Co., switchgear; Walsall Electrical Co., repairing wiring installation at gas works.

Wigan.—The Council has accepted the tender of Massey Bros. for the extension of the electricity station buildings, at £8,030.

Appointments Vacant and Filled.

Blackburn Corporation advertise for a switchboard attendant. Salary 65s. per week, inclusive of all awards, plus a sum dependent on conditions. Applications by Oct. 14 to Mr. P. P. Wheelwright, M.I.E.E., borough electrical engineer.

Darwen Corporation invite applications for the position of electrical engineer and manager of their electrical undertaking. Salary £300. Applications to the Town Clerk by Oct. 12.

St. Helens Corporation require a distribution engineer. Salary £280 per annum. Applications to Mr. E. M. Hollingworth, borough electrical engineer, by Oct. 22.

A lecturer on physics is required at the South African School of Mines and Technology, Johannesburg. Salary £450 per annum, rising after two years by £25 annually to £550. Applications by Oct. 14 to Messrs. Chalmers, Guthrie & Co., 9, Idol-lane, London, E.C.

Applications are invited for the position of professor of physics in the University of Cape Town. Salary £800 per annum. Applications by Jan. 1 to the High Commissioner for the Union of South Africa (32, Victoria-street, London, S.W.1), from whom particulars can be obtained.

Bradford Tramways Committee has selected Mr. R. H. Wilkinson, of Huddersfield, for the position of tramway's manager at £800 per annum.

Mr. O. S. Spokes, of Londonderry, has been appointed Principal of the Banbridge Technical School.

Business Items.

The head office and works of the Concordia Electric Wire Co. have been removed to Trent Mills, New Sawley, Derbyshire (Telegrams: "Polianite" Long Eaton; telephone, 249); but the company has opened a branch London office and stores at 155, Victoria-street, S.W.1 (Telegrams: Polianite London; telephone, 4120 Victoria).

Owing to the increasing demand for Parkinson a.c. motors, steps have had to be taken to increase the manufacturing capacity of Messrs. F. A. Parkinson & Co., Ltd.

As a beginning, the output of small standard polyphase motors up to 10 h.p. has been greatly improved, and stock is now available for the execution of urgent orders. This stock will be extended to include larger sizes of polyphase motors, together with Parkinson single-phase commutator motors built under Creedy's patents. London stores have been opened at 25, Victoria-street, S.W. (Messrs. Pooley & Austin), and stock motors and spare parts are held in London as well as at the works. A list of stock motors will be supplied on request. The circulation of the monthly stock list has had to be temporarily suspended, but a weekly list can be obtained from Messrs. Pooley & Austin.

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Municipal Accounts.

Islington (London).—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £591,778, of which £393,234 is outstanding.

Revenue was £87,339 (compared with £82,087 in previous year) and working expenses were £55,147 (£51,129). Interest required £14,071 (£13,934) and instalment of loans £14,843 (£14,226), leaving net profit £2,522 (£2,073). Average price obtained for all services (public and private) was 2·11d. (1·92d.) per unit. Total running costs were 1·29d. (1·18d.) and capital charges 0·726d. (0·701d.) Units generated were 11,879,990 (12,342,040) and sold 9,554,210 (9,644,248). Maximum load was 6,077 k.v.a. (5,740 k.v.a.) and load factor 17·94 (19·18) per cent.

King's Lynn.—The electricity department accounts for the year ended March 31 show gross capital outlay £59,482, of which £16,159 is outstanding.

Revenue was £12,226, and gross profit after paying working expenses, war service allowances, &c., £4,820, against £3,031 in previous year. Interest required £650 (£708), and repayment of capital £2,017 (£2,017), net profit being £2,146 (£290). Average price obtained for current was 2·73d. (2·96d.) and costs were 1·88d. (2·25d.) exclusive, and 2·76d. (3·61d.) inclusive of capital charges, war allowances, and maintenance of public lamps. Total maximum load was 503 (311) kw., and load factor 17·48 (18·65) per cent. Units generated were 832,683 (552,782) and sold 768,106 (507,724).

Companies' Meetings and Reports.

DUNDEE, BROUGHTY FERRY & DISTRICT TRAMWAYS CO. (LTD.)—For the year ended July 31 the profit (including £587 brought forward) was £5,117. A dividend on the ordinary shares at 3 per cent. per annum is proposed, after placing £1,000 to reserve, carrying forward £830.

ELECTRIC SUPPLY CORPN. (LTD.)—At the meeting last week the chairman (Mr. J. G. B. Stone) stated that the gross earnings had risen to £44,140, an increase of £1,322 over the previous year. The sum taken into net revenue account was £14,020, against £15,599, including £1,159 allowed to Chelmsford Corporation on the old contract for street lighting. There was an increase of 3,437 in the number of lamps connected to the company's own mains in addition to a considerable increase in Hendon, Dawlish and North Berwick. With regard to the operations of the year, various restrictions, economic and administrative, had further curtailed private lighting, which was in the small towns their most lucrative business, but they had found an outlet for their supply in other directions, notably in power supply. The representatives of the electric supply industry had pointed out to the Government the difficulty of meeting the increases in coal and wages due to the action of Government Departments and the Ministry of Munitions had issued a letter approving of the suggestion that they should receive increased payment from those consumers who were receiving a supply from them under contracts made before the war, and which had no provision for these increased prices. The views expressed by the Ministry of Munitions were not readily accepted by the Admiralty, for whom several of the Corporation's largest consumers were working, and whose payments had to be approved by the Admiralty. Unfortunately, the case of the electric supply industries was tacked on to that of the gas and other utility companies, although the conditions governing the electric supply companies, whose tenure was not perpetual, were quite distinct. As a result of this arrangement, they were brought under the Statutory Undertakings (Temporary Increase of Charges) Act, 1918. This did not permit of increase in rates unless the dividend of the company was reduced 25 per cent. They had now got to start de novo, enter into new proceedings, furnish new figures, and go into the whole matter afresh. He feared, therefore, that it was unlikely that they could get any increase in their charges authorised before the end of the current year. This was a great hardship, considering the great rise in wages and in the cost of coal. The accounts were adopted, and dividend at rate of 1 per cent. was agreed to.

SOUTHERN BRAZIL ELECTRIC CO. (LTD.)—The accounts for 1917 show, after deduction of all charges in London and Brazil, interest on debentures and loan, a profit of £4,838, which, added to £4,271 brought forward, makes £9,109, which the directors propose to carry forward.

The chairman (Mr. E. H. Tootal) stated at the meeting last week that the gas works at Campinas had been shut down, owing to inability to get coal, but the old customers would now be supplied with electricity instead. The receipts from the Campinas tramway service had suffered from several causes. The electrification of the steam railway, of which only a small part remained to be done, would be soon completed, when a considerable increase of traffic might be expected. At Piracicaba the results had been very satisfactory and would have been still more so if their trains had been allowed to run over the bridge. Amparo showed good progress, and the new municipal concession at Itapira and the other small stations were giving very satisfactory results. They had had a sufficient volume of water during the year for all requirements, and on the completion of the new Jaguary station their capacity for supplying power would be materially increased.

VICKERS (LTD.)—Mr. Douglas Vickers, who presided over the adjourned annual general meeting on Tuesday, said that in 1915 they had inaugurated a policy, since adopted by the Ministry of Munitions, of mobilising not only their own resources, but those of every outside engineering firm that they could bring together. The result was an enormous output—something over 29 millions if all works were reckoned. The actual profits paid to the shareholders were only about 3½ per cent. on the turnover. It was the intention of the directors to pay off the 5 per cent. third and the 4½ per cent. second mortgage debentures, and it was stated that by Dec. 2 they would be reduced by £615,300.

With regard to their peace proposals, he did not propose to go fully into them. His references at the last meeting had been widely circulated, and they had actually received suggestions from the United States as to the best way to develop their peace resources. The company expected to get a very largely increased output of ships, railway materials, motor cars, turbines, electrical materials, gas engines, wood products, sewing machines and electrical work generally. They would have to go a good deal further afield in the search for work in the nature of electrical and railway material. And in going further afield they would get into one where the conditions of payment were not quite what they had been accustomed to in this country. Quite probably they would have to do a good deal more financing undertakings, and they might have to join with banks in doing so, out of which they hoped not only to get a return of the work done, but also a return upon their financing arrangements. The Germans had made a good deal of that form of trade, and it was to be hoped that we should not leave the field to them in the future.

The Treasury have sanctioned the issue of 1,850,000 new ordinary shares.

New Companies.

BRITISH GAUGE MANUFACTURERS' ASSOCIATION (LTD.) (151,442)—Reg. Sept. 11, limited by guarantee with 100 members each liable for £5 in the event of winding up, to encourage, protect and promote the British gauge manufacturing industry. The first members of the Committee are: W. C. Pitter, W. J. Bassett-Lowke, S. H. Jones, S. A. Hartsmann, A. L. Railthorpe, P. A. Bartley and L. H. Hounsfield. Reg. office: 44, Caxton House, London, S.W.1.

CHAIN ELEVATORS (LTD.) (151,486)—Private company. Reg. Sept. 21, capital £30,000 in £1 shares, to carry on the business of manufacturers of and dealers in devices for raising and promoting the circulation of carriage of liquids and fluids, pump manufacturers, electrical and general engineers. Agreement with J. C. Grant and A. Jarvis.

FABRIC RUBBER CO. (LTD.) (151,073.)—Private company. Reg. July 30, capital £25,000 in £1 shares. Manufacturers of india rubber goods, airship proofing, electric cables and general contractors, &c. First directors are M. F. Frankenburg, S. T. Rowe and H. Standring.

NEWCASTLE GRAPHITE CO. (LTD.) (151,385.)—Private company. reg. Aug. 26, capital £50,000 in £1 shares. To manufacture and deal in amorphous and graphite electrodes, graphite powder and other forms of artificial graphite, &c. First directors are H. Peile, H. Harrison, F. Priestman, J. E. Davidson and S. Beeton.

PROTECTOR CO. (LTD.) (151,497)—Private company. Reg. Sept. 23, capital £2,000 in 1,900 ordinary shares of £1 each and 2,000 founders' shares of 1s. each. Mechanical, technical, commercial, electrical or general engineers, &c. Agreement with Justus Eck. Justus Eck is one of the first directors, and may retain office while holding 1,000 shares of any class. Sergius Brook, of 13, Grange-road, Gunnersbury, may, while holding 600 shares of any class, appoint any person approved by the board as a director.

REMCO CARBON CO. (LTD.) (151,393.)—Private company. Reg. Sept. 10, capital £7,625 in 7,500 ordinary shares of £1 each and 2,500 deferred shares of 1s. each, to carry on the business of manufacturers of and dealers in electrical apparatus, &c.

A. W. RICHARDSON & SON (LTD.) (151,301.)—Private company. reg. Aug. 28, capital £10,000 in £1 shares. To take over the business of mechanical, electrical and general engineers carried on by C. W. Richardson, at Patricroft, as A. W. Richardson & Son. First directors are C. W. Richardson, W. R. Francis, A. Williams, W. W. Mills and W. H. Liggins.

SMETHURST & CO. (LONDON) (LTD.) (151,479)—Private company Reg. Sept. 19, capital £3,500 in £1 shares, to take over the business of wax chandlers, oil merchants and electricians, carried on as Smethurst & Co. Reg. office: 72, Duke-street, Grosvenor-square, W.

City Notes.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—An interim dividend at the rate of 5 per cent. per annum, tax free, has been declared for the half-year ended June 30.

DIRECT UNITED STATES CABLE CO. (LTD.)—An interim dividend of 2s. per share, less tax, has been declared, making with the interim dividend already paid 4 per cent. per annum for the year ended Sept. 30.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—During the week the company has invited applications for an issue of 500,000 ordinary shares of £1 each at 20s. 6d. per share.

SUBMARINE CABLES' TRUST.—The coupon due on the 15th inst. will be paid by Messrs. Glyn, Mills & Co., 67, Lombard-street, E.C.3.

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ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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CONTENTS.

NOTES 507
Arrangements for the Week 509
Electric Traction on the Central Argentine Railway. Illustrated 510
The Size and Working Cost of Machines for Continuous-Current Transformation. By Thomas Carter. Illustrated.—*Concluded* 514
The Electrical Equipment of Keadby Bridge. Illustrated 516
The Labour Outlook. By Our Labour Correspondent 517
THE BRITISH DESIGNER OF YESTERDAY 518
A Thermo-Electric Standard Cell. By C. A. Hoxie. Illustrated. 519
CORRESPONDENCE 520
Patent Record 521
Volunteer Notices 522
Commercial Topics 522
Electricity Supply 523
Educational 525
Tenders Invited and Accepted 525
Companies' Meetings and Reports 526

Notes.

The Central Argentine Railway.

ON another page will be found the beginning of an article describing the electrification of an important section of the Central Argentine Railway, which has been undergoing the necessary transformation for the last two or three years. This section of the line is important owing to the fact that Buenos Ayres contains more than one-fifth of the whole population of the Argentine. It is the centre of Government and a large centre of commercial activity. The population is steadily increasing, and thus the directors of the railway realise the necessity of dealing with the suburban traffic by up-to-date methods. Consequently, electrification was adopted, and Messrs. MERZ and MCLELLAN were asked to prepare specifications in co-operation with the consulting engineers of the Company, Messrs. LIVESEY, SON & HENDERSON. The service is now in operation, and has proved most satisfactory from both the engineering and traffic points of view, the passenger journeys in the first six months of 1917 being 11 per cent. in excess of the figure in the corresponding period of 1916. It may be said that, in general, the electrification follows standard lines. The scheme includes a power station of 15,000 kw., and the electrified line is equivalent to 100 miles of single track. A point of interest is the arrangement of some of the boilers for oil firing in view of the shortage of coal. As time went on it appeared that there would be a shortage of both coal and oil, owing to the war, and therefore other boilers were adapted for wood firing. Another interesting detail is the collector gear. An under-running rail is used; but, owing to special conditions, the shoe is more complicated than usual, being provided with two motions—a side motion and an upward motion. This requires somewhat careful construction. The up-and-down movement follows the level of the conductor rail, whilst the sideways movement allows for the end play of the axle boxes and want of alignment of the rail. Protection to the conductor rail is provided in the form of creosoted wood boarding, and this appears to be quite efficient. It is well that this protection should be good, for, apparently, bare-footed boys are not averse to running along the rail, and men have used it as a barrow plank Probably this immunity from unpleasant consequences is to some extent a testimonial to the climate of Buenos Ayres, for we can scarcely imagine that bare-footed urchins in this country under similar conditions would find the experiment entirely to their liking.

Electric Traction in the United States.

THE spread of electric traction in South America reminds us that the Director General of Railroads in the United States (Mr. W. G. MCADOO) has been very favourably impressed with electric traction and desires its rapid extension to railways in the U.S.A. Mr. MCADOO has expressed the view that although at present nothing can be done towards substituting water power for power from coal, the change might come as a plain matter of necessity while the war is on. In his opinion, even if there were no great necessity to conserve the coal supply, the fact that the present burden on transportation limits the available power from coal would be a justification for electrifying many of the railroads. Mr. MCADOO therefore suggests that probably electrification would be undertaken while the Government has control of the railways and the problem would be attacked where the value of water power is most obvious and the cost of making the change would be comparatively light; moreover, the available water power is now mostly under Government control and can thus be commandeered at a low cost. Although we are fully convinced of the great future in store for electric traction on railways, we think that Mr. MCADOO is underestimating the difficulties in carrying out such a programme at the present time. It is well known that hydro-electric works take far longer to build than steam plant, which depends mainly on mechanical engineering, and it is very improbable that such a programme as Mr. MCADOO has in mind could be carried out until after the war. In many ways it would be better to postpone such an undertaking. When these developments are carried out under the stress of war they generally result in make-shift arrangements, which, although satisfactory for the moment, are by no means necessarily the best when viewed under ordinary economic conditions.

Boycotting Enemy Men of Science.

IN another column we give the substance of a statement which has been adopted by the Inter-Allied Conference on the Future of International Organisations in Science, which met at Burlington House on the 9th inst. During the present war every scientific man has been disappointed with the attitude adopted by German scientists, with very few exceptions, for it was expected that science would be found in company with a high standard of humanity and of honour. It may, perhaps, have been felt at first that a kind of patriotism might for the moment get the better of the recognition of right and wrong, and that the early days of war would lead to a lack of mental balance. Unfortunately, however, years have passed and yet there has been no indication of a change in attitude. It is true, of course, that we have had little contact, even indirectly, with scientific men in Germany during the past four years, in so far as chemistry, physics and kindred subjects are concerned. There has, however, been direct contact with medical men, who must assuredly be considered

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scientific men and who should normally have a high regard for humanity. Unfortunately, the evidence is much too strong to disregard in this respect, and it has been with deep regret, and indeed with nothing short of astonishment, that we have read of the absolutely cruel conduct on the part of many doctors towards our own unfortunate men who have fallen into their hands. This is a type of cruelty which is peculiarly revolting, and it very naturally reflects upon all scientific men in enemy countries, more particularly in Germany. Under these conditions we do not think the Conference could have arrived at any other decision than to discontinue personal relations in scientific matters until the Central Powers can be re-admitted into the concert of civilised nations.

Light Transmission Through Water.

The development of aerial traffic has given a great stimulus to the study of searchlights, visibility problems and the transmission of light through the air. In the period following the war, when aerial traffic for the purposes of peace will doubtless make great strides, these problems will undoubtedly command even more attention. The use of aircraft in war, however, is attended chiefly by conditions requiring concealment. Similarly another problem, the use of light under the sea, is naturally opposed to the surreptitious work of submarines. But it is not inconceivable that submarine traffic for peaceful purposes may develop considerably in the future, and in this event ships under water may avail themselves of some form of searchlight. Submarine vessels may prove to have important functions to discharge in reconnoitring shallow bottoms or sunken objects in connection with salvage work, and for such work a searchlight for the illumination of near objects may prove very useful. The transmission of light through water is thus a subject of some future importance. Few people realise how rapidly light is absorbed by its passage through water, even such as is substantially free from sediment or particles in suspension. Some experiments on this subject by Mr. S. L. E. Rose, summarised in a recent number of the "General Electric Review" (U.S.A.) are illuminating in this respect. The author deduces by experiment the formula $I = I_0 \times T^{-f}$, where I_0 is the initial intensity of the light, I its intensity after passing through f feet of water, and T a constant expressing the transmission through 1 ft. of water. According to these experiments, 72·5 per cent. of light emerged after passage through 1 ft. of water, and "T" has the value 0·725. Applying the formula, it can be shown that after passage through 100 ft. of water only 10^{-14} of the original light survives! It is evident, therefore, that for the illumination of any but very near objects an enormously powerful beam would be needed, and it is probable that the scattering effect of the water, producing a luminous haze much more distracting than that experienced by operators of searchlights working in air would prove a great difficulty.

A Rare Opportunity for Professional Men.

Visiting teachers of electrical engineering, mechanics, mathematics and machine drawing are required by the L.C.C. Education Authority for the School of Engineering and Navigation, Poplar; and on receipt of a stamped addressed foolscap envelope the Education Officer will send a form giving particulars of the jobs. The only particulars of the least interest to us are that the pay offered is 10s. 6d. per evening; that half-a-guinea to-day is equivalent to 4s. 9d. on a pre-war basis; and that an important public body is endeavouring to get something for very little. On several occasions recently we have criticised the methods of the Education Department of the London County Council, and were we the Principal of the school at Poplar we should protest in the strongest terms against such an advertisement. Before applying for these positions, those who think they hold the necessary qualifications will be well-advised to consider how they propose to reach an out-of-the-way place like Poplar, and to determine the number of hours of a professional man's time the L.C.C. expects to buy for a paltry 4s. 9d.! It will not be less than four, which works out at about 1s. 2d. per hour, omitting the cost of travelling. The only standard on which values can be judged at the present time is the pre-war standard. It would be better for our technical teachers to sell quack medicine in the market place than be so imposed upon, and we urge the teachers who read this note not to waste their pence in sending stamped addressed foolscap envelopes to the establishment on the Embankment. We talk at times of sweated industries. There is such a thing as the sweating of technical teachers, and the above might be so described.

Belfast Association of Engineers.—The opening meeting of the 28th session of this Association was held yesterday, when the president, Mr. W. Walker, delivered his address.

Batti-Wallahs' Society.—It is announced that Mr. C. H. Wordingham, Director of Electrical Engineering, Admiralty, and President of the Institution of Electrical Engineers, will be the guest of the Batti-Wallahs' Society at their luncheon on Monday next at the Holborn Restaurant, London.

Royal Engineers (Volunteers).—In order to assist recruiting for this branch of the London Army Troops Companies, a smoking concert will be held on Saturday the 26th inst., at the Regent-street Polytechnic, London, when the chair will be taken by Lieut.-Col. C. B. Clay, V.D., the commandant.

Industrial Reconstruction Council.—A conference on "Women in Industry" will be held under the auspices of the Industrial Reconstruction Council on Tuesday, Oct. 22, at 6 p.m., in the Hall of the Institute of Journalists, 2 and 4, Tudor-street, E.C. 4. The subject will be introduced by Miss Lilian Dawson, secretary of the Fabian Society Women's Group, after which the discussion will be open. No tickets are necessary.

Key Industries Exhibition.—At the request of the Board of Trade, the New British and "Key" Industries Exhibition, Central Hall, Westminster, S.W., will remain open until Oct. 24, to enable the Greek Minister of Agriculture and an influential party representing Greek commercial interests, now touring the leading industrial centres of the United Kingdom, to pay a visit to the Exhibition. We are glad to find that the attendance is very satisfactory, the daily average being 4,000.

Institution of Electrical Engineers—Western Area.—The 25th ordinary general meeting and the first meeting of the 1918–19 session was held at the Merchant Venturers' Technical College, Bristol, last week. Prof. David Robertson, in the unavoidable absence of Mr. R. Howard Fletcher (the retiring president), presided over a fair attendance, and inducted Mr. H. F. Rogers to the presidential chair for the coming session. We hope to deal with Mr. Rogers' address in our next issue.

Faraday House Journal.—The "Faraday House Journal" for the Michaelmas Term contains the customary notes on doings of Old Faradians in the Forces, among which we note that Capt. E. T. F. Hayne has been awarded the Distinguished Flying Cross. Reference is made to the death of 2nd Lieut. K. J. Hawkins, who entered Faraday House in September, 1913, and joined the 6th Manchesters (Territorials) on the outbreak of war. A contribution by the principal, Dr. Alex. Russell, deals with "The Percentage Error," and an abstract is given of Mr. L. J. Kettle's recent article on "Irish Peat Utilisation." Other matters dealt with editorially are "Scientific Research," "The Case for Decimal Coinage," and "The Engineers of Education."

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Electricity Supply at Leeds.—Last week a considerable extension of the Leeds electricity works, in the form of a new works, was formally put into operation by the Lord Mayor. The old works consist in the aggregate of 33,000 kw. The new works so far include one 6,000 kw. set and one 12,000 kw. set. In the boiler house are eight Babcock-Wilcox water-tube boilers, each capable of evaporating 30,000 lb. to 35,000 lb. of water per hour, this number being half the capacity for which the boiler house is laid out. The coal is brought to the works either by barges or motor wagons. The 6,000 kw. turbo-generator is by the B.T.-H. Co. and the 12,000 kw. set is by Siemens Bros. Dynamo Works. The new works are electrically connected with the old works through a large sub-station containing 12,000 kw. of transformers, Scott-connected, so that the stations always operate in parallel. Further extensions are in progress.

Co-ordination in Technical Libraries.—In the current issue of the "Library Association Record" there is an article by Mr. A. E. Savage on "Technical and Commercial Libraries." In this article attention is drawn to some of the points which were raised in the recent discussion before the Faraday Society. Certainly much remains to be done before bibliographical information is placed on a satisfactory footing. It is not unlikely that if Dr. Ludwig Mond were still alive the situation would have been different. Dr. Mond was largely responsible for maintaining the work of the international catalogue of the Royal Society, and if his ideas had been extended some uniformity in the treatment of bibliographies and rendering them accessible would have been achieved. It may not be remembered that Dr. Mond went to Brussels to attend an international conference there on behalf of the International Committee's important work, and if the suggestions he put forward there had been adopted it would no doubt have been possible to realise an international bibliographical unity that would now have been most useful; in fact, its value can hardly be estimated. It is well known that both his sons, Sir Alfred Mond, Bart., M.P., now First Commissioner of Works, and Dr. Robert Mond, have continued the great interest shown by their father in scientific work.

Aluminium Production in the United States.—According to the "Electrical Review and Western Electrician" the United States is now the largest producer of aluminium in the world, turning out about 135,000 to 150,000 tons per annum, or approximately half the world's consumption. The aluminium production of the world in 1916 is set down at approximately 140,000 tons, of which approximately 62,000 was the product of the United States, 20,000 produced in France, 16,000 in Norway and 8,000 in Canada. Figures differ radically as to Great Britain, ranging from 4,000 to 12,000 tons production. In Switzerland the normal production is about 20,000 tons, but has been materially reduced by inability to obtain from France the bauxite from which aluminium is mostly produced. Bauxite is found in many parts of the United States, though the bulk of that now used in the industry is the product of the State of Kansas. The fact that aluminium is proving an acceptable substitute for tin in certain industries, and that its cost is no greater than that of tin, is especially interesting and important to the United States, because of the fact that while U.S.A. produces no tin, and sends large sums of money abroad for that article, it is now the world's largest producer of aluminium and able to increase indefinitely its output.

Scientific Societies and Enemy Scientists.—As the result of an inter-allied conference on the future of International Organisation in Science which met at Burlington House on Oct. 9, a statement has been adopted to serve as a preamble to a number of resolutions dealing with the withdrawal of the allied nations from existing international associations, and the formation of new ones to take their place. After dealing with the fact that in the past science has formed a bond strong enough to resist the strain of national antagonism, and that this bond was strengthened during the latter part of last century, it is stated that the representatives are forced to declare that they will not be able to resume personal relations in scientific matters with their enemies until the central powers can be re-admitted into the concert of civilised nations. The last paragraph of the statement reads as follows:—

Civilisation has imposed restrictions on the conduct of nations which are intended to serve the interests of humanity and to maintain a high standard of honour. Such are the recognition of the sanctity of treaties—especially those designed to apply to a state of war—and the avoidance of unnecessary cruelties inflicted on civilians. In both these respects the Central Powers have broken the ordinances of civilisation, disregarding all conventions and unbridling the worst passions which the ferocity of war engenders. War is necessarily full of cruelties: individual acts of barbarity cannot be avoided and have to be borne. It is not of these we speak, but of the organised horrors encouraged and initiated from above with the sole object of terrorising unoffending communities. The wanton destruction of property, the murders and outrages on land and sea, the sinking of hospital ships, the insults and tortures inflicted on prisoners of war, have left a stain on the history of the guilty nations which cannot be removed by mere compensation of the material damage inflicted. In order to restore the confidence, without which no scientific intercourse can be fruitful, the Central Powers must renounce the political methods which have led to the atrocities that have shocked the civilised world.

Obituary.

Hy. Howgrave-Graham.—We regret to announce the death on the 10th inst. of Mr. H. Howgrave-Graham, who had been for many years secretary and registrar of the Chartered Institute of Patent Agents. Mr. Howgrave-Graham was 79 years of age.

Thomas Dence.—The death is announced of Mr. Thomas Dence, a director of Johnson & Phillips, Ltd., and other industrial companies.

Death on Active Service.—Recent reports of deaths on active service include the following:—

Major Leslie P. Aizlewood, M.C. (R.A.F.), was accidentally killed while flying over the sea on Sept. 29. He was 23 years of age, and was formerly a student of mechanical and electrical engineering at Sheffield University and Parkgate Iron & Steel Works, Sheffield. He had been awarded the Military Cross and mentioned in despatches for his bravery in the air.

Victims of the "Leinster" Tragedy.—We regret to notice that one of the victims of the "Leinster" outrage was Mr. James Roberts, barrister-at-law and author of works on patent law.

Amongst other passengers reported missing are Messrs. B. Ralph Murray, Anthony Jones and — Baker, who were going to the Commercial Cable Company as probationers, having just completed their preliminary training at Waterville.

Personal.

War Honours.—Capt. D. S. Baddeley (manager of Messrs. Crompton & Company's Glasgow office) has won the Croix de Guerre and also a Belgian decoration.

Gunner R. Vickers (R.F.A.), formerly a Bolton tramwayman, has been awarded the Military Medal.

War Casualties.—The following casualties are reported:—

L.-Corp. L. C. Suggars (8th London Regt.), formerly assistant draughtsman with Messrs. Crompton & Co., is a prisoner of war in Limburg, Germany. He has been awarded the Military Medal, and the following extract from a letter written to his parents by one of his comrades in August last conveys some idea of the manner in which he won the decoration. At Cambrai, on Nov. 30, 1917, he was one of eight or nine who dared to cross a hundred yards of open ground swept by machine gun bullets, and he carried Corp. Perry (the writer of the letter) to a place of safety behind the line, and then returned to the front and carried on with great pluck.

Pte. R. W. Dennis (W. Yorks Regt.), formerly in the India Rubber Company's general offices, has been wounded.

Pte. J. G. Nelson (Lincolnshire Regt.), formerly employed by Messrs. Dick, Kerr & Company, is a prisoner of war in Germany. He enlisted at the age of 16.

Arrangements for the Week.

FRIDAY, Oct. 18th (to-day).

Institution of Mechanical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Papers to be read on "A Law Governing the Resistance to Penetration of Metals which are Capable of Plastic Deformation, and a New Hardness Scale in Fundamental Units," by Prof. C. A. Edwards and F. W. Willis; "The Value of the Indentation Method in the Determination of Hardness," by Mr. R. G. C. Batson; and "The Ludwik Hardness Test," by Dr. W. C. Unwin, F.R.S.

FRIDAY, Oct. 25th.

Junior Institution of Electrical Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Paper on "Cooling Towers," by Mr. J. Elliott.

SATURDAY, Oct. 26th.

Royal Engineers (Volunteers) London Army Troops Companies.

7.30 p.m. At Regent street Polytechnic, London, W.1. Smoking Concert.

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Electric Traction on the Central Argentine Railway.

Our readers are no doubt aware that an important section of the Central Argentine Railway has been under transformation to electrical working during the last two or three years. The electrification is now complete, and we are able to give an account of the equipment.

The Central Argentine Railway, with a present mileage of 3,300, serves the northern portion of the Argentine between Tucuman, Cordoba and Rio Quarto on the west, and Santa Fé, Rosario and Buenos Aires on the River Plate. The number of passengers carried on the system during the 12 months ending June, 1914, was 23 millions, of whom 16 millions were carried on the three sections which serve the north-western suburbs of Buenos Aires. The explanation of the large ratio which the suburban traffic bears to the total traffic is found in the fact that Buenos Aires, with a population of over 1½ millions, contains more than one-fifth of the whole population of Argentina. The city handles more than half (in value) of the total imports and exports of the country, and new docks are under construction which will increase the capacity of the port by more than 50 per cent.; all the great railways, British engineered and British owned, converge towards it; it is the centre of government, and its climate is good. During the last 20 years its growth has been at the average rate of 7½ per cent. per annum and there is every reason to believe that this rate will be maintained during the next 20 years. Realising the importance of dealing economically with the development of their suburban traffic, the directors of the Central Argentine Railway decided to electrify the suburban sections, and the work was put into the hands of Messrs. Merz and McLellan, who were instructed to act in co-operation with the consulting engineers of the company, Messrs. Livesey, Son & Henderson, the two firms being jointly responsible for the design and supervision of the whole equipment.

On August 24, 1916, the President of the Republic, Dr. Victorino de la Plaza, inaugurated electric traction on the line from Retiro Terminus in Buenos Aires, to Tigre, on Las Conchas River, via Victoria (Fig. 1). The Central Argentine Railway thus had the distinction of being the first of the great railway lines in the Argentine to adopt the modern method of dealing with suburban traffic.

The service on the branch has operated with marked success, not only from the engineering but also from the traffic point of view, the passenger journeys in the first six months of the year 1917 being some 11 per cent. in excess of the figures for the corresponding period of 1916.

The complete electrification works for the suburban system include a power station of 15,000 kw. capacity, 57 miles of high-tension transmission cables, four traction sub-stations with 14,000 kw. of converting plant, and the electrical equipment of 100 miles of single track. Power is produced in the generating station as three-phase current at 20,000 volts with a periodicity of 25 cycles, transmitted to the sub-stations, converted to direct current at 800 volts, and supplied to the trains through a third rail.

The suburban route of the Central Argentine Railway already electrified is shown in Fig. 1, with the location of the power station and existing sub-stations.

The whole of the apparatus used in connection with the electrification was manufactured in Great Britain, and the principal contracts covered the erection of their plant by the various contractors; they are set out in Table I.:—

Table I.

Power station buildings and complete boiler house equipment—Babcock & Wilcox (Ltd.).
Turbo-alternators, transformers and motors—C. A. Parsons & Co. (Ltd.)
Condensing Plant and Pumps—British Westinghouse Electric & Mfg. Co. (Ltd.).
Switchgear in power station, auxiliary motors, &c.—British Thomson-Houston Co. (Ltd.).
High-tension transmission and low-tension track cables—W. T. Henley's Telegraph Works (Ltd.).
Structural steel work for power station entrance way, test room, offices and sub-stations; also the cranes for the sub-stations—David Rowell & Co. (Ltd.).
Electrical equipment of sub-stations—British Thomson-Houston Co. (Ltd.).
Rolling-stock, bodies, underframes and bogies—Metropolitan Carriage, Wagon & Finance Co. (Ltd.), Birmingham Carriage & Wagon Co. (Ltd.).
Rolling stock, electrical equipment—British Thomson-Houston Co. (Ltd.).
Supervision of erection of electrical equipment of permanent way—British Thomson-Houston Co. (Ltd.).

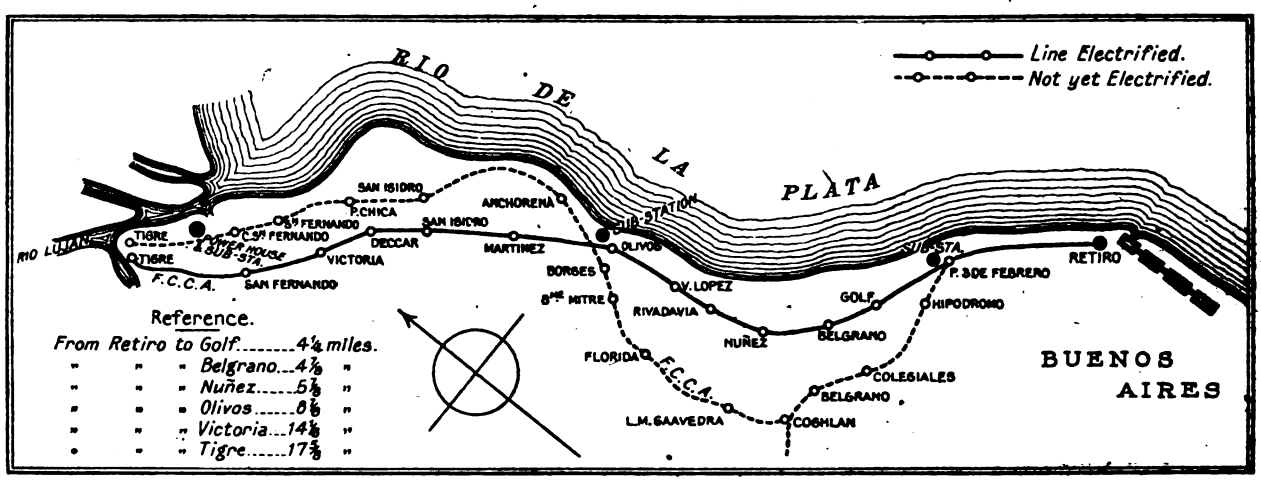

Fig. 1.—Map of Tigre Branches, Central Argentine Railway.

The provision of the foundations for the power station and sub-stations, the walling of the sub-stations, excavation for cables, and the erection of the third-rail were carried out by the railway company with their own staff.

Power Station.

The power house has been placed at the station of Canal San Fernando on a parcel of ground between the Tigre (Rosario) line and the Rio Lujan. The site was swampy and in order to make a sound foundation some 3,000 ferro-concrete piles were driven down 33 ft. till they reached the hard clay (tosca), which is found at varying depths all around Buenos Aires. On top of the piles a concrete raft 2 ft. 6 in. thick reinforced with old rails was formed, to which pipes were laid for the cables serving the apparatus in the station. The level of the engine-room floor is 4·50 metres above datum. This was fixed with reference to the highest recorded flood level, 4·07 metres; since the station was built flood water has reached 4·38 metres above datum.

The general arrangement of the power station is shown in Fig. 2. The engine room and boiler house are arranged parallel to each other with coal and ash-handling sidings behind the latter. In front of the engine-room are a rotary converter sub-station, laboratory and offices. A fitting shop and workmen's accommodation are provided at the permanent end of the engine-room. There is space on the site to double the capacity of the station by extending the buildings towards the river.

The buildings are steel-framed structures panelled with armoured concrete, finished with a white cement. The roofs of the sub-station and offices are concrete; that of the boiler house is corrugated iron. The engine-room roof consists of a wood ceiling covered with waterproof felt and with corrugated iron on top: this construction was required to avoid the condensation of moisture from hot, humid air striking a cold corrugated iron roof.

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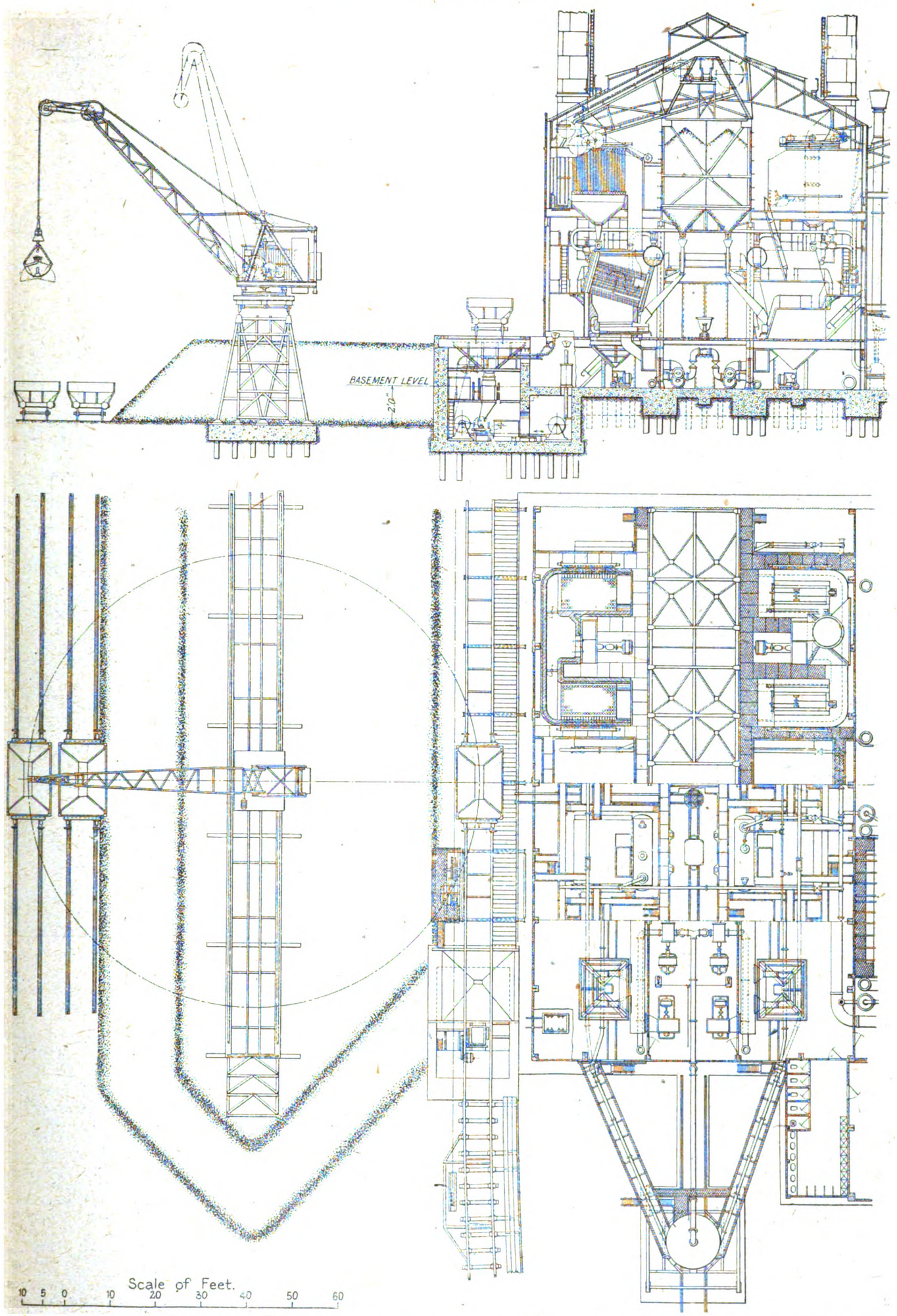

Fig. 2.—Plan and Cross-section, showing General Arrangement of Boiler House and Coal and Ash-handling Plant at San Fernando Power Station.

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Boiler House.—Table II. gives particulars of the principal plant in the boiler house. :—

Table II.—*Details of Boiler House Plant.*

Number and type of boilers—Six Babcock & Wilcox marine-type water-tube boilers (ultimately eight).
Normal evaporation of each boiler—20,000 lb. of water per hour.
Working steam pressure and temperature—210 lbs. per square inch ; 600°F.
Heating surface of each boiler—4,170 sq. ft.
Grate area of each boiler—98 sq. ft.
Type of stokers—Underfeed.
Type and size of economisers—Green's ; 200 pipes in each.
Number of fans—Eight "Sirocco" fans.
Number and type of feed pumps—Two impulse turbine-driven centrifugal pumps ; two vertical reciprocating Nichols' type ; capacity of each feed pump, 75,000 lb. per hour.

The boilers are arranged four a side, grouped in pairs, each boiler having its own superheater and economiser. One steel chimney with an induced draught fan serves each pair of boilers and forced draught is supplied to the furnaces by four fans in the basement.

The furnaces are lined with Glenboig bricks, and are suitable for burning either Welsh or Durham coal. The stokers are of the underfeed type, operated by steam rams. In anticipation of a shortage of coal two of the boilers were arranged for oil firing, and a complete equipment of the Wallsend-Howden system has been put into operation, with storage tanks, filters and pumps. As the shortage of both coal and oil, due to war conditions, became more acute, other boilers were adapted for wood firing, and the fuel consumption figures for a recent week are :—

Coal	72·5 tons
Oil	15·5 ,,
Wood	690·0 ,,

The wood burnt is red and white quebracho and algarrobo, and the relative values of the different fuels are roughly as follows :—

1 lb. of coal (calorific value 15,000 B.Th.U.)	is equivalent to	0·8 lb. of oil.
Ditto	ditto	2·5 lb. of red quebracho.
Ditto	ditto	3·3 lb. of white quebracho.
Ditto	ditto	3·3 lb. of algarrobo.

The combined efficiency of the boilers and economisers works out at about 85 per cent. when Welsh coal is being burnt.*

A high pressure water main served by the feed pumps gives a supply to fire hydrants throughout the boiler house and also for boiler tube cleaning. The feed-pumps draw their supply from hot-well tanks in the pump house and make-up water comes from a storage reservoir constructed alongside the power station to two storage tanks erected above the hot-wells. Water is pumped from the River Lujan through a 6 in. pipe to the reservoir and is there treated with alumino-ferric to precipitate the sediment which the river water contains.

The steam piping consists of a range of solid drawn pipes, the flanges, of forged steel, being riveted in the case of pipes of 7 in. diameter and over, and screwed in the case of smaller pipes. The blow-off piping is solid drawn steel and connects to a blow-off sump formed of a boiler drum. The exhaust and escape steam piping is lap-welded.

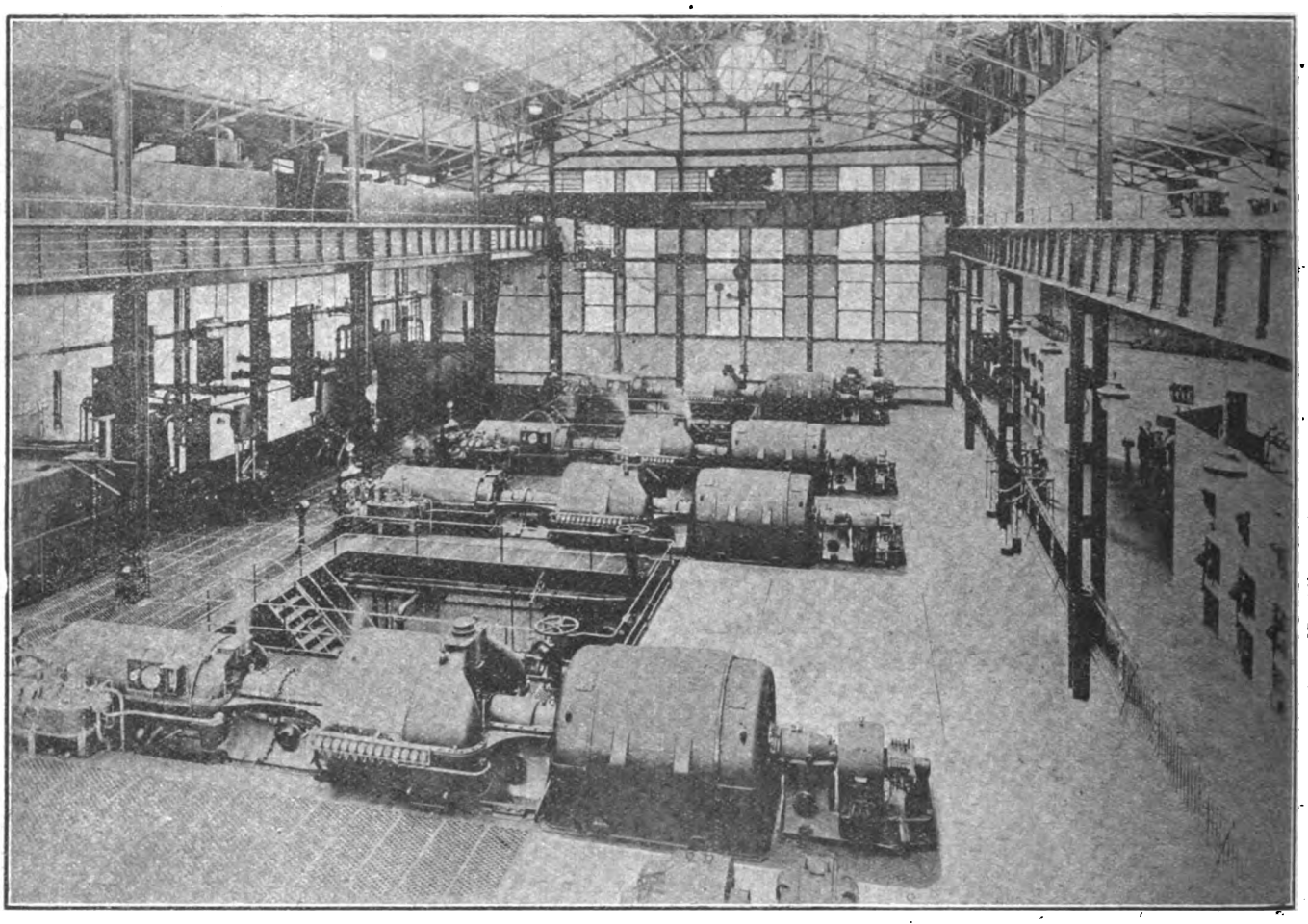

FIG. 3.—VIEW OF INTERIOR OF ENGINE ROOM.

Coal and Ash Handling Plant.—The storage and handling of coal is provided for by means of an elevated railway track running alongside the boiler house at firing floor level, a gantry parallel to the buildings and carrying a level-luffing jib crane with a grab of 2 tons capacity, and two sidings at ground level. (*See* Fig. 2.) The coal trucks are brought on the site from the main line at Canal San Fernando Station, and the coal can be grabbed from them and either filled direct into two 15-ton receiving hoppers, or into bottom discharge wagons which can be hauled along the elevated siding by a winch till they come over the receiving hoppers ; thence the coal passes through crushers to gravity bucket conveyors. These elevate it to a tray conveyor which takes it to coal bunkers above and between the two ranges of boilers. The coal bunkers have a capacity of 1,000 tons ; they are built of mild steel plates lined with armoured cement and the bottoms are "V" shape in section. Alternatively, the arriving trucks can be pushed direct up the 1 in 25 incline to the elevated siding and the fuel—coal or wood—can be discharged

* Labour transport difficulties have become very acute recently, and the supplies of oil and wood have become so precarious that experiments have been made in burning maize. The results obtained indicate that maize gives slightly better results than red quebracho.

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direct on the firing floor by hand. The stock coal is grabbed from the trucks and stored below and around the gantry in a coal deposit floored with sleepers and constructed within range of the jib crane which can plumb to a radius of 50 ft. The capacity of the store is 10,000 tons. The ash handling arrangements comprise a suction ash plant with two 38 H.P. exhausters, which take the ashes from the furnace ashpits through electrically operated crushers and specially heavy cast-iron pipes to a mild steel ash bunker of 80 tons capacity, lined internally with armoured concrete. The bunker is erected at the end of the boiler house at such a height that railway trucks can pass underneath to receive and remove the ashes. Alternatively, the ashes can be taken from the ashpits by half-ton wagons along rail tracks laid along each side of the boiler-house basement, and deposited outside on the site.

Engine Room.—The generating plant is so arranged that provided one boiler is steaming any one of the turbo-alternators can be started up and can give a supply to the main 'bus bars and to all the station auxiliaries. In addition, the breakdown of anything comprised in one generating unit will not prevent the operation of the remaining sets. There are four turbines in the engine room (Fig. 3); each has its own steam-driven oil pump for use when starting up, its own condenser with air and water extraction pumps, and an independent circulating water pump. On the electrical side it has a self-excited exciter direct coupled to the alternator shaft; leads from the alternator run direct to the "unit" transformer which steps down the generated voltage from 2,500 to 440 and gives a supply to the unit distribution board. From this board are fed the motors which operate the auxiliaries definitely belonging to the generating set to which it is attached, viz., those driving the air pump, exhaust valve, step up transformer oil pump and circulating water pump. The other station auxiliaries which are common to the whole station, *e.g.*, economiser and fan motors, are fed from a station distribution board divided into four sections, each of which can be isolated at will and fed from one of the unit boards, the feeders to the auxiliaries being so distibuted among the sections that failure of one section will not put out of operation all the individual pieces of any auxiliary gear. The main leads from the alternator (1 sq. in. single-core cable) run to a step-up transformer, housed in the same compartment as the unit transformer, which steps up the generated voltage from 2,500 to 20,000, at which pressure the power is supplied to the station 'bus bars. The station equipment as a whole is divided into two independent parts, either capable of running without the other. The main 'bus bars are divided in the middle by a 'bus bar sectioning switch; two generators feed each half, and from each half a supply is given to a "station" transformer. Either of these station transformers can feed the station distribution board, the four sections of which are normally run coupled up. Connected to the extreme sections of the station distribution board are two motor generators giving a supply for lighting the station and for charging the two batteries which form a duplicate source of power for the tripping coils on the switches and the indicating lamps on the switchboard. The main outgoing feeders are distributed between the 'bus bar sections, so that failure of one section will not shut down any sub-station.

Details of the engine-room plant are given in Table III. :—

Table III —*Details of Engine-room Plant.*

Number and type of turbines.—Four Parsons horizontal re-action turbines, with high and low-pressure cylinders.
Working conditions.—Steam pressure, 200 lb. per square inch; steam temperature, 600°F.; vacuum, 2½ in. of mercury; normal speed, 1,500 revs. per min.
Current generated.—Three-phase 25 periods 2,500 volts.
Economical output of set.—3,000 kw. at 0·85 power-factor.
Maximum continuous capacity of alternators.—3,750 kw. at 0·85 power-factor.
Momentary capacity of set.—5,500 kw. at 0·85 power-factor.
Type of condensers.—British Westinghouse surface condensers; cooling surface, 8,250 sq. ft.; cooling water required, 6,800 gallons per minute, giving an absolute pressure of 2·0 in. of mercury, with 45,000 lb. of steam per hour each, and cooling water temperature of 80°F.
Air and water extraction pumps.—Westinghouse Leblanc direct-driven by 40 H.P. electric motors at 1,440 revs. per min.
Circulating water pumps.—Four Gwynne vertical rotary pumps, with Westinghouse motors 240 H.P., running at 720 revs. per min., and each delivering 6,800 gallons per minute.
Purified water bilge and emergency pumps.—Gwynne vertical rotary, driven by 13 H.P. electric motors running at 1,440 revs. per min.
Air exhausters.—Gwynne air pumps.
Type of transformers in power station.—British Westinghouse three-phase, shell type, oil-immersed, oil or air cooled.
Main step-up transformers.—Ratio 2,500/20,000; connections, mesh-star; continuous capacity, 4,860 k.v.a.
Unit transformers.—Ratio, 2,500/440; connections, mesh-star; continuous capacity, 250 k.v.a.
Station transformers.—Ratio, 20,000/440; connections, mesh-star; continuous capacity, 1,250 k.v.a.
Lighting motor-generators.—British Thomson-Houston; 440-volt induction motor; 55 kw. direct-current generator; 10 kw. battery charging booster.
Engine-room crane.—Babcock & Wilcox 40-ton crane, with 5-ton auxiliary hoist; span 60 ft.

The high and low pressure portions of the turbines are in separate cylinders, the high-pressure cylinder being of cast steel. This was steamed with superheated steam for 24 hours both before and after blading. The rotor shafts and drums are forged solid of steel, with a tensile strength of 35 to 40 tons and an elongation of 20 per cent. The blades are brass. Each turbine is connected by an expansion pipe to the condenser situated underneath it. Between the turbine and the hand or electrically operated main exhaust valve is an atmospheric release valve. The governor is mechanical and automatic in action, and so constructed that the speed between no load and maximum load can be varied 5 per cent. up or down while the turbine is running. The speed can also be controlled by hand or from the switchboard by electrical means. Oil is supplied continuously under pressure to the bearings, whence it passes through strainers to the oil reservoir, to be picked up by an oil pump and forced through the tubes of an oil cooler.

The alternators are totally enclosed and ventilated by fans on the rotor, which draw air from the basement through a dry air filter and discharge it outside the engine room. The combination of an alternator and a step-up transformer as one generating unit permitted the actual alternator voltage to be selected so as to give the most simple and robust stator winding, the stator slots, which are completely closed, each containing only one conductor. The rotors are of the built-up plate construction, with a distributed winding in slots, and are fitted with mild steel slip-rings.

The step-up and unit transformers belonging to each generating set are housed in a separate chamber in the basement, with hatchways in the engine-room floor through which they can be handled by the crane. The chambers are ventilated by fans, which draw air from the basement, and provision is made for running off the oil from the transformers to the outside of the building in case of fire. Each step-up transformer has its own oil cooler, through which the oil is circulated by a rotary pump driven by a 10 H.P. 440-volt three-phase squirrel-cage motor. The unit transformers are air cooled. The station transformers are situated in separate chambers at the ends of the engine room basement and are air cooled.

An oil store was built on the power station site to contain the supplies of transformer and lubricating oil. An electrically-operated oil-purifying outfit is used for filtering and drying the transformer oil after it has been in service for some months.

Condensing Plant.—The condensing water is taken from a pump house on the River Lujan through two 27 in. diameter pipes about 500 yds. long, and is discharged into a small creek somewhat nearer the power station, called the Rio Rosquetes.

The condenser shells are cast iron and the tube plates are rolled brass 1⅛ in. thick. The tubes are ¾ in. external diameter, and are of solid drawn copper of No. 18 S.W.G. Aluminium blocks are fixed in the water chambers in metallic contact with the tube plates. The air and water extraction pumps, together with their driving motor, are mounted on one bedplate.

The circulating water pump bodies are of cast iron and the impellers are of gunmetal. The circulating water pump motors are housed in a steel framed, corrugated-iron-sheeted house, erected on a wooden jetty projecting from the bank of the river.

In addition to the main circulating pump motors, the jetty carries a centrifugal pump capable of delivering 300 gallons per minute against a head of either 20 ft. or 95 ft. This supplies water through a 6 in. diameter pipe either to the purified water reservoir or direct to the storage tanks in the pump house. Two motor-driven air exhausters are also located in the pump house, each capable of producing in three minutes a vacuum of 20 in. in any one of the main pumps, including its suction pipe and discharge pipe up to the discharge valve.

The main pump motors are started by means of oil-immersed auto-starters, consisting of two separate single-phase transformers and the starting switch. Each motor is connected by a separate cable to one of the unit distribution boards in the power house.

Owing to the swampy nature of the ground between the river and the station, it was not possible to lay the circulating water pipes direct in a trench. Instead they were erected on cross bearers carried by pairs of wooden piles driven down to the tosca. The cables are carried on angle irons supported from the cross timbers. Where the inlet pipes cross the Rio Rosquetes they are carried on a steel girder bridge. The pipes, which are steel, are lapped with tarred Hessian tape.

(*To be continued.*)

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The Size and Working Cost of Machines for Continuous-Current Transformation.

By THOMAS CARTER.

(*Concluded from page* 494.)

Summary.—The article discusses various methods of continuous-current transformation (I.); considers the differences existing between three schemes using a motor-generator, and arrives at expressions for the relative sizes of these machines, which are plotted in curves based on an assumed 100 per cent. efficiency (II.); draws certain conclusions from these expressions and curves in regard to the first cost of the machines and their method of operation (III.); introduces corrections for the actual case when efficiency is not 100 per cent., and deduces curves of overall efficiency of transformation, which show that the cheapest set to buy is also the cheapest set to run (IV.); and concludes by comparing a machine having a double-wound armature with a motor-generator as regards voltage regulation, and by mentioning briefly certain well-known schemes for variable-speed motors which may be simply dealt with on the principles set out (V.).

IV.

In what has already been written, efficiency has been assumed to be 100 per cent., so that the total efficiency of the conversion, denoted by $V'C'/VC$, has also been 100 per cent. In actual practice, the machines composing the motor-generator must be selected, so that they deal with conditions where the efficiency is not 100 per cent., and in this case the power taken from the supply is necessarily greater than the power used, as the supply has to give enough to make up for the losses of the motor generator in addition to the useful power. The overall efficiency of conversion, therefore, becomes less than 100 per cent., its amount depending, in a way now to be shown, on the value of r in schemes 2 and 3, and on the efficiency of the motor-generator in all three schemes as well. If the efficiencies of the two machines of the motor-generator are η and η', the ratio of the output of the generator to the input to the motor is always $\eta\eta'$.

In scheme 1, as the whole of the energy is transformed,

$$V'C'=\eta\eta'VC, \quad \ldots\ldots\ldots \quad (4)$$

and the efficiency of transformation is simply $\eta\eta'$. Now, $V'/V=r$, and hence

$$C'/C=\eta\eta'/r,$$

which shows how the current from the mains is increased by using machines which necessarily have losses.

In scheme 2, when r is <1, machine B is a motor, and hence

$$VC''=\eta\eta'(V-V')C',$$

or,

$$C''=\eta\eta'(1-r)C'.$$

Now, $C=C'-C''=(1-\eta\eta'+\eta\eta'r)C'$, and hence

$$C'=\frac{1}{1-\eta\eta'+\eta\eta'r}C,$$

and

$$V'C'=\frac{1}{\frac{1}{r}(1-\eta\eta'+\eta\eta'r)}VC,$$

or,

$$V'C'=\frac{1}{\frac{1}{r}(1-\eta\eta')+\eta\eta'}VC. \quad \ldots \quad (5a)$$

In scheme 2, again, when r is >1, machine A is a motor, and hence

$$(V'-V)C'=\eta\eta'VC'',$$

or,

$$C''=\frac{1}{\eta\eta'}(r-1)C'.$$

Now,

$$C=C'+C''=\left(1-\frac{1}{\eta\eta'}+\frac{1}{\eta\eta'}r\right)C',$$

and hence

$$VC=\frac{1}{r}\left(1-\frac{1}{\eta\eta'}+\frac{1}{\eta\eta'}r\right)V'C',$$

and

$$V'C'=\frac{\eta\eta'}{\frac{1}{r}(\eta\eta'-1)+1}VC. \quad \ldots\ldots \quad (5b)$$

In scheme 3, when r is <1, machine B is a motor, and hence

$$V'C''=\eta\eta'(V-V')C,$$

or,

$$C''=\eta\eta'\left(\frac{1}{r}-1\right)C.$$

Now,

$$C'=C+C''=\left(1-\eta\eta'+\frac{1}{r}.\eta\eta'\right)C,$$

and hence

$$V'C'=\{r(1-\eta\eta')+\eta\eta'\}VC. \quad \ldots \quad (6a)$$

In scheme 3, again, when r is >1, machine A is a motor, and hence

$$(V'-V)C=\eta\eta'V'C'',$$

or,

$$C''=\frac{1}{\eta\eta'}\left(1-\frac{1}{r}\right)C.$$

Now,

$$C'=C-C''=\left(1-\frac{1}{\eta\eta'}+\frac{1}{r}.\frac{1}{\eta\eta'}\right)C,$$

and hence,

$$V'C'=\left\{r\left(1-\frac{1}{\eta\eta'}\right)+\frac{1}{\eta\eta'}\right\}VC$$

$$=\frac{r(\eta\eta'-1)+1}{\eta\eta'}VC. \quad \ldots\ldots \quad (6b)$$

As the size of the motor-generator is dependent on r in schemes 2 and 3, the value of $\eta\eta'$ is not independent of r, but a sufficiently accurate qualitative picture of what occurs in regard to overall efficiency of transformation is given by

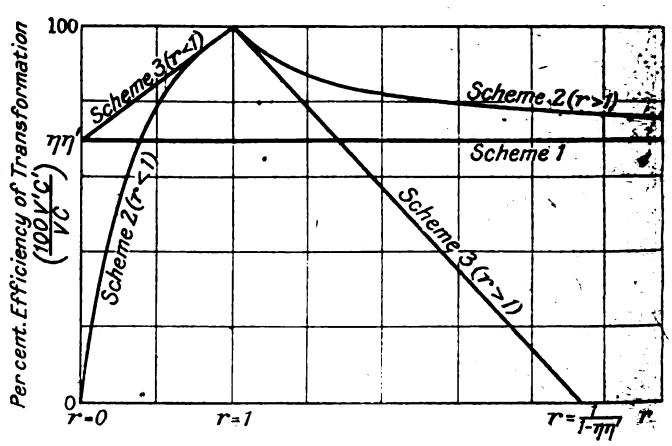

Fig. 5.—Curves Showing Overall Efficiency of Transformation.

assuming $\eta\eta'$ to be a constant, as the exact shape of the curves showing this efficiency is not, for the present purpose, extremely important. Certain definite relations at certain points, under this assumption that $\eta\eta'$ is constant, are simply found. For example, when $r=0$, the overall efficiency in scheme 1 is $\eta\eta'$, while in scheme 2 it is zero, and in scheme 3 $\eta\eta'$; when $r=1$, it is $\eta\eta'$ for scheme 1, and unity for schemes 2 and 3; when r is infinitely great, the efficiency is $\eta\eta'$ in scheme 2, which means that it is asymptotic to $\eta\eta'$, and always greater than $\eta\eta'$, when r is >1 in scheme 2; and when $r=1/(1-\eta\eta')$, which is a value always greater than unity, the overall efficiency is zero in scheme 3. The value is $\eta\eta'$ for all values of r in scheme 1, as shown by equation (4). Fig. 5 shows the comparative shape of the curves, with $\eta\eta'$ assumed constant: the actual value taken is $\eta\eta'=70$ per cent., but the general shape of the curves would be the same for other values. A definite scale is not put on either axis in the figure, as the shapes are approximate only, but certain leading points are shown, which are those specially referred to above. The curves for scheme 3 are, from the form of the equations, clearly straight lines. From Fig. 5, it is evident that, from the point of view of overall efficiency, scheme 3 is best, as long as r is <1, while scheme 2 is best when r is >1; this

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conclusion is the same as that reached previously from the point of view of size of machines, and hence scheme 3 for $r<1$, and scheme 2 for $r>1$, is the best both from the point of view of minimum first cost and from that of minimum running cost.

The fact that efficiency is less than 100 per cent. affects the sizes of the machines composing the motor-generator. Let η be the efficiency of machine A always, and η' that of machine B always. The size of a machine depends on its output, whether it be a motor or a generator, and the sizes actually required are easily settled, bearing in mind that the output of a motor is its input multiplied by its efficiency, while the size of a motor to drive a generator is determined by the output of the generator divided by the efficiency of the generator. Thus, if I_m and O_m and η_m be the input and output and efficiency of a motor, and I_g and O_g and η_g those of a generator, then, since $I_g=O_m$,

$$O_g=\eta_g I_g=\eta_g O_m=\eta_g\eta_m I_m.$$

In any given scheme, the quantities actually specified will be V, V' and C', that is, the supply voltage, and the current required on the secondary side, as well as the voltage at which it is to be used. It will, therefore, be useful to express the size of the motor-generator in terms of $V'C'$. As long as efficiency was 100 per cent., it did not matter whether VC or $V'C'$ was used, as they were equal to each other, but now they are not.

In Fig. 1, where machine A is a motor and machine B is a generator,

$$\text{Output of machine } A=\frac{V'C'}{\eta'}.$$

$$\text{Output of machine } B=V'C'.$$

$$\text{Combined output } =\frac{1+\eta'}{\eta'}V'C', \quad \ldots\ldots (7)$$

and this is a measure of the total size of the motor-generator.

In Fig. 2, when r is <1, machine A is a generator, and machine B is a motor, with an input of $(V-V')C'$.

$$\text{Output of machine } A=\eta\eta'(V-V')C',$$
$$=\eta\eta'\frac{1}{r}(1-r)V'C'.$$

$$\text{Output of machine } B=\eta'\frac{1}{r}(1-r)V'C'.$$

$$\text{Combined output } =(1+\eta)\eta'\frac{1}{r}(1-r)V'C'. \quad (8a)$$

In Fig. 2, when r is >1, machine A is a motor, and machine B is a generator, with an output of $(V'-V)C'$.

$$\text{Output of machine } A=\frac{1}{\eta'}(V'-V)C',$$
$$=\frac{1}{\eta'}\cdot\frac{1}{r}(r-1)V'C'.$$

$$\text{Output of machine } B=\frac{1}{r}(r-1)V'C'.$$

$$\text{Combined output } =\frac{1+\eta'}{\eta'}\cdot\frac{1}{r}(r-1)V'C'. \quad (8b)$$

In Fig. 3, when r is <1, machine A is a generator and machine B is a motor, with an input of $(V-V')C$.

$$\text{Output of machine } A=\eta\eta'(V-V')C,$$
$$=\eta\eta'(1-r)VC$$
$$=\frac{\eta\eta'}{r(1-\eta\eta')+\eta\eta'}(1-r)V'C'$$

from what has gone before.

$$\text{Output of machine } B=\frac{\eta'}{r(1-\eta\eta')+\eta\eta'}(1-r)V'C'$$

$$\text{Combined output } =\frac{(1+\eta)\eta'}{r(1-\eta\eta')+\eta\eta'}(1-r)V'C' \quad (9a)$$

In Fig. 3, when r is >1, machine A is a motor, and machine B is a generator, with an output of $(V'-V)C$.

$$\text{Output of machine } A=\frac{1}{\eta'}(V'-V)C,$$
$$=\frac{1}{\eta'}(r-1)VC,$$
$$=\frac{\eta}{r(\eta\eta'-1)+1}(r-1)V'C'$$

from what has gone before.

$$\text{Output of machine } B=\frac{\eta\eta'}{r(\eta\eta'-1)+1}(r-1)V'C'.$$

$$\text{Combined output } =\frac{\eta(1+\eta')}{r(\eta\eta'-1)+1}(r-1)V'C'. \quad (9b)$$

These results are very slightly incorrect still, owing to field currents having been neglected. They become, when $\eta=\eta'=\eta\eta'=1{\cdot}00$, that is, when efficiency is 100 per cent.,

$$2V'C',$$
$$2\frac{1}{r}(\pm1\mp r)V'C',$$
$$2(\pm1\mp r)V'C',$$

which correspond to the expressions of equations (1) to (3), the factor 2 now appearing because the original equations dealt with the size of each machine when both were equal, whereas equations (7) to (9b) deal with the combined sizes. The reduction of efficiency from 100 per cent. to a lower figure in some cases increases, and in others diminishes, the size of the motor-generator. Equation (8a) is a clear case of a reduced size, due to the fact that while the input to machine B has not changed, the output of machine A is reduced, owing to machine B, as a motor, being no longer capable of driving as large a generator as before. The increased value of C makes up for the reduced value of C''. Again, equation (8b) is a clear case of an increased size, because the output of machine B is unaltered, and machine A will therefore need to be larger in order to drive machine B. Equation (7) also shows an increase, but the results from equations (9a) and (9b) are not so obvious, as r comes into the factor as well as η and η' when the latter are not each 100 per cent., and each case therefore is best considered specially for itself.

The general conclusion previously arrived at is not disturbed, namely, that when r is <1 the balancer scheme, shown in Fig. 3, is best, and when r is >1 the booster scheme, shown in Fig. 2, is best, provided always that, for reasons already discussed, one of these two schemes may actually be used instead of a motor-generator, as shown in Fig. 1, large enough to deal with the whole conversion, and having no electrical connection between its two parts.

An interesting special example is that of equation (9a), when $r=0{\cdot}50$, which is the well-known case of the ordinary rotary balancer for a continuous-current three-wire system. The motor-generator then has a reversible function, and the two machines are the same size, since either of them may be a motor or a generator.

The output of the motor is

$$\frac{\eta'}{0{\cdot}50(1-\eta\eta')+\eta\eta'}0{\cdot}50V'C',$$
$$=\frac{\eta'}{1+\eta\eta'}V'C'.$$

The output of the generator is

$$\frac{\eta\eta'}{1+\eta\eta'}V'C',$$

and C' is the current in the middle wire. The motor being the larger of the two machines, each of the two must be capable of doing the output of the motor, and the total amount of machinery required is

$$\frac{2\eta'}{1+\eta\eta'}V'C',$$

where η' is the efficiency of the machine which acts as a motor.

If the two efficiencies are approximately equal, as they are b und to be, the multiplier of $V'C'$ is approximately of the form

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$2x/(1+x^2)$, which is always less than unity, being zero when $\eta=\eta'=\eta\eta'=$zero, and unity when $\eta=\eta'=\eta\eta'=$unity. Thus each machine of a balancer has a rated output, as a motor, of approximately not more than half of $V'C'$, the out of balance load, and the size becomes less as the efficiency becomes less. The output $V'C'$ is in watts, and must be divided by 746 if it is desired to express the motor output in brake-horse-power. The overall efficiency of conversion is, as shown in equation (6a),

$$0{\cdot}50\ (1-\eta\eta')+\eta\eta'=0{\cdot}50\ (1+\eta\eta'),$$

and hence $$V'C'=0{\cdot}50(1+\eta\eta')VC,$$

or $$VC=\frac{2}{1+\eta\eta'}V'C'.$$

As this clearly increases when $\eta\eta'$ diminishes, it is evident that, while a low value of $\eta\eta'$ in a rotary balancer leads to a reduction in the required size of the machines, it subsequently leads to an increase in the running cost of the whole scheme, and is therefore to be avoided.

If the function of the set is not reversible, the two machines may be of different rated outputs, as shown in the relative equations; and the expressions given enable any scheme to be dealt with when V, V' and C' are given.

V.

When only one fixed value of V' is required, it may be possible to use a single machine with a double-wound armature, instead of two separate machines forming a motor-generator. The only disadvantage of this is that such a machine has not a fixed ratio of terminal voltages, owing to the internal lost volts, and has necessarily a drooping voltage characteristic from no-load to full-load on the generator side, leading to a slightly changing value of r, as the load changes. The motor-generator, on the other hand, can, by means of compound-wound fields, be made level-compounded, so as to give a fixed value of r at all loads.

The various systems which have been employed to give a great range of voltage, so as to obtain very large speed ranges in variable-speed motors, such as the Ward-Leonard, and other well-known schemes, are all applications in some way of the simple principles set down here. To consider these in detail would be impossible now; but if what has been written is clearly understood, an intelligent selection of machines may be made, giving the best all-round results in cost and efficiency, in any case which may come up for consideration in estimating or in designing.

The Electrical Equipment of Keadby Bridge.

A bridge over the Trent at Keadby, 14 miles north of Gainsborough, on the Great Central Railway, was opened in May, 1916. This bridge, of far more than ordinary interest, forming part of an elaborate deviation and widening scheme, is known technically as a "Combined Railway and Highway Scherzer Rolling Lift Bridge," and has replaced the old swing bridge, which carried the railway for nearly 60 years, whilst it also bears a public highway. Its most remarkable feature is the rolling-lift opening span, which weighs over 2,900 tons, and is the largest in Great Britain, if not in the world.

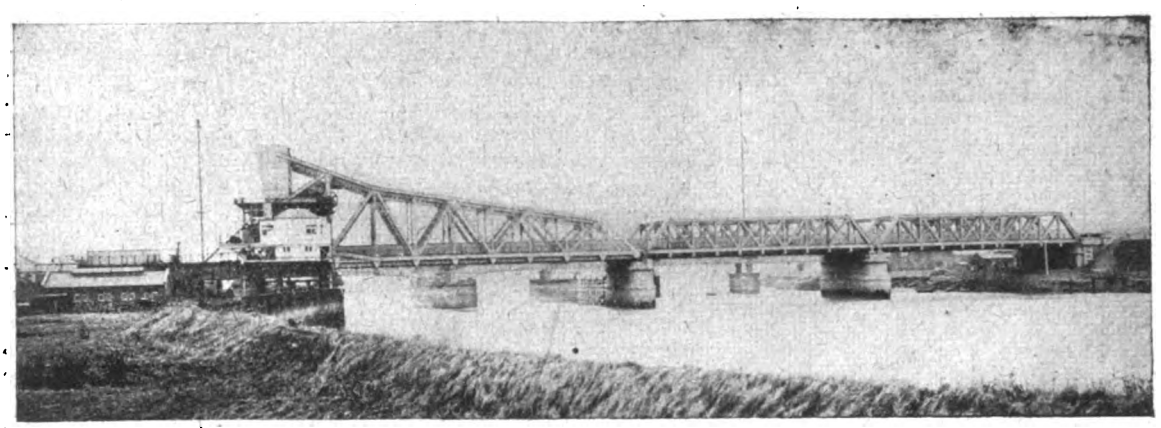

Fig. 1.—General View of Keadby Bridge from East Bank.

When the question of the improvement of the railway line first came under consideration there was a strong desire that the span of the new bridge should be very much greater than that of the old structure, and that ample facilities for traffic across the river should be provided. The Scherzer system recommended itself not only as a complete structure entirely suitable to the special needs of the situation, but for the ease with which it could be built without interference with the traffic on the Trent.

The old swing bridge provided two navigable channels, each 60 ft. in width, whereas the lifting span of the new bridge gives a clear waterway 150 ft. wide, equal to the two openings of the old bridge, including the central dolphin and piers. The roller-lift principle enabled the constructional steel work of the opening span to be built in a vertical position, leaving the river between the abutment and the pier in the river free for the passage of river craft.

The provision of a public roadway parallel to the railway, together with new road approaches on both sides of the river, constitutes an inestimable advantage to the public. The old bridge was a railway bridge pure and simple, and there were no facilities for the crossing of the river within a distance o 15 miles.

The new bridge, as shown in Fig. 1, consists of five spans of the following dimensions: Two fixed river spans of 135 ft. each; a lifting span of 160 ft., giving, as already mentioned, a clear waterway of 150 ft.; a track span of 40 ft., on which the lifting span rolls; and an approach span of 70 ft. on the east bank of the river. The bridge has a width of 53 ft. 6 in. between the centres of the outside girders, of which 29 ft. 3 in. is occupied by the railway and 24 ft. 3 in. by the roadway. Each span consists of three main girders, the central one dividing the roadway from the railway.

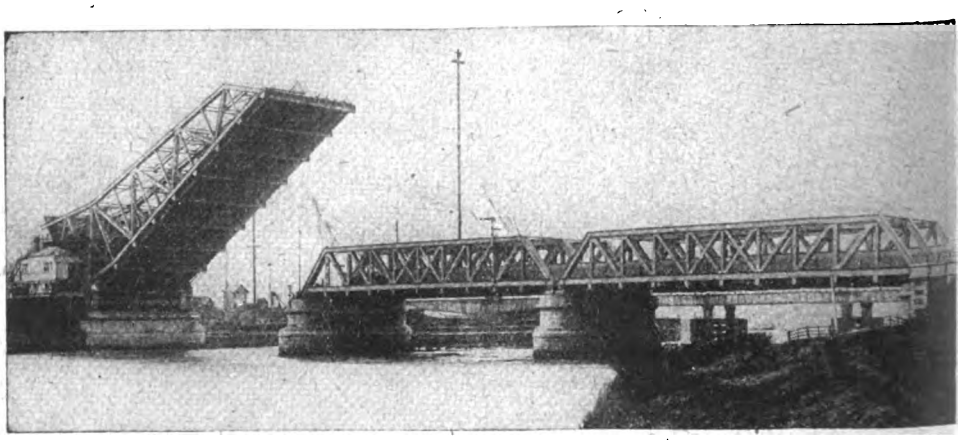

Fig. 2.—View of Bridge showing Roller Lift Span being Lowered.

The three main girders of the track span form a path on which the

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lifting span rolls, and together have to sustain the weight of the lifting span. The lifting span consists of three main trusses spaced at the same distance apart as the main girders in the fixed spans, and is counterweighted at the rear end in order to secure balance at all angles of lift. The counterweight consists of a rectangular steel shell extending across the full width of the bridge (*see* Fig. 3), and is heavily braced internally by lattice frames and strengthening girders. Its internal capacity is 24,780 cubic ft., and it contains 1,800 tons of concrete.

On either side of the lifting span heavy frames are built up alongside the track girders and anchored down to the supporting piers of the bridge. At their upper extremity these frames carry horizontal girders, to which are bolted the main operating tracks. The clearance between these frames allows the span to move freely as the bridge is raised or lowered.

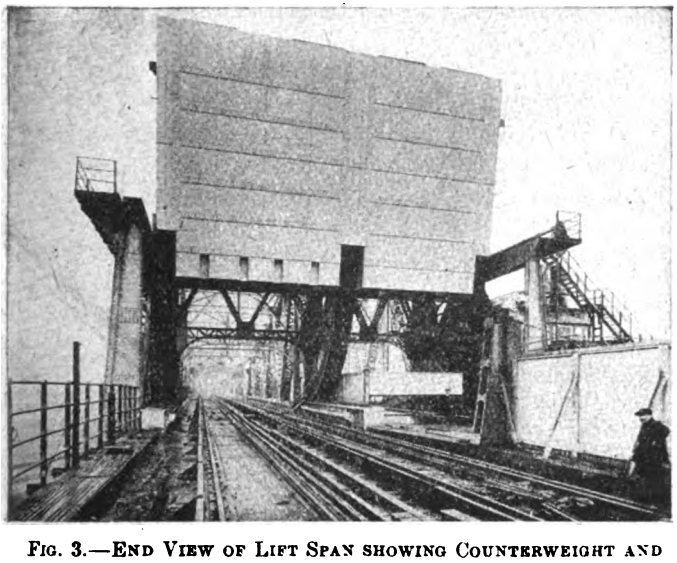

Fig. 3.—End View of Lift Span showing Counterweight and Roller Paths.

The position of the racks coincides with the centre of the rolling circle, of which the segmental girders form part, and the rotation of the pinions attached to the gudgeon pins of the moving leaf, as they travel horizontally along the racks, rolls the leaf backwards or forwards, so opening or closing the bridge. A horizontal platform at the level of the fixed racks is constructed on the leaf itself, and on this platform the lifting machinery is accommodated.

(*To be concluded.*)

The Labour Outlook.*

(BY OUR LABOUR CORRESPONDENT.)

Peace is now in the air. The Labour Peace Programme has been forced well into the public mind, though there is another aspect of the question on which the industrial labour movement has strong views which are not nearly so well known; but recent events to which I shall allude later are bringing this aspect within the range of public attention. I refer to international labour agreements.

It has long been an argument used by employers against the trade unions when the latter were pressing new demands, that if they were granted British industry would not be able to meet foreign competition, as foreign goods were produced under less favourable labour conditions than British goods. There is a certain truth in this point of view, though there are two factors of importance to be taken into account. First, there is the question of the extent to which high wages and good conditions affect the efficiency of production, that is, what is called the economy of high wages, and secondly, it must be remembered that foreign conditions are not static. With the growth of trade unionism abroad, pressure is being put increasingly on employers in other countries to improve conditions. It is clear that international standards, however remote their complete adoption may be, must become more and more important in the future. In the years before the War the International Association for Labour Legislation was engaged in securing international agreements on labour questions. Two subjects dealt with by the Association and for which they obtained the support of a number of Governments, were the use of phosphorus in the manufacture of matches and the prohibition of night work amongst women. Many trade unions in this country were associated with trade unions in other countries in international federations, *e.g.*, the mines, the transport workers, the textile operatives, with a view to international co-operation for the attainment of common ends. But prior to the War these movements were really in their infancy.

At the recent Inter-Allied Socialist and Labour Conference in London, Mr. Samuél Gompers, speaking for the American Labour movement, laid it down that hours of labour and working conditions should form part of the peace programme, and that these matters should be considered as part of the peace negotiations. This proposal was accepted by the Conference. The new German Imperial Chancellor has made the same suggestions, apparently in order to meet the wishes of the German trade unionists and Social Democrats. "At the peace negotiations," he said, "the German Government will use its efforts to the ends that the treaties shall contain provisions concerning the protection of labour and the insurance of labourers, which provisions shall oblige the treaty-making States to institute in their respective lands within a prescribed time a minimum of similar, or at least equally efficient, institutions for the security of life and health as well as for the care of labourers in case of illness, accident or invalidity." Viscount Grey of Fallodon in his speech last week on the League of Nations referred to the possibility that a League might do "a great deal with regard to Labour" by providing an official channel for the discussion of common industrial problems.

It is probable that Labour opinion will ripen rapidly in favour of an attempt to arrive at international agreement at the peace congress on some of the larger questions intimately affecting the workers, and of the regular consideration of them by the League of Nations.

There are two important aspects of the post-war situation which must be borne in mind in this connection. In the first place the trade unions in this country are determined to obtain conditions superior to those existing before the war. How far they can be granted is, of course, a matter for argument. But there can be no doubt that so far as the fear of foreign competition is concerned, the imposition of certain elementary international labour standards will deprive this argument of much of its force. Secondly, there appears to be little doubt that after the war greater use will be made of the labour of coloured peoples, whose economic standards are much lower than those of the white peoples of the West.

Employers of labour in this country must surely in their own interest support the establishment of international labour standards. The real competition in the world of the future must rest upon efficiency of methods, machinery and organisation, and not upon the short-sighted and factitious advantages to be obtained from sweated labour, low wages and bad conditions. It is in the interest of both employer and employed that the inferior standards of many foreign countries should be raised and both should unite to press upon the Government's attention the importance of taking the economic side of the peace into immediate consideration. It is too much to hope that in the near future any real universal standards will be adopted, which will directly affect the standards already obtaining among progressive peoples. But much may be done to prevent the exploitation of coloured races, and in the direction of exterminating the worst evils of sweating and unhealthy conditions of labour. Industrial Councils, Interim Industrial Reconstruction Committees and other joint bodies could do a useful work by turning their minds to this subject. It raises questions of considerable difficulty and complexity. But they should not daunt the industrial world.

* We do not necessarily endorse the views expressed by our Correspondent.—Ed. *E.*

Houses of Ligno-Concrete.—In view of the urgent demands in the way of building that are likely to arise immediately after the war, especially the construction of small houses and cottages in this country, some interest attaches to experiments made in Germany with a new composition termed "ligno-concrete." At present this is being used mainly as a means of economy, but it may prove useful in the future. To produce ligno-concrete, wood that is of little value in itself for building, such as small waste-ends, unseasoned pieces, &c., are completely buried in concrete, and for the latter cheap materials, such as blast-furnace slag and cinders, are used. Inner partition walls and roofs are made of this material, but for the latter small meshed wire netting is also employed on the underside and the concrete is somewhat stronger. Houses so constructed are said to be clean and healthy, and are specially suitable as dwellings for agricultural labourers. Most of the work can be executed by unskilled labour.

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The British Designer of Yesterday.

We suppose that few will cavil at the statement that the designer who really designs is a man of no mean importance. In the present article we refer more particularly to the designer of electrical machinery, although this is equally true of all engineering work. The designer is important because progress very largely depends upon his efforts, at least in so far as the improvement of any type of plant is concerned, although not necessarily the creation of new types. The latter work may be rather that of the inventor who strikes out into new lines. It falls, however, to the lot of the designer to reduce losses, to put material to the best use, and, therefore, to cheapen the product so that the factory may maintain a good output against competition. Further, he should develop designs so as to overcome difficulties encountered in practice; he should introduce improved methods of construction; he must determine empirical constants, keep in touch with modern practice, and generally maintain the efficiency of his products and of himself—all of which constitute a programme demanding much more time than the official working hours. The position of the designer is really one of great responsibility, for a faulty design may mean a serious loss to his employer, not merely immediate, but also consequential, and great inconvenience to the public.

In one respect British design has not been given the support to which it was entitled, quite apart from questions of the individual designer. We refer to the habit of the British purchaser in refusing to place orders except with firms who have already manufactured plant of the size required. Refusal to place an order for, say, a 5,000 kw. alternator with a firm who has hitherto only made dynamos up to 50 kw. is natural, and is only a reasonable precaution; but this policy has been carried much beyond this elementary example, and has made it very difficult for British designers to develop large plant, and thus the designer himself has suffered in what may be termed his own technical development.

Seeing the important part that is played by the designer, what do we find in regard to his position? In making this inquiry we must look at the matter from the position of £ s. d., which is the only ultimate criterion by which services can be judged. In doing so we find (taking pre-war conditions) that the designer starts at what may be considered a low wage, such as 20s. or 30s. per week. This is after an expensive education and after very possibly two years' experience in a works. Yet a low starting wage may be more or less inevitable, from the fact that the would-be designer has much to learn; for no college course, however complete, can or ought to supply practical needs in this direction. It happens frequently, for example, that the methods of design which have been acquired by the aspiring designer are by no means those that are followed by the works in which he finds himself; whilst a considerable time is needed for a newcomer to adapt himself to the routine of the office, to familiarise himself with the firm's standards, and, above all, to learn the art of avoiding mistakes in his calculations. Consequently a somewhat low wage to start with is not altogether unreasonable. Nevertheless, under these circumstances we might expect that either the rise would be rapid or that there would at least be a long ladder to climb. Unfortunately, this has not been by any means the case. On the contrary, the rise, as far as we are aware, has invariably been slow, and a salary of £2 to £3 per week has been looked upon as something quite considerable for an assistant designer. And, what is still worse, the ladder is short.

But there was another unfortunate factor which used to await the young designer, and of which he was wholly ignorant at the start. Speaking of pre-war days, this new fact was the desirability of German birth, or of German or American experience. In other words, many of our leading designers were German or American, with the inevitable result that they favoured those who were German or American, or happened to have a corresponding experience. And yet it is well known that many of the most serious blunders in this country have been due to foreign designs. This love for the German designer was akin to the popular demand for the German musician, which became so marked that in pre-war days no mere English performer stood half a chance against a German competitor. The conductor of one of our provincial orchestras was so impressed with this mental attitude that he changed his good old English name to that of Hindenburg; but some two years ago he found his namesake too illustrious, and returned to the name of his fathers. Electrical engineers are well known to be musically inclined, and so, perhaps, there was some reason to follow the example of the musical world.

This aspect we hope has now changed, but, even where such competition was absent, what was the outlook for the assistant designer? In due course he might become assistant to the chief designer, very possibly at £300 per annum, or a chief designer at £500, which by no means could be regarded as adequate for the services rendered and for the responsibility that fell upon him.

We can imagine the board of directors of a company, with a turnover of, say, £100,000 per annum, and faced with German competition, deliberating as to whether the chief designer was worth so much as £500 a year, and whether his request for a rise of £50 could be considered in the face of competition which rendered it so necessary to practice economy in all directions, except in that of directors' fees. True enough, even £100 a year was only one-tenth of 1 per cent. of the turnover, but why should the designer (who, after all, was not nearly so important as the salesman) be paid more than £500 per annum when other men were willing to work for this salary? It was evident that the work would be done no better on £600 a year than on £500; therefore, why diminish the profits? And so our hypothetical board, while expressing full appreciation of the loyal and able work of Mr. X.Y.Z., and of his designs which required so little alteration to their patterns, regretted they did not see their way under the stress of increasing competition to raise his salary.

And under these conditions the designer of yesterday did his best to uphold the standard of British quality. Is it surprising that our progress was not always what it might have been; or that many of our leading designers, well known for their technical work, should resign their posts in order to get out of the rut?

In another article we shall deal with the Designer of To-morrow.

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A Thermo-Electric Standard Cell.*

By C. A. HOXIE.

Standard cells of the Clark or Weston type will not function at freezing or boiling point temperatures, and are easily damaged if an appreciable current is drawn, as by accidental short-circuiting. The "Thermal" cell now described is not, strictly speaking, a primary standard or source of E.M.F. but is free from the above drawbacks, and may be classed as a secondary standard, either of current or E.M.F. The standard thermal cell in its present form consists of a glass bulb containing a thermo junction T (*see* Fig. 1) a heating filament H, which is not in contact with the junction, the balancing resistance R and the drop resistance R_1. These are mounted in a case with binding post connections on the top. If a battery and galvanometer are connected as shown in Fig. 1, and the

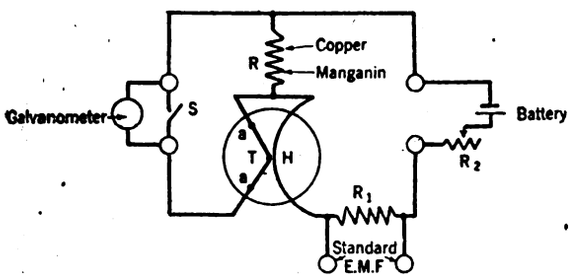

Fig. 1.—Diagram of Standard Thermo-Cell Circuit.

T = Thermo junction. R = Balancing resistance.
H = Heating filament. R_1 = Drop resistance.
a = Cold end. R_2 = Rhe ostat.
s = Galvanometer short-circuiting switch.

current adjusted to a critical value the galvanometer will indicate a balance, for the reason indicated in Fig. 2, where the curve a represents the drop of potential across the balancing resistance R as a function of the current through the heater H. The curve b shows variation of the thermal E.M.F. of the junction with the current through the heating filament. These curves indicate that the thermal E.M.F. is approximately proportional to the second power of the current through the heater, while the drop across the resistance R varies directly. The point of intersection C is that point at which the thermal E.M.F. equals the drop of potential across the balancing resistance. By adjusting the current through the heating filament to this critical value we can obtain a definite potential drop across the resistance R_1. The maximum current that can be used

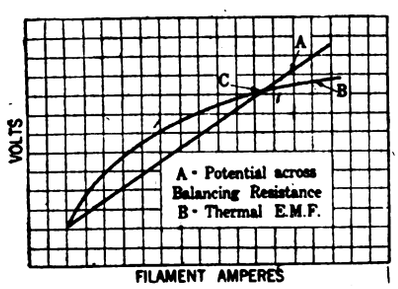

Fig. 2.—Curves showing Relation between Potential Drop Across Balancing Resistance and the E.M.F. Generated at the Thermo Junction.

without affecting the constancy of the cell, is that which will bring the filament to a dull red heat, but it is generally maintained somewhat below this value to prevent damaging the cell due to an accidental increase. The adjustment to the critical balancing current is secured by means of a rheostat in the battery circuit Since the drop and balancing resistances are constructed of wire which has a negligible temperature coefficient, any change in the potential across the drop resistance must be due to a variation of the thermal E.M.F. The cell has no measurable temperature coefficient at balancing point. If adjusted to any smaller value of current a negative coefficient results. This is due to the fact that up to a certain point, a rise in the surrounding temperature increases the thermal E.M.F. of the couple for a given difference in temperature between the cold and hot ends. Apparently this critical point is reached when the filament attains a dull red heat

* Abstract of a Paper in the "Proceedings" of the American Institute of Electrica lEngineers.

Considerable experimental work was necessary to determine the proper construction of the various parts of the thermal cell. The heating filament and junction wires are kept under tension in order to maintain a constant position with respect to each other The heater wire should be of small diameter and of a material having a high resistance and capable of withstanding considerable strain when heated to a cherry red. Tungsten wire 0·07 mm. in diameter was found to meet these requirements, and gave the proper temperature with a current of about 40 milliamperes. A heater wire of larger diameter does not remain constant. A heating filament 1 cm. in length with a resistance of 12 ohms gives good results. The couple wires should also have as small diameter as possible. Nitrogen gas under a pressure of about 2 cm. permits the operation of the cell in any position and a transfer of heat sufficient to produce the required E.M.F. After the bulb has been assembled, the current is passed through the filament, raising its temperature to a point considerably beyond the final operating value. This ages the filament and increases the permanency of the cell. Any lag in the temperature of he balancing coil with respect to that of the heater and the couple wires is prevented by spiralled connections from the bulb to the binding posts on the top of the cell. The heat conducting path is thus lengthened, so that changes in the surrounding temperature have a uniform effect on all parts of the cell.

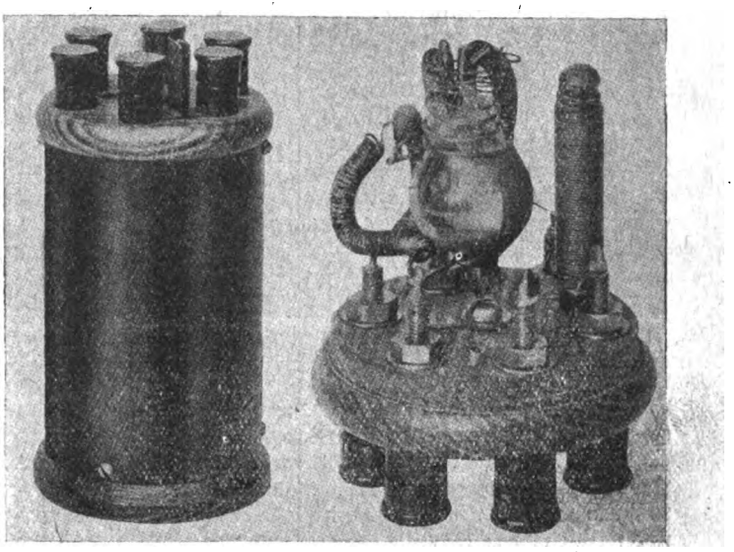

Fig. 3.—General Appearance of Cell.

Fig. 4.—Showing Assembly of Parts of Thermo-electric Standard Cell.

The characteristics of the cell may be summarised as follows :—

The E.M.F. obtainable is not limited, and the potential across it can have any desired value, usually 1 volt. Any combination of E.M.F. values may be obtained by taking taps from the drop resistance.

Temperature Coefficient.—The temperature coefficient may be reduced to zero.

Effect of Temperature.—The surrounding temperature may vary from values below 0°C. to over 100°C. without the slightest injury to the cell, as no liquid is used in its construction.

Effect of Short-circuit on Cell.—When these cells are properly constructed they cannot be damaged by short-circuiting any of the external connections.

Accidental Increase of Filament Current.—An excessive current through the filament may change the standard value of E.M.F., but will not necessarily destroy the usefulness of the cell.

Position of Cell.—The position of the cell does not affect the value of the standard E.M.F.

Strength.—The cells are portable, will stand severe shocks without injury, and can be easily shipped if ordinary precautions are taken in packing.

Accuracy.—Since a null method is employed in balancing the cell, the observation error will be a minimum. The principle sources of error are the temperature coefficient of the cell and thermal E.M.F.s other than the E.M.F. generated at the junction, but a standard thermo cell that is properly constructed and operated should remain

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constant to at least 5 parts in 10,000. These tests cover a period of 14 to 23 months, and indicate variations well within the above limits.

In conclusion, the characteristics of the standard thermo cell justify its use in many measurements in which standard cells are now required. This cell has been successfully used with potentiometers designed for thermocouple work. During the past year several such potentiometers have been in constant use, operated by unskilled labour, and no trouble has been experienced that could be charged to the standard cell.

Correspondence.

PATENT LAW REFORM.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Apropos of the criticism of the two proposed new Bills—*i.e.*, the Trade Marks Bill and the Patents and Designs Bill, "1917"—towards the end of last year and during the present year, it may be interesting to your readers to know that these Bills have now been withdrawn and are dead.

As the result of the question being raised, conferences were held in the larger cities of the kingdom which culminated in the formation of a General Committee in London, which ultimately adopted a comprehensive report drawn up by the Institution of Electrical Engineers for presentation to the President of the Board of Trade. By arrangement a large and influential deputation, consisting of doctors of science, inventors, electricians, patent experts, and representatives of technical and scientific societies and of some of the principal progressive industries in this country, was formed and appointed to wait upon Sir Albert Stanley to place before him its views on the imperfections of our patent system and the grievances under which inventors in this country suffered.

It was ultimately settled that Sir Albert Stanley would receive the deputation last Thursday, the 10th inst.; it was rather unfortunate, however, that though the meeting had been arranged for with Sir Albert a considerable time ahead, and even after the day and hour had been fixed and confirmed, the time of meeting was put back one hour at Sir Albert's request by telephone, he (Sir Albert) was not present, but sent a deputy in his place, much to the regret of the deputation, many of whom had come so far to lay their views before the right honourable gentleman on a matter so important to "the commerce and industry of the country after the war," upon which Sir Albert had been lecturing lately throughout the United Kingdom.

Some of us, old enough to remember being present in the same room in 1883, when the late Mr. Joseph Chamberlain, as President of the Board of Trade, met a somewhat similar deputation, and eloquently spoke to us on the benefits of invention and its encouragement, and just before introducing his own revolutionary Patent Bill of 1883, could not very well help comparing our reception *then* and *now*, with so much more at stake in competition after the war.

Anyone who knew the late Mr. Chamberlain, with his proud, imperial and patriotic spirit, and who magnified every public office he ever held, could scarcely conceive his delegation of the reception of any such representative deputation to a deputy. Apart from that, however, the deputation were led inferentially from the chair to understand that no new Bills had yet been drafted, while the various speakers of the deputation urged with considerable force an automatic moratorium or prolongation of patents to meet war conditions, the protection of inventions relating to food, medicinal or surgical products, the importance of product claims to chemical and other industries, the extension of (*a*) the term of patents, (*b*) the period of provisional protection, (*c*) the period of acceptance of the complete specification, the reduction of patent fees, the protection of patentees in relation to utilisation of their inventions by the State, the limitation of provisions for revocation of patents, the abolition of the compulsory working of patents, which principally benefited foreigners, and especially Germans, the safeguarding of patents of addition, the formation of a special tribunal to deal with patent cases, and the adoption if possible of a British Empire patent system. In regard to the latter, Sir Robert Hadfield graphically pointed out the absurdity of the present Canadian patent system (part of which system was incorporated in the proposed Bill of last year) under which he found he had to pay the sum of eight guineas for a type-written copy of a Canadian specification, while the British printed specification of same only cost here some 2½d. As regards the moratorium, patentees do not want any one-sided favours, but they desire justice. In my own knowledge there are patents for apparatus, say, for street and other lighting, &c., on which renewal fees are being regularly paid, which have been turned into dead letters by the Government war restrictions, and surely it is only fair that an extension of time should be given these in the proposed new Bill. Then, as to the necessity for compulsory working clauses, why should these be required here any more than in the United States, unless to prevent us getting so good terms from other countries as the Americans get, because they have no compulsory working under their more perfect patent system? Unquestionably, our principal competitors after the war (Germany, let us hope, being barred) will be our American friends, and it is very desirable in the interests of invention, commerce and industry in this country, that we should have equal opportunities with our American Allies, to say the least. We were promised by the Board of Trade representative that all these various matters would receive the earnest consideration in the preparation of the new Bill, but, to my mind—the end of the war being now at least in sight—the question comes to be, would it not be better now to wait till the war is over, and then, if possible, to secure a new Bill on American lines, formed on democratic principles to suit our conditions for the whole British Empire, in order that Britishers here and throughout the Dominions could have an opportunity of holding our own in the race for the coming world's business?—I am, &c.,

Leigh-on-Sea, Oct. 12. James Keith.

"THE DISABLED SOLDIER."

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to your very pertinent article in your issue of the 4th inst. under the above heading, a letter which I recently received from the Ministry of Pensions may be of interest in this connection.

The Minister, who is appealing to public utility corporations, wrote that he was desirous, in anticipation of demobilisation and the re-settlement of labour, to make special provision for the re-employment of men discharged as disabled from naval, military and air service. He enclosed with his letter a memorandum giving the nature of the scheme which he had in view, and in order to assist the Ministry in its praiseworthy object we sent round copies of the memorandum to our member-companies.

The memorandum is too long to quote here, but I have no doubt the Ministry of Pensions would be pleased to send a copy to anyone writing them, or I would do so.—I am, &c.,

T. W. Cole, Secretary,
The Provincial Electric Supply Committee of Great Britain.

Moorgate Court, Moorgate-place, E.C., Oct. 12.

A FEW ADVANTAGES OF INDUSTRIAL COMBINATION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: May I, through the medium of your columns, be allowed to make a few remarks in regard to some of the very obvious advantages of syndication in the brass industry. The economies to be derived from a closely knit and well organised combination of a large number of firms, in point of number probably outstrips those to be secured by a like effort in any other field of industrial endeavour. I will, however, only deal with those economies falling under various main headings, as the serious reader will no doubt easily elaborate them into dozens of different minor channels.

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Commencing with the beginning of operations, there is *Economical Purchase of Raw Materials* in bulk, as against the petty-fogging little parcels bought by the hundreds of different firms to-day, and coupled with this, there is the important consideration of being able to take fuller advantages of the market fluctuations. This, of course, not only refers to our metals, but also chemicals used in processes and other things such as small tools, files, drills, taps, &c., which would be purchased far cheaper in bulk.

Unnecessary Duplication of Plant, as specific types of machines would be peculiar to certain factories only, and would be kept running and in work practically all the time, whereas at present, each factory employs many and varied types, in order to be in a position to cope with various classes of product, which results in many of the machines being idle for nine months out of the year.

Simplification in Details of Manufacture in each works, due to specialising in a few articles instead of ones energy being spread over a large number.

The accumulated experience and brain power of all being directed to every department of each factory under the control of the combine, or, in other words, the advantage of the application to each firm of the combined experience and knowledge of the whole.

Reduction of management expenses not only in administrative positions, but in all subsequent executive positions, because of simplification of processes and reduction of detail, thereby permitting greater output for each unit of energy expended in every department.

The application of science to all processes in the factory is easily possible when a firm is concerned with huge quantities of a small variety of products. This is impossible, on account of prohibitive cost, when each plant is turning out only small quantities of a huge variety of patterns.

Reduction of office machinery and staff due to simplification of all details of its work.

Considerable saving of banking expenses due to a method of centralised book-keeping and few instead of many banking accounts.

Credit and finance. It naturally follows this will flow more readily to a large prosperous amalgamation of firms comprising the main part of a single industry, than to individual firms in their present unorganised and insecure state.

Scientific distribution and reduction of all selling effort to a minimum as compared to the present, where a dozen salesmen may be selling the same lines to the same buyers in the same month.

Rebates and reductions in freight and transport, which could no doubt be negotiated with the principal railway and steamship companies, as the syndicate would negotiate in tons where the individual firms would only deal in hundredweights.

Elimination of competition, not by the oppressive and immoral use of the weight of capital, but by methods of efficiency and superior organisation. This would overcome the senseless war of price cutting that exists to-day with "the man in the next street," which, whilst bringing profit down to the lowest ebb does not cheapen the product, but rather debases it, robbing it of that element of quality and finish we often desire, but rarely see in the industry.

Export economies, comprising first-class representation in all markets, instead of inferior representation in a few markets. The poor efforts that are made at present in mostly all markets by agents and representatives knowing nothing about the trade, and probably caring less, whilst they can hold other agencies which, in the nature of things, are more profitable, is because of the unorganised state of the industry at home, and is not the agent's fault in any way. He finds he meets so many competitors all trying to sell the same lines that when the business available is divided up amongst them, it is not worth seeking, and, therefore, he is content to use the agency as a sort of "fill gap" when things are slow. Reduction of selling costs would be possible, as a combination would create and build up a sales organisation which would adequately cover every market of the world at less cost than the few principal ones are being covered at present.

In conclusion, the size of the syndicate and its various ramifications would be such as would ensure to it the first offer of all new inventions, improvements in processes, &c., as well as the absorption of the best type of worker—men at the summit of their own particular sphere of work, whilst as regards profits, a combination can keep for itself for a longer period than can individual firms, those savings which are effected by the aforementioned new inventions and improvements in processes instead of having to immediately hand them over to customers, as is necessary when competitors are closely following on one's heels.—I am, &c.,

Birmingham, Oct. 11. HOWARD F. SMITH.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 SPECIFICATIONS.

118,864 WESTERN ELECTRIC CO. & POLINKOWSKY. Call distributing systems for telephone exchanges. (13/7/17.)
118,878 ROSS. Electrical resistances. (7/9/17.)
118,880 PARSONS & LAW. Dynamo-electric machines. (10/9/17.)
118,836 STONE & CO. & DARKER. Brush and terminal contact mechanism of dynamo-electric machines. (13/9/17.)
118,889 STEVENS. Automatic telephone sub-station mechanism. (14/9/17.)
109,815 WESTERN ELECTRIC CO. Telephone exchange systems. (22/9/16.)
118,902 BEAVER, RICHARDS & CLAREMONT. Detective and protective device for electric cables. (22/9/17.)
118,928 CARETTA. Electrically-heated soldering iron. (19/10/17.)
116,256 SMITH. Electric storage batteries. (17/5/17.)
112,441 AKTIEBOLAGET LJUNGSTROMS ANGTURBIN. Rotary field magnets. (19/12/16.)
118,984 FAWSSETT & PARRY. Electrical relays. (21/2/18.)
118,992 SMYTH. Apparatus for therapeutic treatment by means of electric and other forms of radiant energy. (15/3/18.)
118,994 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Electric motor controllers. (15/3/18.)
119,016 B.T.-H. CO. (G.E. Co.) Means for controlling electric circuits. (1/6/18.)
119,017 STOKES. Interlocking plug switches for electric circuits. (1/6/18.)
119,018 KILBURN. (Norse Aktieselskab for Elektrokemisk Industri, Norsk Industri Hypotekbank.) Manufacture of carbon electrodes. (9/1/18, divided application on 551/18.)

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

September 2, 1918.

14,213 ENGELKE & WRENCH. Arc lamps.
14,221 REYROLLE & CO., CLOTHIER & GREGORY. Switchgear.
14,223 DRYSDALE. Alternating-current relays.
14,228 HINTON. Determining electrical characteristics of high-frequency oscillation circuits.
14,235 BIBBY. Electric arc furnaces.
14,239 REMY ELECTRIC CO. Electromagnetic speed-controlling device. (1/9/17, U.S.)
14,242 AKT. GES. BROWN, BOVERI & CIE. Safety device of tanks of transformers &c. (1/9/17, Germany.)
14,264 LEONARD. Electric welding.

September 3, 1918.

14,284 RUTHERFORD. Lamp and switch holder.
14,301 BURTON & ATTLEY. Electrical warp stop motion for looms.
14,315 B.T.-H. CO. & POLLOCK. Dynamo-electric machines.
14,322 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Welding controllers.
14,328 HIGGS. Incandescent lamps.

September 4, 1918.

14,350 POOLE. Electromagnetic separator.
14,362 SCHATTNER & BARBOUR & WALTON. Electric motor control gear.
14,372 KAYSER & MACDONALD. Improving conductivity at joints of electrodes.
14,397 BETULANDER. Electric relay mechanism. (4/9/17, Sweden.)

September 5, 1918.

14,448 LANE & WINGATE. Electric light and heat fittings.
14,451 IGRANIC ELECTRIC CO. (Cutler Hammer Mfg. Co.) Lock-out switches.
14,454 TELEGRAPH CONSTRUCTION & MAINTENANCE CO. Apparatus for measuring distances.
14,458 LATOUR. Telephone Apparatus. (5/9/17, France.)

September 6, 1918.

14,505 JENSEN & TILNEY. Magneto-electric generating machine for lighting vehicles, &c.
14,510 COULSON. Arc lamps.
14,523 SPLITDORF ELECTRICAL CO. Adjustable interrupters for ignition dynamos. (16/5/16, U.S.)
14,530 PEARSON & WHITE. Accumulators.

September 7, 1918.

14,559 SHILLITO. Direct-current dynamo-electric machines.
14,567 B. T.-H. CO. (G.E. Co.) Signalling apparatus.
14,574 VANDERVELL & CO. & MIDGLEY. Electric ignition devices.

September 9, 1918.

14,612 STARR. Controlling torpedoes or boats by wireless.
14,619 CROSS. (Hulfish.) Automatic switches, circuit systems, &c.
14,646 SPLITDORF ELECTRICAL CO. Ignition mechanism. (2/1/18, U.S.)

September 10, 1918.

14,680 LOTHERMO PATENTS, GREENHALGH & LONGBOTTOM. Dynamo-electric machinery.
14,703 CASE. Signalling systems.
14,704 CASE. Variable resistances.
14,705 CASE. Light reactive resistance elements.
14,715 TOWER. Electrical system for generating intermittent high-tension impulses for ignition purposes.
14,721 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Steam condensers. (19/9/17, U.S.)
4,731 RAWLINGS. Electric arc striking devices.

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September 11, 1918.

14,738 Colson. Terminal fittings of lamp-holders.
14,767 Wheeler. Securing shades to lamp-holders.
14,778 B. T.-H. Co. (G. E. Co.) Wireless signalling.
14,795 Tocchis. Electrical transmission of voices and music.
14,806 Lander. Electrical switches.
14,807 Lander. Electrical generating machines.

September 12, 1918.

14,815 Morris (H.) (Ltd.), Robertson & Weston. Electrically-operated pulley blocks, &c.
14,851 Price. Instruments for testing batteries, &c.
14,856 Bjerknes. Wattmeters.
14,857 Boorne. Electrodes for arc welding.
14,859 Fuller Accumulator Co. & Jones. Electrodes for primary and secondary batteries.
14,861 B.T.-H. Co. (G.E. Co.) Electric motor control systems.

September 13, 1918.

14,917 B.T.-H. Co. (G.E. Co.) Temperature indicators for transformers, &c.
14,932 Waters. Current-regulating apparatus. (3 7 18, U.S.)
14,943 & 14,944 Bradley. Electrical treatment of gases. (21 6/16, U.S.)
14,947 Bradley. Electrical treatment of gases. (21 6 16, U.S.)

September 14, 1918.

14,965 Angold, Railing & Solomon. Electro-magnetic control of electric arcs.
14,984 Hamer. Direct conversion of basic or heat energy in fluids into electrical energy.
14,987 Western Electric Co. Power modulators for radio-transmission.

September 16, 1918.

15,009 Pulford. Electric igniting devices.
15,042 B.T.-H. Co. (G.E. Co.) Temperature indicators for transformers, &c.
15,045 Damey. Electric switch.
15,049 McKay & Pollock. Arc welding.
15,052 M.L. Magneto Synd. Ignition magnetos.

September 17, 1918.

15,073 Higgs & Rayner. Alternating-current motors.
15,093 Muir. Means of generating electricity.
15,094 Grafton. Electric signalling telegraph.
15,102 Poyner. Converting sea and river tides into continuous power for generating electric current, &c.
15,104 Sepulchre. Production of undamped oscillations for wireless telegraphy.
15,124 Fabrique des Longines Francillon & Co. Meters for alternating current. (17/9/17.)

September 18, 1918.

15,153 Aldred. Dynamic electric machines and motors.
15,187 B.T.-H. Co. & Hastings. Electromagnetic switches.
15,188 B.T.H.-Co. (G.E. Co.) Electric heating devices.
15,197 Withers. (Cox.) Electromagnetic recording apparatus for telegraph circuits.

September 19, 1918.

15,214 Woodland. Electric power supply systems.
15,228 Aktieselskabet Mekano & Schepeler. Switch for closing electric circuit for certain period.
15,230 Osram-Robertson Lamp Works & Chelcoti. Making sealed joint between wall of vitreous material and electric conductor which passes therethrough.
15,235 Barr & Stroud. Electrical apparatus for transmitting motion step by step to receiver.
15,243 Elnegaard & Sorensen. Electrical boring machine.
15,250 B.T.-H. Co. (G.E. Co.) Welded joints.
15,261 Henricksen. Combined push button and automatic switch.

September 20, 1918.

15,277 Hart Accumulator Co. & Clark. Accumulators.
15,280 Lewis. Control gear for motors.
15,299 Gerrard & Partridge. Magnetic devices for detection of submerged objects or firing of mines.
15,301 Lonides. Detection of conducting bodies submerged in electrolyte.
15,302 Fawcett & Hoyle. Electric furnaces.
15,306 Harding & Joseph. Detachably connecting conductors to terminals of magnetos, &c.
15,320 B.T.-H. Co. (G.E. Co.) Electric furnaces.
15,345 Boving & Bibby. Electric blast furnaces.
15,346 Western Electric Co. Telephone transmitters.

September 21, 1918.

15,353 Belcher. Holders for incandescent electric lamps.
15,367 Fletcher. Electrically heated warming or cooking plates of enclosed type.
15,375 Automatic Telephone Mfg. Co., Wade & Savin. Telephone switching apparatus.
15,398 Hall. Coin-collecting means for telephone services.
15,402 Low. Electrical apparatus.

September 23, 1918.

15,140 Woodman. Pocket flash-lamps.
15,433 B. T.-H. Co. & Hastings. Electromagnetic switches.
15,434 Automatic Telephone Mfg. Co. Automatic telephone systems. (4/2/18, U.S.)
15,457 Hearn. Switches.
15,461 B. T.-H. Co. (G. E. Co.) Electric contactors.
15,462 B. T.-H. Co. & Wedmore. Disposition of conductors in distribution systems.

September 24, 1918.

15,500 B. T.-H. Co. (G. E. Co.) Alternating-current motors.
15,508 G. Kent, Ltd., & Avery. Field magnets of dynamos and motors.
15,523 Westinghouse Lamp Co. Treatment of filaments for incandescent lamps. (15/10/17, U.S.)
15,529 Remy Electric Co. Ignition apparatus. (19/9/17, U.S.)

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.

Orders for the Week.

Captain of the Week.—Capt. E. G. Fleming.

Next for Duty.—Capt. W. Hynam.

Sunday, Oct. 20.—Annual Musketry Course at Pirbright. Parade Waterloo Station 8.45 a.m. Drill Order with Rifles. Mid-day and tea rations to be carried.

Monday, Oct. 21, to Saturday, Oct. 26.—Drills as usual.

Sunday, Oct. 27.—Commandant's Parade at Waterloo Station 8.45 a.m. for work at Esher. Drill Order. Mid day and tea rations to be carried.

Commercial Topics.

Dealing in Second-Hand Boilers.

The Minister of Munitions has made an Order prohibiting dealings, without a permit, in any second-hand steam boiler of any type, not being a boiler for use in any locomotive, motor-car or vehicle, or in a ship or other vessel. Applications for permits to purchase or sell second-hand boilers, or to deal as a second-hand boiler merchant, should be made to the Controller, Department of Engineering, Charing Cross Embankment-buildings, W.C. 2.

* * * *

Rubber Control Committee.

The Minister of Munitions has appointed a Committee, under the chairmanship of Sir Clarendon Hyde, to advise him as to the control of rubber. It is stated that it may become necessary to fix maximum prices for transactions in rubber, and that the Minister may be compelled to make orders rendering inoperative any forward contracts or transactions.

* * * *

Alcohol for Motor Fuel.

A committee has been appointed to investigate the available sources of supply of alcohol, with particular reference to its manufacture from materials other than those which can be used for food purposes, the method and cost of such manufacture, and the manner in which alcohol should be used for power. The members of the committee are: Sir Boverton Redwood, Bart. (chairman), Major Aston Cooper Key, C.B., Mr. Arnold Philip, Mr. H. F. Carlill, Prof. Charles Crowther, Dr. J. H. Hincheliff, Brevet-Col. Sir Frederick Nathan, Mr. H. W. Garrod, Sir H. Frank Heath, K.C.B., Sir Frederick W. Black, K.C.B., Prof. H. B. Dixon, F.R.S., Brig.-General Sir Capel Holden, K.C.B., F.R.S., Dr. W. R. Ormandy, Mr. E. S. Shrapnell Smith, C.B.E., and Mr. Horace Wyatt.

Mr. Shrapnell Smith will act as secretary to the committee, and all communications should be addressed to him at the office of H.M. Petroleum Executive, 12, Berkeley-street, W. 1.

* * * *

Compulsory Wage Awards.

The Minister of Reconstruction has, with the concurrence of the Government departments interested, appointed a Committee with the following terms of reference:—

1. Whether the compulsory operation of awards made under the Munitions of War Acts, of Orders extending such awards, and of Orders regulating wages made under those Acts, should be continued after the war.

2. Whether the power to make such awards or Orders should be continued after the war.

3. The manner in which awards and Orders if made or continued should be enforced after the war and for what period.

Sir John Simon, K.C., M.P., will act as chairman of the Committee, which will consist of representatives of employers and trade unions, besides representatives of the Government Departments concerned.

* * * *

Provisional Advisory Council.

Pending the formation of a permanent Advisory Council for the Board of Trade, the President of the Board has invited the chairmen and other representatives of various Committees, including those on Trade After the War, the Presidents of the Association of Chambers of Commerce, and the Federation of British Industries, to form a Provisional Council to advise the Department of Commerce and Industry.

The Provisional Advisory Council includes the Hon. Sir C. A. Parsons, K.C.B., F.R.S., Sir R. Vassar Smith, and Messrs. G. Scoby Smith, Douglas Vickers, F. Huth Jackson and E. Manville. Mr. S. J. Chapman and Mr. P. Ashley, assistant secretaries of the Board of Trade, will act as General Secretaries to the Council, the first meeting of which was held on the 7th inst.

* * * *

Japan's Industrial Progress.

From time to time we have given some particulars of the electrical progress made by Japan, and it would appear that her general industrial and commercial progress has been equally striking. In fact, the war has helped Japan enormously, and in the markets of China and the Far East her progress has been very rapid.

The last issue of "Production" contained an interesting article on Japan's industrial progress, and the following extracts from it may be of interest: Japan's exports were worth £64,264,000 in 1913; they had increased to £71,453,000 in 1915, and £114,000,000 in 1916. In the first six months of 1917 Japan exported as much as she did in the whole of 1915, and these figures represent a whole host of products with which the Western world has not previously associated her name. Japan, at the outbreak of the war had little surplus capital with which to build up new industries. Her attention was at first directed to making munitions for the Allies, especially Russia, and in return she obtained large sums of money which enabled her to develop various new industries. The lessons learned by her captains of industry when organising the production of munitions were not thrown away, and an immense impetus has been given to the national desire to become self-supporting. In Japan there is an abundance of cheap labour, for the average wage for unskilled labour is 8d. a day or less. The country has a large supply of cheap power from its numerous waterfalls, and owing to its vicinity to one of the biggest potential markets and sources of raw materi l in the world, namely, China, it is in a very advantageous position. They

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have driven American cotton almost out of the country, and in the Yangtse Valley they are acquiring concessions of the utmost value. One of the features of Japanese policy is to encourage the starting of new industries, and, in addition to subsidies for the dye and chemical industries, the Government has granted immunity from taxation for 10 years to persons who will undertake the erection of iron foundries, the ores and plant being imported duty free. Since the outbreak of war several new companies have been formed for the production of iron, and among them six companies, with a combined capital of about £4,000,000, have erected new works. Three new companies have commenced the manufacture of steel, five companies have been formed for the treatment of zinc ore, and in the textile industry 11 new companies, operating 14 factories, have been formed. These companies will, it is stated, devote their main energies to the export trade. The outstanding feature from the point of view of our exports to Japan, is the destruction of many of our markets there. Thus Japan no longer requires tungsten filament electric lamps from Europe; she can make all she requires, and in 1917 was able to export 13,000,000 lamps worth £300,000, most of which went to China and Russia.

It is particularly in the cheap and medium priced goods that Japan has been able to compete successfully. The Japanese aim chiefly at replacing Germany as makers of cheap goods, and certainly they are able to beat our enemies in this matter. But just as cheap German goods were often badly finished and shoddy, so many of the Japanese products are decidedly poor in quality. At one time practically all the cheap glass seen in England came from Belgium, Germany and Austria. To-day, what little arrives here comes chiefly from Japan, and but for the prohibition on import and shipping difficulties, it seems likely that Japan would control the whole market. Taking sheet glass first, we find that Japan now supplies the whole of the local demand, and in 1917 exported 22,000,000 sq. ft., worth £320,000. Japan no longer imports any glass ware. On the contrary, she exports about £1,500,000.

In machinery, we find equally great progress. Owing to the building of new mills and factories, there has been an unprecedented demand for all kinds of machinery, and owing to the prohibition on exports of the United Kingdom, Japan has had to depend mainly on her own resources. At the big Mitsubishi and Kawasuki works Japan produces steam, gas and oil engines, and also turbines. In the great shipbuilding yards marine engines have been produced in large quantities. She also makes practically all the locomotives she requires. There are three large up-to-date private factories, as well as a Government factory, all of which are considered by foreign experts to be model factories. Of spinning machinery Japan imported £500,000 worth, most of which came from the U.S.A., and of machine tools she imported £35,000 worth, mostly from the U.S.A.—not because she could not produce them, but because of the great demand for them throughout the country. Indeed, she produced them in increasing quantities throughout last year, and even exported some to the value of £66,000, mainly to Russia. Most of the heavy tools which have been installed in the great shipbuilding yards were made in Japan, principally at Osaka and Tokio.

In the paper-making industry she is making immense strides, and has manufactured most of the machinery required. She likewise makes most of the wire rope she requires at the Tokio and Yokohama Rope works, but there is still a steady demand for the best quality of British wire rope for use in the mines. Under the heading of "Other Machinery," Japan exported £400,000 worth, of which the chief items were sugar-making machinery £65,000, and steam boilers £53,000. It will thus be seen that Japan is producing large quantities of various kinds of machinery, but so great was the demand that she still had to import some from abroad, and would have imported more if she had been able.

After providing for her own requirements she exported cotton yarn value £11,715,000, most of which went to China and Hong-Kong. In cotton piece goods she exported nearly £14,000,000 worth in 1917, whereas the figure for 1916 was £6,200,000 and for 1915 £4,000,000. In haberdashery, &c., Japan is also a large exporter, and in rubber goods, bicycles, chemicals, paper, toys, clocks, scientific instruments, and a hundred other trades, Japan is making goods meant for the European markets. Her business men have proved themselves good organisers, her workpeople a capable and hard-working race, her sailors are able seamen and navigate their modern Japanese-built steamers with as much skill as any European race. She has labour and power and now she has obtained the requisite capital. She has marked China as her special market, but has no intention of restricting her efforts to that field.

Electricity Supply.

At Brighton the flat lighting rate of charging for electricity is increased to 7d. per unit.

Leyton Council's charges for current for all purposes are being increased by 50 per cent.

Shrewsbury Corporation is increasing its charges for current for all purposes by 50 per cent.

Willesden Council's charges are increased by 10 per cent. as from Sept. 30.

Colne Corporation is increasing its charges for lighting from 5½d. to 6d. and for power and traction by ½d. per unit.

St. Helens' Electricity Committee is increasing its charges for power and lighting by 20 per cent., in addition to the previous increase of 50 per cent.

The Tayside Electric & Gas Light Company (Wormit) has added 1½d. per unit to the charge for current supplied by meter, making 8½d. per unit, and 22 per cent. to charges under contracts.

Islington's charges are increased by a further 50 per cent. (making 100 per cent. on pre-war prices) for units at 1d. or under, and 16 per cent. (50 per cent. over pre-war rates) on units above 1d.

The salary of the acting electrical and mechanical engineer at Swindon (Mr. F. Newey) has been fixed at £275 per annum.

Messrs. Edgar Allen & Company, Sheffield, are erecting two electric furnaces, one of 10 and the other of 3½ tons capacity.

Barnes Urban Council has accepted tenders for additional plant, and application has been made to the L.G. Board for sanction to borrow £5,500 for the extensions.

The Borough Electrical Engineer of Swansea, having recommended that the question of the extension of the electricity works should be gone into at once, the Electric Supply Committee has decided to obtain tenders.

On Monday Wolverhampton Corporation decided to apply to the Local Government Board for sanction to a loan of £10,000 for extensions of the electricity supply undertakings.

Wolverhampton Council has sealed an agreement with the Midland Electric Corporation for Power Distribution for the suppy of energy to the Small Heath and Heath Town pumping stations for the period of the war and 12 months afterwards.

At West Bromwich ½d. per unit is being added to the price of current for power, and a sliding scale is to be adopted, under which prices for power and lighting will be increased by 2 per cent. for each 6d. increase in the price of coal per ton.

Under Walthamstow's revised scale, which is now in operation, the charges for lighting range from 6d. to 5d. per unit, and for power from 2½d. to 1½d. The special rates for current used in arc and metal filament lamps are increased to 60 per cent. over pre-war rates.

At the last meeting of Brierfield Council the following quarterly charges for electricity were decided upon: *Lighting*—Up to 1,000 units per annum, 6d. per unit; over 1,000 and up to 3,000, 5½d.; over 5,000 and up to 8,000, 5¼d.; over 8,000, 5d. *Power*—3d. per unit, first hour, 2d. per unit after.

At Loughborough, last year's revenue of the electricity department amounted to £14,221 (against £8,796) and working and general expenses were £8,947 (£5,741), leaving gross profit £5,274 (£2,855). Interest and sinking fund required £4,262 and net profit was £1,012.

The past year's revenue of the electricity department at Motherwell was £24,096, or, after deducting discounts and public lighting rebate, £22,932. Exposes on revenue account were £14,873, and on net revenue account £8,064, leaving net profit £212, which is carried to reserve. Capital expenditure during the year was £298.

At May 15 the Leith electricity department had a gross capital expenditure of £176,033, of which £92,802 is outstanding. Revenue was £40,459 and working expenses were £30,933. After providing for interest, repayment of capital, taxes, &c., the excess of expenditure over revenue was £782 (compared with £3,373 in previous year). Units generated were 4,540,261 and sold 4,126,405. Maximum supply demanded was 2,322 kw.

The past year's revenue of the Walthamstow electricity department was £53,722 (compared with £45,788 in previous year. The net profit was £1,144 (compared with a loss of £4,500), although working exposes increased by £10,000. Coal consumed was 2·8 lb. (3·07 lb.) per unit. Working expenses were £32,704 (against £31,931), leaving gross profit £20,958 (£13,796). After meeting capital charges and wiping off the deficit of £6,169 brought forward from the previous year, there was a net profit of £1,195. Units generated were 11,397,660 and sold 9,223,209. Total maximum supply demanded was 3,351 kw. for lighting and power, and 450 kw. for traction. Capital expenditure is £300,532, of which £121,950 has been repaid.

The accounts of the Lincoln electricity department for the year ended March 31 show gross capital expenditure £94,766 (increase £1,495). Mortgage debt repayments, loan fund accumulations, depreciation and cost of permanent works defrayed out of revenue amount to £63,897. Income was £21,804 (£27,324) and gross profit £6,153 (£8,540). Repayment of loans and interest required £5,352 (£5,329), and a balance of £658 (£4,819) has been transferred to depreciation account. Units generated were 3,985,885 (6,204,993) and sold 3,203,877 (5,345,009). Total maximum supply demanded was 750 kw. h.t. and 725 kw. l.t. for lighting and 100 kw. for traction.

Sheffield Corporation were informed last week by Councillor Warlow, chairman of the Electric Supply Committee, that the Ministry of Munitions, having been convinced of the urgent need for the provisions of a large additional supply of electric power for war purposes, the Council commenced the erection of a new power station at Blackburn Meadows, and placed orders as authorised by the Ministry for plant. Recently the Ministry had recalled their promise to the Corporation to acquire this plant, and the Corporation were placed thereby in a most serious position. Their present plant was quite inadequate to meet the demands made upon it. It was being run to an extent considerably beyond its proper capacity, and he feared that a serious breakdown might take place at any time. Even if the supply proposed to be given by Rotherham Corporation were available—and that certainly would not be the fact for several months yet—that supply would not be adequate to meet outstanding requirements.

Several Councillors having expressed the opinion that it was most essential that the power station should be equipped and completed as early as possible, the Council unanimously passed a resolution protesting against the action of the Ministry.

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Electric Traction.

Ilford Urban Council have placed an order with the makers of their "Orwell" wagon for an electric tipping gear at £50.

The Board of Trade has extended by one year from Aug. 15, 1918, the time limited by the Leicester Corporation Act, 1913, for the completion of certain tramways.

The provisional agreement between Blackpool Corporation and the Blackpool and Fleetwood Tramroad Company for the transfer of the company's undertaking has been sealed.

The capital expenditure on Leith tramways is £237,987, of which £90,050 has been repaid. Revenue was £59,281, working expenses were £39,903, and after providing for interest and instalment of debt and placing £1,400 to renewals fund, there is a debit balance of £761. Passengers carried were 13,634,312, and car-miles run 1,058,706.

The net profit on the past year's working of the Reading Corporation tramways is the record figure of £8,400. The gross profit was £21,515, and after payment of working expenses and capital charges there remained the net profit mentioned above, of which £4,000 is being transferred to the borough fund and the balance to the reserve fund. Passengers carried were 13,771,598 (against 10,919,533 in previous year).

In a report on the unification of the tramways in the Blackpool district, by Mr. Chas. Farness, borough electrical engineer and tramways manager, it is pointed out that the prosperity of Greater Blackpool would in future depend in no small measure upon the transportation facilities provided. The capital expenditure for the unified system from Lytham to Fleetwood would, within six years of being sanctioned, amount to £800,000. He estimates the traffic at that time at 55,000,000 passengers, with a gross revenue of £340,000 and a net surplus of £60,000.

The capital expenditure on Lincoln tramways is £45,106 (increase £119) of which £16,836 has been repaid. Revenue was £10,799 (£7,741) and working expenses were £6,236 (£5,050). Interest and sinking fund required £2,600 (as in previous year). Capital charges were £2,600, war service allowances £195, and the balance (transferred to depreciation) was £1,857. Revenue per car-mile was 17·69d. (12·69d.) and working expenses, including power, were 10·28d. (8·34d.) Passengers carried were 2,209,286 (2,112,293) and car-miles run 145,577 (145,343).

The Salford Tramway Department's Accounts for the year ended March 31 show gross capital outlay £765,295, and £355,752 has been repaid or provided for repayment. Revenue was £350,101, compared with £284,443 in previous year, gross profit £110,332 against £80,417, and net profit £26,970 against £967; £10,000 has been placed to depreciation, and £16,970 devoted to relief of rates. Revenue per car mile was 15·016d., and working expenses, including power, were 9·467d. Passengers carried were 65,061,878, car miles run 5,595,633, and units used 11,008,348.

Australasian Notes.

The Colonial Secretary in Western Australia has replied sympathetically to a recent labour deputation asking that books for the State schools should be compiled and printed in the State.

The chairman of the Federal Alkali Committee is visiting Western Australia, inquiring into the possibilities of establishing an alkali factory in the State. It is proposed to expend from half a million to a million of money in the industry.

Wollongong (N.S.W.) Council has been officially informed re the project of the Public Works Department to install an electric service from their power house at Port Kembla, that a clause has been included in the Local Government Bill to enable municipal bodies to purchase current wholesale, and to retail it.

The Federal Government being unable to get copper wire from Wollongong (N.S.W.), has placed an order in America for several years' supply. Metals Manufacturers (Ltd.), Port Kembla, were given, when formed, a contract for the supply of 10 years' requirements, but the war has greatly delayed the complete installation of machinery. Recently, however, the first coil of wire was produced.

The Electrolytic Refining & Smelting Co.'s plant, Port Kembla (N.S.W.), is now in use for smelting; the old mill is being fitted for the extraction of the by-products, copper sulphate and nickel.

The rails which the Fitzroy, Northcote & Preston (Victoria) Tramway Trust is now laying on the new electric tramway system in the northern suburbs of Melbourne are being obtained from the Newcastle (N.S.W.) steel works of the Broken Hill Proprietary Co.

In spite of rough weather and shortage of labour and supplies, fair progress is being made with the Lake Margaret (Tasmania) hydro-electric power scheme extension, which is designed to increase the present 5,000 h.p. capacity to about 7,000 h.p. Portions of the additional machinery has been delivered. The water supply has been increased by cutting a channel to divert the water from two small lakes, known as Peter and Paul, into the Lake Margaret watershed.

In regard to the King River hydro-electric scheme of the Government, matters are very quiet. Delay in getting something definite as to when the power is likely to be available is interfering with the operation of the Mount Read-Roseberry Mines Co. in connection with securing power for electrolytic plant for ore treatment. At present, it looks as if the main King River scheme will not be completed for some years. The Mount Lyell Co. does not feel inclined to wait so long, and it is understood that an auxiliary power scheme will be initiated to meet the initial requirements of the Mount Read-Roseberry mines.

Picton (N.S.W.) Municipal Council recently had an electricity installation scheme prepared by Mr. Franki, of Sydney, but finding it beyond their powers of finance, decided to have a specification prepared upon which tenders could be invited for an installation.

At a recent meeting of the Western Australian Institute of Engineers the proposal to form an Institution of Australian Engineers was discussed. It is proposed to form a council of 22 members, consisting of two representatives from each State Institute, and two representatives from each of the five branches of the profession, including the civil, mining, electrical and mechanical sides, to be elected to the Council by the several institutes. Several prominent members advocated turning, say, the New South Wales or Victorian Institute into the governing council, with one representative upon it from each of the States. It is estimated that there are some 3,000 professional men in Australia eligible for membership in the proposed Commonwealth Institution. It is proposed that no one shall be entitled to be a full member until he reaches the age of 33, and shows by his professional attainments that he is fully qualified.

The report of the manager of the Magnet Silver Mine, Waratah (Victoria) for the first half of the current year, states that extensive works have been carried out in connection with the hydro-electric scheme. The whole of the work at the mine would now be done electrically, including pumping and winding, while the concentrating plant would be run by water-power.

Mr. A. Cameron (chairman of the Prahran & Malvern Tramway Trust) recently read a Paper before the Electrical Association of Australia on "Tramway Control in Melbourne and Suburbs." In the course of the Paper, Mr. Cameron says the reception given to the Greater Melbourne Council Bills of Mr. Watt and Sir Alexander Peacock indicate that the notion of a Greater Melbourne Council is premature, and that a reduction of the number of existing Councils by amalgamation into groups is necessary to the attainment of the larger scheme. Direct election by ratepayers in the case of a tramway trust is unsatisfactory, because there is no broad general issue to put before ratepayers, but only details requiring expert knowledge. There are four tramway trusts, consisting of representatives elected by their respective Councils, and that system has worked excellently. Perhaps the best system would be for such boards to appoint three expert members to manage business details. That has been successful in Canada. State control of metropolitan tramways has also been suggested, but, so far, has not received Ministerial sanction, and Australian experience tends to show that municipal control is more successful than Government control. Had there been no war, and if money and materials were available at normal rates, the advisability of converting the Melbourne cable tramways to electric traction as quickly as possible would have been beyond question, but, under existing conditions, Mr. Cameron suggests that certain loops should be constructed, certain small existing sections should be electrified and some other portions made available for both cable and electric cars, so as to bring the electric cars on all routes within easy access of the city, and enable electric cars on certain routes to run through and beyond the city. The scheme proposed in the Paper would cost from £250,000 to £300,000.

Electric Furnace Progress in Sweden.

In a recent lecture, the engineer of a Trollhättan firm of ferro-alloy manufacturers gave some particulars of the progress made by the electric furnace in Sweden during the past five years.

There are now more than 150 electric furnaces in use in Sweden, with a consumption of about 160,000 kw. All the furnaces have been erected within the last 10 years, and more than half were invented by Swedes.

The raw material for the production of ferro-molybdenum is found in Sweden, but not sufficiently concentrated to be employed directly in the manufacture of alloys. The problem of the concentration of the ore has been satisfactorily solved. At first ferro-molybdenum was manufactured from Norwegian concentrates, and manufacture on an experimental scale was continued at Hallstahammer in 1916. Production is now on a large scale by a company at Arboga, and by a second firm at Trolhättan.

There are no raw materials in Sweden containing tungsten in workable quantities, and the manufacture of ferro-tungsten was only undertaken experimentally (December, 1914, and October, 1915) at Hallstahammer in a small Rennerfelt furnace.

Ores suitable for the manufacture of ferro-manganese are found at Spexeryd, Langbanshyttan and Dalsland, and ores from all those districts have been used in its manufacture, which began in October, 1914, at Trollhättan, and since then several other firms have produced this alloy. The annual production of this alloy in Sweden in the years 1914 to 1917 has been 300, 900, 500 and 1,100 tons respectively.

Recently the necessary raw material for the manufacture of ferro-vanadium was found in the ash of coal from mines at Bellingen. Many Swedish iron ores contain vanadic acid, but not in utilisable quantities. The problem of their utilisation is being studied, but no solution has yet been discovered. Hitherto the raw material for this alloy has come from Germany, the waste product from the manufacture by the alumino-thermic method of ferro-vanadium. The sole manufacturer in Sweden of this product (a Trollhättan company) produced 1,500 kg. in 1914, and 3,800 kg. in 1915.

Sweden contains raw materials for the manufacture of ferro-alumino-silicon in the form of refractory and other clays, as well as in the form of quartz. A beginning was made in the manufacture of this alloy by a Trollhättan company in August, 1914. The annual production has risen from 64 tons in 1914 to 1,000 tons in 1917. The manufacture of ferro-alumino-mangano-silicon, began in 1915, and a Trollhättan company has been, since 1915, the sole producer in Sweden of this alloy. The quantities produced in the years 1914 to 1917 were respectively 422, 785, 733, and 1,329 tons.

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Experimental manufacture of cupro-manganese and cupro silicon alloys has been undertaken at Trollhättan, but the quantities produced in the three years 1915–17, have not in any year exceeded 100 kg.

Ceric iron is employed solely in the manufacture of flints for artificial lighters. In 1917 a company was formed for the exploitation of a process of manufacture of a Swedish expert, and the plant (situated at Motala) has recently produced a small quantity of this alloy. Several months will elapse, however, before the manufacture of this product is in full working order.

Educational.

The number of students at the Manchester College of Technology who have enrolled for the first year of the three years' university course is slightly larger than that of last year, or rather less than one-third of the number for the normal pre-war year. Of the part-time students, a large majority attend the evening classes, and for the present session it is expected that the total will reach from 2,200 to 2,300, compared with 2,500 last winter. Before the war the average was about 4,000.

An important development of the college is the training of disabled men. Between 40 and 50 officers are taking the course in engineering, chemistry or textiles with the object of taking a degree, and it is expected that the number will be increased to 100 before Christmas. By university statute, they are allowed to take a degree in two instead of the usual three years. It is reported that already 65 disabled men have been trained in electrical work, textiles and sanitary science. These men have been placed in employment, and there are at present about 45 others in training.

The report of the Departmental Committee on salaries in secondary schools, technical schools, &c., which was recently issued, makes (*inter alia*) the following recommendations:—

Secondary Schools.—A minimum initial salary for (graduate) teachers in all secondary schools in receipt of public money to be fixed by the Central Authority, and a minimum amount prescribed at a later stage in the teacher's career. Salaries of assistant teachers should be regulated by scales. They should be such that teachers receive a substantial salary at the age of 32 or 33, with increments continuing up to the age of about 42 or 43. Equality of pay for the two sexes would, in existing circumstances, lead to one being underpaid and the other overpaid. No differences in salary should be made upon the basis of the subject taught or the size of the school. The possession of a high degree or other special qualification of a scholastic character may be recognised by placing its holder at a point on the scale above that which he would otherwise occupy. Heads of departments and assistants performing special duties should be remunerated by additions to their salary.

Technical Schools.—Full-time assistant teachers of senior and advanced students, who are graduates (or have equivalent qualifications) should be paid by scale at as high a rate at least as is paid in secondary schools, higher remuneration being given in exceptional cases where a teacher's qualification consists of long works experience and high technical knowledge. The salary may be determined by what will induce him to leave his occupation, otherwise the scale should be similar to that of the secondary-school teacher. The salaries of artisan teachers will be settled in the main by competition with industry.

Miscellaneous.

We have recently received a second edition of the pamphlet on a Complete Scheme of Syndication, which Mr. Howard F. Smith (of Smith & Davis, Ltd., Birmingham) has republished. A considerable amount of additional matter is given, which will be read with interest by those who are earnestly looking forward to the post-war conditions of this industry.

A by-law has been issued by the Australian Commonwealth Department of Trade and Customs authorising the importation of wire braiding machines for weaving textile covering for wire for electrical purposes at the rates of duty leviable upon recognised machine tools.

The rate of import duty leviable upon recognised machine tools is 10 per cent. *ad val.* under the general tariff, and British goods duty free.

The New Zealand Customs Department has decided that wireless electric pipe locators and finders (British or foreign) will be admitted free.

A Canadian Order in Council, dated April 5, 1918, states that when imported materials on which Customs duties have been paid are used in the manufacture of wireless telegraph apparatus suppiled to vessels in Canada there may be a drawback of 99 per cent. of the duties paid on materials so used.

An Italian decree dated May 31 is to the effect that the export of certain classes of goods, including machines, scientific instruments, motor cars, indiarubber and manufactures thereof, and electric wires and cables shall only be permitted if the amounts due from abroad representing the price of the goods sold and the credits resulting from the same are ceded to the National Institute of Exchange (Instituto nazionale dei cambi).

The French Customs Department has decided that in regard to electric lifting apparatus, the electric motor, rheostat, sliding levers, connecting plug, &c., are to be assessed for duty separately

Tenders Invited and Accepted.

The Commissioners of His Majesty's Works, &c., are prepared to receive tenders before 11 a.m. on Friday, Oct. 25, addressed to the Secretary, H.M. Office of Works, &c., Storey's-gate, Westminster, London, S.W. 1, for the supply of electric cable. Forms of tender from the Controller of Supplies, King Charles-street, Westminster, S.W. 1.

The Great Northern Railway Company (Ireland) require tenders by 10 a.m. Nov. 7 for six or 12 months' supply of stores and materials, including electrical fittings and lamps, electric cable and wire, carbons, rubber goods, signalling materials, oils, &c. Forms of tender from the Secretary, Amiens-street Terminus, Dublin.

Bedford Corporation require tenders by noon Nov. 13 for the supply and erection of two water-tube boilers, mechanical stokers and induced draught plant. Specifications, &c., from the Engineer, Electricity Works, Cauldwell-road, Bedford.

Johannesburg (Transvaal) municipality require tenders by noon Nov. 27 for supply of 2,000 copper ribbon bonds and 2,000 copper solid bonds (contract No. 424). Specification, &c., from the Town Clerk.

Barnes Urban Council has accepted the tender of the British Thomson-Houston Company for a 500 k.v.a. rotary converter at £3,685.

Lewisham (London) Guardians have accepted the tender of H. E. Olby for the supply of Osram lamps as follows: 15 watt, £21. 12s. per gross; 30, 40 and 60 watt, £20. 2s. per gross.

Stretford Council has accepted the tender of Doulton & Company for 750 yds. 3½ in. diameter four-way Doulton conduits at 7s. 2½d. per yard net and 450 brown glazed stoneware tile covers at 5d. each net.

Southend Council has accepted the following tenders: Edison Accumulators, Ltd., 2 ton tip wagon, £1,242: W. Ward & Company, pump and starter, £27. 2s. 6d.: British Insulated & Helsby Cables, Ltd., 1 mile 600 yds. trolley wire, 1s. 5½d. per lb.

Larne Urban Council has accepted the tender of the Larne Electric Light & Power Company for the public lighting for three years from Sept. 1 (exclusive of May, June, July and August) at £760. 18s. 8d. per annum, less £49 per annum while restricted lighting continues.

Appointments Vacant and Filled.

A telegraph storekeeper is required for the Post and Telegraph Department of the East Africa Protectorate. Salary £200, rising by increments of £10 to £300 per annum. Applications to the Crown Agents for the Colonies, 4, Millbank, S.W. 1.

Applications are invited for the position of professor of physics in the University of Cape Town. Salary £800 per annum. Applications by Jan. 1 to the High Commissioner for the Union of South Africa (32, Victoria street, London, S.W.1), from whom particulars can be obtained.

Mr. J. W. Warr, deputy electrical engineer at St. Helens, recently resigned in order to become chief mechanical engineer of the United Glass Bottle Manufacturers, Ltd.

Mr. J. R. Groves, manager of the Gravesend & Northfleet tramways, has been appointed to a similar position at Barrow-in-Furness, and Mr. J. Dobson, of Barrow, will take up Mr. Groves' former position.

Mr. Wm. Blair Smith, chief assistant electrical engineer at Greenock, has been appointed borough electrical engineer at Paisley at £600 per annum. There were 150 applicants, and Mr. Smith was chosen from a short list of three, the other two candidates being from Glasgow and Kilmarnock.

Business Items.

The new address of the Dalyte Electrical Co. is Deco Engineering Works, West-row, North Kensington, London, W. 10.

With the consent of the Board of Trade, the title of the Dubilier Electrical Syndicate, Ltd., has been changed to the Dubilier Condenser Company, Ltd.

In future the address of the Electrical Contractors' Association, Incorporated, the National Electrical Contractors' Trading Association, Ltd. (N.E.C.T.A.) and the National Federated Electrical Association, of which Mr. L. G. Tate is secretary, will be 11-13, Southampton-row, London, W.C. 1.

Messrs. Watson & Sons (Electro-medical), Ltd., have removed to Sunic House, Parker-street, Kingsway, W.C. 2. Telephone: Regent 1227; Telegrams: "Skiagram Westcent London."

Messrs. Johnson & Phillips, Charlton, London, S.E. 7, have recently issued their revised net price booklet dealing with V.I.R. cables. The list is issued for the trade in order to facilitate estimating work.

The General Electric Company, Limited, announce that they have completed the purchase of the Erith Works, and of the goodwill of the manufacturing business hitherto carried on by Messrs. Fraser & Chalmers, Ltd. Practically the whole of the personnel have transferred their services to the G.E.C., who will carry on the business as a going concern and under the title of Fraser & Chalmers Engineering Works (proprietors, the General Electric Company, Ltd.).

Liquidations, &c.

A meeting to receive an account of the winding up of Venner's Electrical & Heating Appliances, Ltd. (in vol. liq.), will be held at Blomfield House, 85, London Wall, London, E.C., on Nov. 12.

An application for the discharge of Saml. Smith (trading as Smith & Sons), electrical engineers, &c., 22A, 24 and 26, Victoria-square, Widnes, will be heard on Oct. 25 at the Court House, Government-buildings, Victoria-street, Liverpool.

A petition for winding-up the Weaverham Electricity Supply Company, Ltd., has been presented by Messrs. Johnson & Phillips, Ltd., and will be heard at Nantwich Petty Sessional Court House on Nov. 13.

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Companies' Meetings and Reports, &c.

The Indo-European Telegraph Company has declared an interim dividend for the half-year to June 30 at rate of 5 per cent. per annum, tax free.

For the year ended June 30 there was a loss of £206 on the working of the National Telewriter Company, Ltd., against £246 the previous year.

An interim dividend of 4s. per share, tax free, has been declared on the ordinary shares of the Brisbane Electric Tramways Investment Company.

The tramway and electricity receipts of the Electric Supply Company of Victoria for the three months ended June 30 last were £25,545 and the expenses £16,396.

The recent issue of ordinary shares of the Newcastle-upon-Tyne Electric Supply Company, Ltd., was over-subscribed, and letters of allotment have been posted.

The United River Plate Telephone Company has declared an interim dividend of 3 per cent. (3s.) per share on the ordinary shares, tax free, for the half-year ended June 30.

The directors of the Anglo-American Telegraph Company have declared an interim dividend for the quarter ended Sept. 30 of 15s. per cent. on the ordinary stock, less tax.

The Oriental Telephone & Electric Company has declared the following interim dividends: 3 per cent. on the 6 per cent. cumulative preference shares for the current year (less tax), and 4 per cent. on the ordinary shares, tax free.

The directors of the Shanghai Electric Construction Company, Ltd., announce an interim dividend at rate of 5 per cent. actual (10s. per share), less tax, in respect of the year 1918.

A dividend of 1½ per cent. is payable against Coupon No. 18 of the Lima Light, Power & Tramways Company, Ltd., by Messrs. Grace Bros. & Co., 144, Leadenhall-street, London, E.C.

The accounts of the Associated Fire Alarms, Ltd., for the year ended June 30 last, show a profit £2,180, including £563 brought in. Preliminary expenses (£1,306) have been written off and £2,020 Dominion of Canada stock written down by £358, leaving £515 to carry forward.

Mr. Theodore Vail, president of the American Telephone & Telegraph Company, states that an eminently satisfactory arrangement has been made with the Government for the war-time control of the telegraph and telephone lines. The Government allowance covers fixed charges and dividends at current rates on stock. The allowance is not to be the basis for a valuation of the properties.

The profit and loss account of the Cape Town Consolidated Tramways & Land Company, Ltd., for the year ended Dec. 31, 1917, shows a debit balance of £530. 15s. 8d. carried to the balance-sheet, against £630. 19s. 4d. for the previous year. No dividends have been declared by the subsidiary companies. The operation of the Camps Bay tramways resulted in a profit of £3,018. 11s. 10d., against £2,225. 11s. 3d.

The directors' report of the West African Telegraph Company, Ltd., for the year 1917 states that the revenue amounted to £59,041, from which has been deducted £18,020 for ordinary expenses and £31,181 for expenditure relating to maintenance of cables, sundry differences in exchange, income tax payable abroad, special contribution to pension and superannuation funds towards depreciation of investments, and payments to staff and other expenses in connection with the war, leaving £9,840, to which is added £711 brought forward, making a total available balance of £10,551. The sum of £1,257 has been provided for income tax payable in England, and the usual interim dividend of 2 per cent., absorbing £4,622, was paid on Dec. 1 last. An additional payment, equal to a dividend of 2 per cent., was made on May 15, bringing the total distribution for the year up to 4 per cent., tax free. The balance of £50 is carried to the next account.

Meetings of the holders of the bonds, notes and preference share capital of the Barcelona Traction, Light & Power Company will be held on Nov. 14 to consider proposals for reorganising the finances of the company, &c. Interest on the bonds is to be raised from 5 to 5½ per cent. as from June 1 last, on condition that only 2 per cent. is payable in cash until June 1, 1921, and the remainder only so far as surplus revenue permits. After that date 4 per cent. will be payable in cash until the full interest has been paid for six consecutive half-yearly periods, when the full interest will be payable. The application of the sinking fund is to be postponed until June 1, 1935, and the date of maturity of the bonds until Dec. 1, 1974. It is proposed to issue 5½ per cent. income bonds in redemption of interim certificates or receipts in respect of the 10-year notes, of the outstanding coupons for interest on the prior lien B bonds and the 5 per cent. bonds, and on the bonds of the Cia Barcelonesa de Electricidad and the coupons on the 10-year notes. It is also proposed to increase the total authorised issue of prior lien B bonds by £1,000,000 to £3,000,000. Interest on existing bonds will be reduced from 7 to 6 per cent. as from June 1 last, this interest to be satisfied down to June 1, 1921, one-half in cash and the other half in income bonds.

At the meeting of the Victoria Falls & Transvaal Power Company, Ltd., on Friday last, the Marquis of Winchester, who presided, stated that the accounts showed a further improvement in revenue of over £36,000, notwithstanding a period of exceptional circumstances which increased the cost of everything. In July they declared the same dividends as in respect of 1916 on the ordinary and preference shares, the latter again receiving the full amount of participation to which they were entitled. The amount of first mortgage debentures purchased and drawn for redemption, but not yet presented for payment, had increased from £161,480 to £312,444. Only a small proportion of the issue was held in this country, the issue having been taken entirely by the Dresdner and Deutsche banks. The second mortgage debentures had been reduced from £1,650,000 to £1,376,640, the total reduction of their debenture indebtedness being £573,360, leaving the amount of first and second debentures outstanding £4,076,640. The reserve fund had been increased by £50,000, which, in view of the constant reduction of the debenture debt, they considered a sufficient sum to set aside annually until the reserve fund had been brought up to a sum commensurate with the scope of the undertaking.

The report of the Eastern Extension Australasia & China Telegraph Company, Ltd., for 1917 states that revenue amounted to £1,508,440, from which are deducted £351,261 for ordinary expenses and £200,886 for expenditure relating to maintenance of cables, maintenance ships reserve fund, payments to staff and other expenses in connection with the war, and share of special contributions to pension and superannuation funds against depreciation of securities, leaving £956,294. After providing £427,057 for income-tax and excess profits duty payable in England, and £30,096 for interest on mortgage debenture stock, there remains £499,141, to which is added £63,121 brought in, making £562,262 available. The directors have placed £250,000 to general reserve. Four dividends of 1½ per cent. each and a bonus of 2 per cent. have been paid, amounting to £240,000, or 8 per cent., tax free. These appropriations absorb £490,000, and leave £72,262 to be carried forward. The cost, amounting to £28,280, of the diversion and partial renewal of the New Zealand cables has been debited to general reserve, together with £25,000 as a further provision on account of investment fluctuations, and £6,546 representing loss on sale of investments during the year. The concession, granted by the Spanish Government in 1897, for providing and maintaining under a subsidy arrangement cable communication between Manila and the Islands of Iloilo and Cebu (Visayas), having expired in November last, the company's stations in those islands have been closed and the cables picked up for utilisation elsewhere.

The report of the directors of the Eastern Telegraph Company, Ltd., for the year 1917, states that the revenue amounted to £2,901,579, from which are deducted £770,354 for ordinary expenses, and £491,963 for expenditure relating to maintenance of cables, sundry differences in exchange, income and war taxes payable abroad, share of special contribution to pension and superannuation funds, towards depreciation of investments and payments to staff and other expenses in connection with the war, leaving a balance of £1,639,263. After providing for income tax and excess profits duty payable in England, interest on mortgage debenture stock, and dividends on the preference stock, which in all absorb £809,581, there remains £829,681, to which is added £54,688 brought forward, making a total available balance of £884,370. The directors have placed £500,000 to general reserve fund. Three interim dividends of 1½ per cent. each, a final dividend of 1½ per cent. and a bonus of 2 per cent. have been paid on the ordinary stock amounting together to £320,000, making a total distribution of 8 per cent., tax free, for the year 1917. These appropriations absorb £820,000, and leave £64,370 to be carried forward. The general reserve fund has been charged with £9,507 in respect of loss on sale and redemption of investments, and £40,000 as a further provision on account of investment fluctuations. After crediting the £500,000 referred to above, the net addition to the general reserve fund for the year is £450,493. The directors refer with regret to the death in January last of the chairman, Sir John Wolfe Barry, K.C.B. The vice-chairman and managing director, Sir John Denison-Pender, K.C.M.G., has been elected chairman. Capt. Henry W. Grant, C.B., R.N., who had been attached to the Admiralty War Staff, was elected a director on March 13 last and appointed a managing director. The Company announce payment by warrants, on Nov. 1, of interest for the half-year ending 31st inst., on their 4 per cent. mortgage debenture stock. The transfer books will be closed from Oct. 26 to 31 inclusive.

Thirty-Seven Years Ago.

[From The Electrician, October 15, 1881.]

"The Telephone."—A new "Telephone" is announced as the "smartest thing going," and as being able to "transmit the future voice of the nation." On closer inquiry we find that all this refers to a new evening paper of that name, not to a new telephone.

Electric Light in Sheffield.—We hear that Messrs. Tasker, Sons & Co., engineers and electricians, Sheffield, are arranging with several firms for illuminating their premises with the electric light. A successful experiment was made with their own premises in Station-road recently.

Electric Light at the Grand Opera, Paris.—It is stated that four special representations of opera and ballet are to be given at the Grand Opera in Paris, at which the entire house, including the stage, will be illuminated by the electric light. M. Jules Cohen has composed for the occasion a cantata commencing with the words "Terre, éclaire toi!"

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CONTENTS.

NOTES 527
Arrangements for the Week 529
Electric Traction on the Central Argentine Railway. Illustrated. —*Continued* 530
Electric Winding Engines and Mine Hoists. By H. H. Broughton. Illustrated.—*Continued* 534
The Electrical Equipment of Keadby Bridge. Illustrated.—*Concluded* 536
THE BRITISH DESIGNER OF TO-MORROW 538
REVIEWS 538
Mr. H. I. Rogers' Address to the I.E.E. Western Section 539
Industrial Coal Economy 540
CORRESPONDENCE 541
The Labour Outlook. By Our Labour Correspondent 541
The Batti-Wallahs' Society 541
LEGAL INTELLIGENCE 542
Volunteer Notices 542
Commercial Topics 542
Electricity Supply 542
Educational 544
Tenders Invited and Accepted 544
Companies' Meetings and Reports 545

Notes.

Industrial Coal Economy.

IN a Paper read recently before the Association of Engineers-in-Charge, Mr. D. WILSON, of the Coal Controller's Department, gives some useful advice based on his experience in attempting to reduce coal consumption. An abstract of the Paper will be found in another column. It is common knowledge that coal is still being used very inefficiently in many works, but few people have had an opportunity of getting at the facts. Even in electricity supply stations there is often a good deal of waste. It appears that the amount of coal consumed by the electric supply industry in 1917 was about 7½ million tons, and from this quantity the number of kilowatt-hours generated amounted approximately to 5,000 millions, so that the average coal consumption was 3·36 lb. per kilowatt-hour generated. As an average figure this is perhaps lower than might have been expected, but it must be remembered that a very large proportion of the electricity is generated by large stations, which are, of course, run on up-to-date lines, so that the average is brought down. Actually the coal consumption has been found to vary from 2 lb. up to 13 lb. per kilowatt-hour and the thermal efficiency from 3 per cent. to 16 per cent. We certainly cannot be proud of such figures as 13 lb. and 3 per cent. As would be expected, the excuse from the inefficient station is generally that bad results are due to poor load factor, obsolete plant, &c. Mr. WILSON points out, however, that after making due allowance for these adverse conditions there is still a large unaccounted waste which should not exist, and the first thing that should be done is to establish definitely what each section of plant is doing.

Results in Industrial Power Plants.

IN the case of industrial undertakings a simple *questionnaire* was sent out, but it became evident that the information so obtained was in most cases inaccurate. It appears that many firms simply asked the boiler contractors or insurance companies what figure they ought to expect! As we have often stated in these columns, it is in the boiler-house that the greatest opportunity exists for the saving of fuel. So much impressed was the late Mr. STOTT with this view that he seriously considered the employment of trained engineers to control individual furnaces. Yet in this country any number of boiler-houses have no means of determining the flue temperatures or the percentage of carbon dioxide in flue gases. This is unpardonable, for a great deal can be done with equipment which does not cost very much. Of course, it will be admitted that present-day conditions are far from those which are desirable, but some of these conditions must be accepted as being imposed upon us. Take, for example, the quality of the coal; in many cases this is very poor, but as Mr. WILSON points out, a good thermal efficiency can be obtained even with low-grade fuels. One electric power station is mentioned in which an average thermal efficiency of 16 per cent. is obtained, though using a coal with the low average calorific value of 10,000 B.Th.U. Again, the Victoria Falls & Transvaal Power Company use a coal of only 7,000 B.Th.U. calorific value, and yet their thermal results are excellent. It may be troublesome to use such coal, but in these days we must be prepared to work under difficult conditions, and in any case the best results cannot be obtained without the most careful supervision.

The Winter Session.

THE receipt of Mr. H. I. ROGERS' Address to the Western Section of the Institution of Electrical Engineers reminds us that the technical and scientific societies are once more starting their winter sessions. Although we cannot look forward to all the old vitality, it is highly desirable that these lines of activity should be maintained. In his Address, Mr. ROGERS dealt with many of our national shortcomings, such as the low pay of the scientific worker, which is undoubtedly a scandal; and he made some interesting comments upon the importance of repetition work in reducing costs. In his own experience the wages per head have rather more than doubled, but at the same time the output per head has quadrupled in value. This is not due to war prices, as these results have been obtained in the manufacture of shells, the prices of which have been greatly reduced since the war began. Mr. ROGERS also made the interesting statement that some time ago the manufacturing engineers in Bristol requested the Educational Committee to afford better facilities for giving technical education to prospective employees, with the result that in September, 1917, a junior technical school was started. The boys go to the school after finishing their elementary education, and receive two years' whole-time instruction, which has a considerable technical bias; but at the same time their general education is by no means neglected. An important feature of this scheme is that the manufacturers have undertaken to absorb these boys into their works when the school period expires and this fact has had an excellent effect upon the movement. We regard junior schools of this type as being of the highest importance, and we hope that this example will be followed in other parts of the country.

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Scientific Education in Infancy.

We recently received a copy of an address delivered before the Association for the Scientific Development of Industry by Mr. E. C. Reed early in the present year, which raises some interesting points in connection with scientific education. The author deals with an aspect of science teaching that has not been sufficiently studied—the inculcation of scientific ideas and knowledge among quite young children. The author disclaims any idea of making children into "super-infants" or precocious and, probably priggish little semi-scientists, a result which there would be some reason to fear if conventional methods of teaching science were pursued. But he argues that a mind is permanently warped by total ignorance of scientific fact and method in its early stages, and nothing should be more acceptable and more readily assimilated than the wonders of science presented in an attractive form. Such teaching should be associated *with doing*. This does not mean a laboratory or any exceptional apparatus, but the kindling of an interest in science by reference to common processes and things. The present coal situation, and the facts of combustion being brought home in every home, affords an excellent instance of the possibility of grafting scientific knowledge on to everyday life. Importance is also attached to pictorial methods. A kinematograph lantern should be as much an article of school equipment as a blackboard, and children might also become familiar with the use of a simple microscope. To the child, reasoning by association of ideas is a logical necessity. It is shrewdly remarked that "an imperative command to think would hardly produce any effect on a serious practised thinker," much less on a child. And yet we can recall professors who apparently believed in such general exhortations! We notice that Mr. Reed disclaims the idea that great men of science are phenomena—men with abnormal brains or gifted to a superlative degree. Great results are the result of steady well-directed effort. "All wish to think, but few the price will pay."

The Fahy Permeameter.—The City of Philadelphia, acting on the recommendation of the Franklin Institute, has awarded to Mr. Frank P. Fahy, of New York, the John Scott Legacy medal and premium for the development of the Fahy Permeameter.

Patent Law Reform.—*Erratum.* An error appears to have crept into Mr. James Keith's letter on this subject, published in our last issue. We are informed that the charge of eight guineas should have been eight shillings for a typewritten copy of the Canadian specification.

A Radium Substitute.—The "Times" reports that Dr. Richard N. Moore, of the U.S. Bureau of Mines, has discovered a substitute for radium, which he has named "menothorium." It is expected that the new mineral will come into wide use for luminous dials, compasses and gun sights.

North-East Coast Institution of Engineers and Shipbuilders.—The Engineering Gold Medal of the North East Coast Institution of Engineers and Shipbuilders has been awarded to Mr. Harry R. Ricardo, B.A., for his Paper entitled, "High speed Internal Combustion Engines," which was read before the Institution on April 30th last.

Industrial Reconstruction Council.—The third lecture of the Series arranged by the Industrial Reconstruction Council will be held in the Saddlers' Hall, Cheapside, E.C. 2, on Wednesday, October 30th. The chair will be taken at 4.30 by Sir Wilfrid Stokes, K.B.E., President of the Council, and an address on "The Functions of the Government in Relation to Industry" will be given by Mr. W. L. Hichens, Managing Director of Messrs. Cammell, Laird & Co. Applications for tickets should be made well in advance to the Secretary, I.R.C., 2 & 4, Tudor Street, E.C. 4.

The "Key" Industries Exhibition.—The "Key" Industries Exhibition, promoted by the Tariff Reform League, closed yesterday after an extremely successful run, during which there were over 80,000 visitors, the average being about 5,000 daily. Mr. H. J. McKinder, M.P., chairman of the League, has sent out an earnest appeal for funds to provide national and non-party support in meeting the demands from many quarters that other cities of the United Kingdom should be afforded the opportunity of seeing the Exhibition. As no charge was made to exhibitors or to visitors, a substantial fund is necessary. Contributions should be sent to Mr. E. J. Duveen, at 7, Victoria-street, London, S.W. 1.

Institution of Electrical Engineers.—The programme has been issued for the first half of the session, from which we note that on Nov. 7 Mr. L. B. Atkinson will deliver the tenth Kelvin lecture, taking for his subject "The Dynamical Theory of Electric Engines." The following three Papers will be by Mr. J. H. Shaw, on "The Use of High Pressure and High Temperature Steam in Large Power Stations": by Prof. Miles Walker, on "The Supply of Single-Phase Power from Three-Phase Systems": and by Mr. P. Hunter-Brown, on "Carbon Brushes." On Jan. 9 Mr. M. B. Field will give a lecture on "The Navigational (Magnetic) Compass as an Instrument of Precision," and on Jan. 23 Mr. A. P. M. Fleming will read a Paper on "Planning a Works Research Organisation."

The Investigation of Pulverised Coal Systems in America.—Mr. Leonard C. Harvey, of Malden, Surrey, has returned from the United States after having carried out for the Director of Fuel Research a full investigation into the progress made in recent years in the application of pulverised coal for metallurgical and general industrial purposes, for steam raising in land and marine boilers and in locomotives on railways. This report will be issued as a Government publication by the Department of Scientific and Industrial Research at an early date. Important developments have taken place in America in the utilisation in pulverised form of low-grade coals of high ash contents, and it is hoped that similar developments will follow the adoption of the system in this country. It is possible that in this way considerable quantities of material which is at present regarded as waste at the coal mines may ultimately be made available as fuel and thus supplement the restricted supplies of coal.

The Ludwik Hardness Test.—In a recent Paper before the Institution of Mechanical Engineers Prof. W. C. Unwin dealt with what is admittedly a difficult problem, the question of hardness tests. The well-known Brinell test is open to the objection that the hardness number derived is influenced by the magnitude of the load and the radius of the ball. This is apparently due to the fact that the indentations are dissimilar. Dr. Paul Ludwik, of Vienna, has proposed the use of a right angle cone as the indenting tool; the indentations in this case are always geometrically similar, so that the hardness number is a much more constant quantity. Prof. Unwin presents a variety of data comparing the two methods. If a truncated cone is used, one possible objection to the Ludwik test—that the point of the cone is unable to withstand constant pressure—is removed. In these circumstances the indentations are not quite geometrically similar for different loads, but are more nearly so than in the ball test, and the hardness number will be, within limits, independent of the load. The rational direction of standardisation would seem to be to vary the load so that the volume of indentation is approximately constant. It is shown that in these circumstances the load requires to produce a given indentation can be approximately predicted. The volume of indentation is greater for a less load in the cone test than in the ball test, which seems an advantage on the side of the former.

Use of a Transformer Between the Stator and Rotor in Polyphase Motors.—In considering this question in the "E. T. Z." Mr. Ernst states that there are many advantages in using a transformer between the stator and rotor in polyphase series motors with six sets of brushes. Generally speaking, this transformer is smaller and cheaper than an external transformer placed in series with the whole motor,

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because at synchronism there is scarcely any magnetic flux therein; also it limits the speed of the motor on no load. It is shown that this is not the case with all positions of the brushes; there is, therefore, the possibility of very high speed under certain conditions. The saturation of the transformer iron at low speeds has a stabilising effect. The number of the turns on the rotor can, therefore, be increased in order to produce a good power-factor without the risk of a loss of stability at low speeds; but this is not the case with all positions of the brushes. The author gives curves and diagrams showing the voltages and fluxes, taking into account the losses and magnetic leakage. An example in the design of such a combination is given in detail.

Cutting Lubricants and Cooling Liquids.—A bulletin on the above subject, issued by the Department of Scientific and Industrial Research, gives a brief and succinct summary of existing knowledge. The first section, prepared by Mr. T. C. Thomson, a member of the Lubricants Committee, deals with a number of points of primary interest to engineers, while a second section contains some notes on skin diseases produced by lubricants, and is prepared by Dr. J. C. Bridge, H.M. Medical Inspector of Factories (Home Office). Mr. Thomson divides the available cutting lubricants into various classes, comprising soluble oils, compounds which form a greasy paste when mixed with water, cutting-emulsions formed by mixing soluble oils with water, and cutting-oils (lard, oil, rape and mineral oils) which are free from water and ordinarily do not form emulsions with it. The qualities of these lubricants and liquids for (1) cooling, (2) lubrication, (3) the production of a smooth finish, (4) the washing away of chips, and (5) the production of the finished product from rust or corrosion are discussed, and some useful hints are given. The selection of cutting-lubricants is discussed in some detail, and here also the advice given is eminently practical. The same applies to the remarks of Dr. Bridge on skin diseases produced by lubricants. These comprise: (*a*) Plugging of the glands of the hair follicles—primarily a purely mechanical process, and (*b*) mechanical injury to the skin by suspended metallic particles, the abrasion enabling germs to enter, causing septic infection. The importance of cleanliness, both in the worker and the material, is insisted upon, and advice is given regarding the use of antiseptics, the sterilisation of cutting oil by heat and other preventive measures.

Deep Coal-Seam Working.—At the opening meeting of the Midland Institute of Mining, Civil and Mechanical Engineers, which was held at Leeds on the 17th inst., the "Peake" medal was presented to Sir Wm. E. Garforth, of the Altoft's Colliery. In the course of his reply, Sir William Garforth said the time had arrived when means should be taken to deal with the detrimental effects of continuous working under certain conditions of high temperature. From his experience at the Ashton Moss Colliery (the deepest in Great Britain) and others, he considered that many improvements which had been made during the last 30 years would be as essential in working seams of coal at 4,000 ft. as they had been within recent years in mines at one-third of that depth. Among these improvements were a safety lamp capable of withstanding an explosion current travelling at a high velocity, the introduction of electric light, the modern fan, and the mechanical cutting of the seam (in longwall working) in straight lines. There would be a greater percentage of small coal in deeper mines, but modern experience had shown that small coal had now become a valuable asset by the introduction of by-product plants. In order to effect a reduction of the temperature of the deeper mines, and render it as suitable for human effort as in seams of less depth, some modifications would be required of the systems hitherto adopted of conveying the intake air along certain roadways to the coal face and returning the vitiated air along other roads to the upcast shaft. Information was now required from the makers of modern refrigerating plants of their experience in cooling atmospheres, so that colliery officials might consider how similar systems might be utilised for reducing the temperature in deep workings.

Obituary.

T. R. Taltavall.—We regret to announce the death of Mr. Thos. R. Taltavall, editor of the "Telegraph and Telephone Age," and formerly an associate editor of the "Electrical World."

Dr. Wm. Kent.—The death is also announced of Dr. W. Kent, a well-known American mechanical engineer. From 1903 until 1908 he was dean of the College of Science at Syracuse University, and among his publications are Kent's "Mechanical Engineers' Pocket-Book" and works on "The Strength of Material" and "The Strength of Wrought Iron and Chain Cables."

J. O. Callender.—We regret to record the death of Mr. James Ormiston Callender, A.I.E.E. Mr. Callender, who was 35 years of age, was a son of the late Mr. W. O. Callender, and brother of Sir T. O. Callender. He was manager of Callender's Cable & Construction Co., and a director of the Uxbridge & District Electric Supply Company.

E. Russell-Clarke.—The death of Mr. Edward Russell-Clarke, C.B.E., A.I.E.E., occurred on Oct. 17. Mr. Russell-Clarke, who was 47 years of age, was a barrister-at-law, but during the period immediately preceding his decease he was engaged upon wireless telegraph research work for the Naval Intelligence Division. He was the leading junior at the Patent Bar, and a legal friend claims that by his wireless work, which undoubtedly caused his death, he rendered as great a service to his country as any man in the trenches.

Deaths on Active Service.—News has only just been received that Pte. W. R. Y. Kneller (Essex Regt.), formerly on office staff of rubber department of the India Rubber Company, died in Turkey on Oct. 29, 1917. He was taken prisoner in the first attack on Gaza.

Pte. A. Kettlewell (R.A.F.), formerly employed by Messrs. Dick, Kerr & Company, has died of wounds.

The death is announced of Wm. Millar Weir of Rutherglen), aged 18, while on duty as a wireless telegraphist on one of H.M. ships.

Lieut. Graham Johns (Scots Guards), who was killed in action on Sept. 27, had been an engineering pupil with Messrs. Vickers Limited.

Personal.

The King has granted permission to Mr. W. Bullard, of the Eastern Extension Australasia & China Telegraph Company, to wear the decoration of the Chinese Order of the Excellent Crop which has been conferred upon him by the President of the Republic of China.

Military Honours.—The President of the French Republic has conferred the Cross of Chevalier of the Legion of Honour on Captain Wedgwood Benn, D.S.O., D.F.C., M.P.

L.-Corp. F. G. Kane (Berkshire Regt.), formerly in the service of the India Rubber Company, has been awarded the Military Medal.

Messrs. A. Reyrolle & Company inform us that another employee of their firm, Pte. J. Stafford (R. Munster Fus.), has been awarded the Distinguished Conduct Medal. A gold albert was also presented to him by the firm and employees last week.

War Casualties.—Gunner S. A. Rushan (R.F.A.), formerly in the general office, and Pte. R. Blythe (Essex Regt.), formerly in the rubber department of the India Rubber Company, have been wounded.

Arrangements for the Week.

FRIDAY, Oct. 25th (to-day).

Physical Society.

5 p.m. At the Imperial College of Science, Imperial Institute-road, South Kensington, London, S.W. A discussion will take place on "The Case for a Ring Electron."

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. 1. Paper on "Cooling Towers," by Mr. J. Elliott.

North-East Coast Institution of Engineers and Shipbuilders.

7.30 p.m. At the Literary and Philosophical Society, Newcastle-on-Tyne. Presidential Address.

SATURDAY, Oct. 26th.

Manchester Association of Engineers.

6.30 p.m. At the Grand Hotel, Manchester. Paper on "Fuel Oil and its Applications," by Mr. A. F. Baillie.

Royal Engineers (Volunteers) London Army Troops Companies.

7.30 p.m. At Regent street Polytechnic, London, W. 1. Smoking Concert.

TUESDAY, Oct. 29th.

Junior Institution of Engineers, North-Eastern Section.

7.15 p.m. At the Mining Institute, Neville-street, Newcastle-on-Tyne. Paper on "Coal and Ash Handling Plants," by Mr. N. Thornton.

FRIDAY, Nov. 1st.

Junior Institution of Engineers

7.30 p.m. At 39, Victoria-street, London, S.W. 1. Paper on "Engineering as Applied to Cinemas," by Mr. W. E. Dines.

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Electric Traction on the Central Argentine Railway.

(*Continued from p.* 513.)

Power Station Switchgear.—All main switching is carried out at 20,000 volts. The main switchgear is located in a bay on the side of the engine room opposite to the pump house and boiler house, the operating gallery being raised about 4 ft. above the engine-room floor, so that the operator has a good view of all the machines. The generator panels, which are in the middle of the gallery (Fig. 4), are set round a recess, so that all the instruments and gear can be seen from one position. The station transformer and feeder panels stand on either side of the generator panels parallel to the axis of the engine room. Fig. 5 shows the general arrangement.

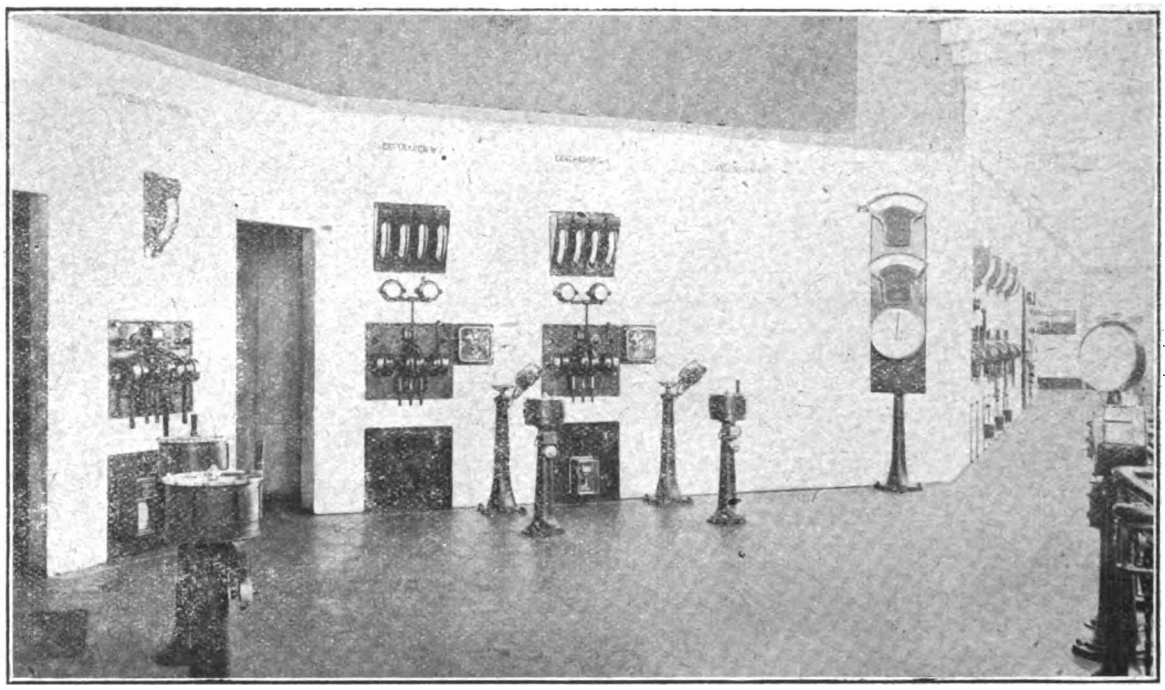

Fig. 4.—Main Switchboard in Power Station.

Each operating panel consists of two cast-iron plates built into a wall of moulded concrete 11 ft. high, faced with glazed tiles; this wall is set forward 3 ft. from the main panels, and at the back carries the auxiliary wiring, which is run as vulcanised indiarubber cable on porcelain racks. In the case of the generator panels, the instruments (of the edgewise pattern and comprising an ammeter, voltmeter, power-factor meter and indicating wattmeter), are mounted on the wall above the upper cast-iron plate. Below them are the red and green indicating lamps, which show whether the oil switch is closed or open. The upper cast-iron plate carries the oil switch operating handle, and, interlocked with it, the handles controlling the cable and bus-bar isolating switches. Below the oil switch lever are the automatic trip coils, and above it the time limit fuses. The voltage regulator is mounted on the wall to the left of the plate The bottom plate carries the integrating wattmeter, the exciter field switch, the governor control switch, and the change-over switches, for the voltage regulator and the ammeter.

In front of each generator panel is a pedestal carrying the exciter, ammeter and voltmeter, and the handwheel which operates the exciter field rheostat mounted on an intermediate floor in the basement. A second pedestal carries the transmitter of an electrically operated telegraph, by means of which the switchboard attendant can communicate with the driver when synchronising. Similar instruments mounted at the front of the gallery give communication with the boiler house.

The main panels are formed of moulded concrete cubicles 5 ft. wide; the main wall is 9 in. thick and the sides of the cells are 4 in. thick. Intermediate floors 4 in. thick separate each cubicle into five storeys, which (starting from the bottom) are occupied as follows (*a*) Potential transformers, (*b*) cable isolating switches and current transformers, (*c*) oil switch, (*d*) bus-bar isolating switches and (*e*) bus bars. The different compartments are protected by screens of expanded metal interlocked with the main switch, so that they can be opened only when the switch is open. The whole structure was moulded in position, the holes for the apparatus being cored out so that no cutting of the work was required. Porcelain only is used for insulation, and in general connections are made with bare copper, a minimum spacing of 15 in. between phases and to earth being adopted; where there is risk of conducting fumes causing short-circuits the leads are covered with porcelain tubes. Small wiring in the cells is kept down to a minimum, and is run as rubber-covered cable on porcelain cleats.

The three phases of each high-tension switch are contained in one tank, which is built up of wrought-iron plates with special stiffening channels to take care of the maximum pressure generated in the tank when the switch opens on a fault. A vent pipe leads from the top of the tank to the outside of the switch cubicle to carry off any gases that may form. The leads to the switch terminals are introduced into the tank through cast-iron U bends filled up solid with compound. Provision has had to be made for the expansion of this compound in hot weather, otherwise the bends or porcelains are liable to crack.

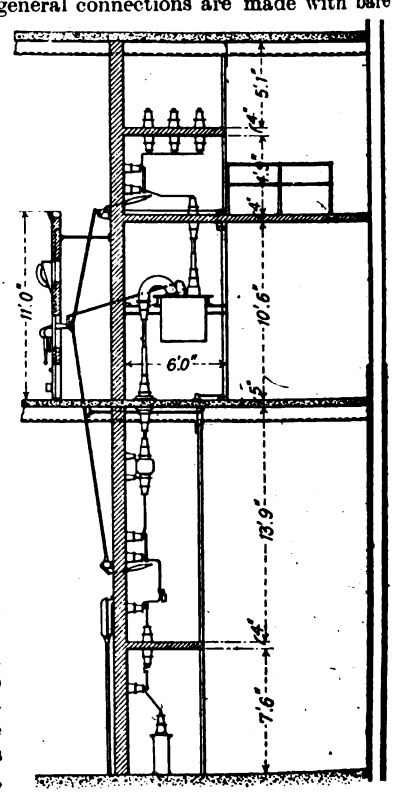

Fig. 5.—Section through Long Feeder Equipment, 20,000 volt Switchgear at Main Station.

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The current transformers are compound filled and ironclad. They are of two types, one suitable for mounting against a wall, the other passing through the floors between the compartments of the panels. The use of the latter saves floor insulators and economises space.

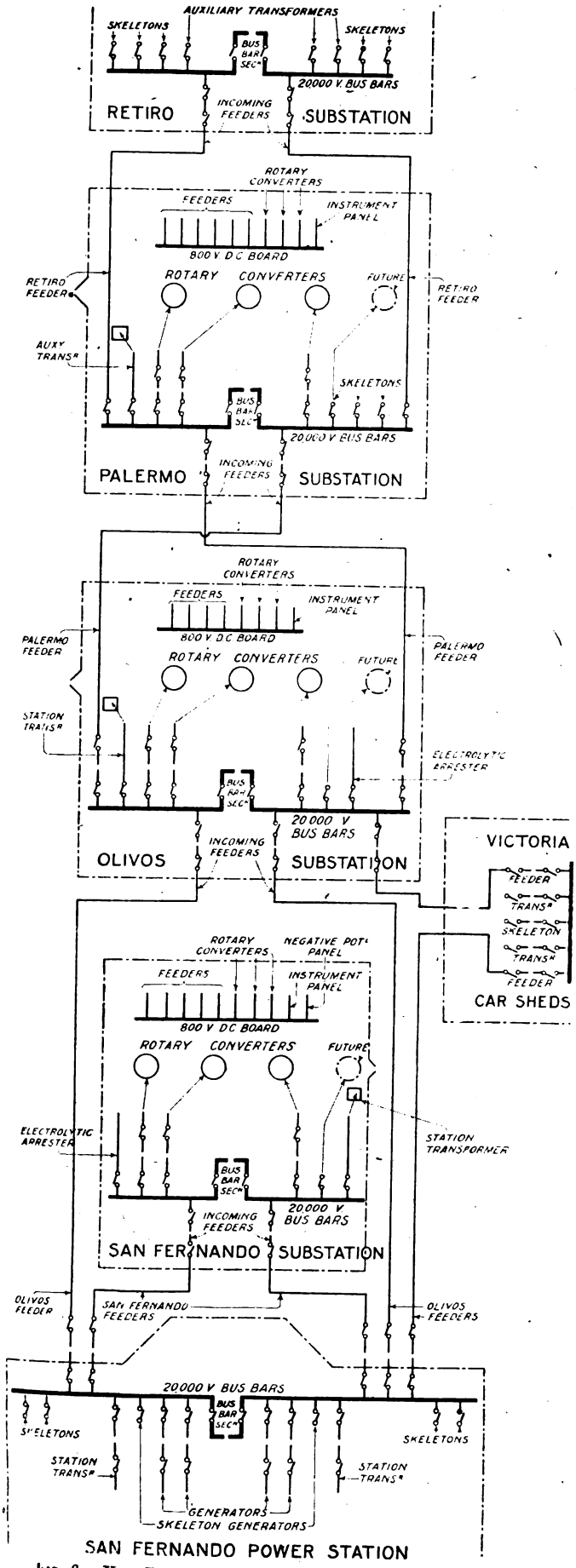

Fig. 6.—Key Diagram of Feeder Connections (20,000 volt Switchgear)

On the generator panels current transformers are provided for the instruments, the protective devices and the voltage regulators.

The potential transformers are oil-immersed and self-cooled. Isolating switches and fuses are installed between them and the cable terminals, so that a faulty transformer can be isolated from the rest of the switchgear.

Permanent testing bus bars are provided in the generator panels, connection to the main switch being made by removable jumpers. A water resistance was provided for taking the load of a generator under test; it consisted of three sets of wooden tanks mounted on insulators, and with a partition down the middle. The water passes up one compartment and down the other, leaving the tank at the end at which it entered. The dimensions of each tank are:—

Length of water column	...	6 ft.
Width of „	...	two columns each 9 in. wide
Depth of „	...	1 ft. 6 in.

The leads are attached to plates slung from a carriage, which can be moved along the tank to regulate the load on the generator. During the tests on the machines considerable difficulty was experienced in preventing the sides of the tanks from charring.

The unit distribution boards are built up of enamelled slate panels, and have the bus bars mounted in front; porcelain handle fuses connect the bus bars to studs, which pass through the slate to the motor leads at the back. The oil switch controlling the feeder cable from the unit transformer is mounted at the back of the panel along with the current transformers for the trip coils and instruments. Bus-bar isolating switches are mounted on the front of the incoming feeder panel.

The main motor distribution board is of slate panels, similar to the unit distribution board. It is surrounded with expanded metal to prevent articles from falling on it from the engine-room floor above.

Feeders are run from the station distribution board to the station auxiliaries, and also to the unit distribution boards, so that the latter can be made alive when a supply is not available from the unit transformers—*e.g.*, when starting up or shutting down a generator. In order to avoid any risk of paralleling a generator out of phase through its unit transformer, the switches on the two feeders to each unit distribution board (viz., from the unit transformer and the station distribution board) are interlocked, so that only one can be closed at once. They are also so arranged that the change over from one supply to the other can be so quickly effected while the auxiliary plant is running that there is no appreciable drop in the speed of the motors.

At each end of the switchboard gallery is installed a 110 volt direct-current board to control the supply from the lighting motor generators to the lighting circuits and the batteries. Two 250 ampere-hour Tudor batteries provide current for the indicating lamps on the main switchboard, the trip coils of feeders, electric telegraphs and a stand-by to the lighting system. The end cells of each battery are cut in or out of circuit by a solenoid operated remote controlled regulating switch.

The switchgear in the jetty pump house consists of seven ironclad switch panels.

The protective gear used for all high-pressure apparatus in the power station and on the system is of the Merz-Price type. Low-tension panels with oil switches are equipped with overload trip coils and time limit fuses.

Cables.

When the scheme was under consideration the split conductor system of feeder protection had not been sufficiently tried out to justify its adoption in foreign work of such importance. Accordingly the high-tension transmission system consists of 20,000 volt underground feeders, with three simple cores, and of pilot cables for the protective devices. A system of telephone cables was also installed (Fig. 6). Two high-tension cables are laid through the streets from the power station to the nearest point of the electrified railway track. Then they run, one on each side of the line, to Olivos sub-station, the western one being looped into Victoria power and lighting sub-station. A third feeder is taken from the power station to Olivos along the track via Anchorena. Two feeders run from Olivos sub-station to Palermo sub-station, and two from Palermo sub-station to Retiro power and lighting sub-station.

The high-tension cables (Fig. 7) are 0·1 sq. in. in section, 3-core, paper insulated, lead covered, single wire armoured; the pilot cables for the protective gear are 0·005 sq. in. in section, 3-core paper insulated, lead covered, single wire armoured; the telephone cables are 8-pair, dry core, air spaced, paper insulated, lead covered, single wire armoured, and suitable for the use of super-imposed circuits where necessary. Both below and on top of the armour all cables are served with specially compounded water-proof preservative coverings.

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In general the three types of cable are laid in the same trench at a distance of about 1 in. from each other. Above the high-tension cable and about 4 in. from it is laid a creosoted plank, 8 in. by 2 in., to protect the cables in case of future excavations. The high-tension cables were shipped on drums in lengths of 100 metres. On the Company's land the cable trenches were kept as far away as possible from the rails, the depth of the trench being at least 1 metre. Where an embankment extended to the boundary fence the trench was taken down till undisturbed ground was reached.

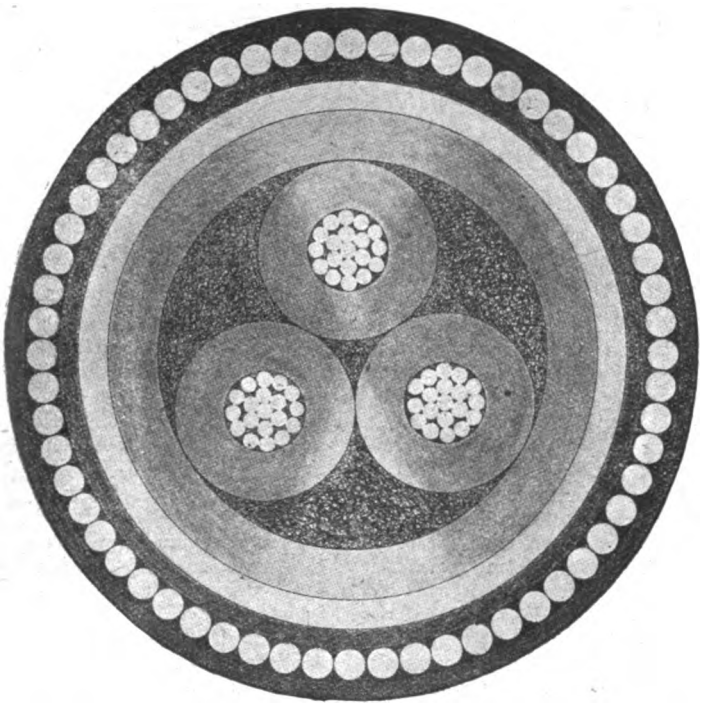

Fig. 7.—Section of 20,000v. E.H.T. Three-core Feeder Cable.

Where the cables cross bridges they are supported on cast-iron racks attached to the structure. Sheet steel covers are fixed over the troughs to shield them from the direct rays of the sun.

The feeder from the power station to Olivos via Anchorena is taken across the Canal San Fernando, which is navigable for barges and small boats, in a concrete tunnel laid in a trench in the bed of the canal. The internal diameter of the tunnel is 3 ft. and of the shafts 4 ft.

The direct-current feeders from the sub-stations to the track and the jumpers spanning gaps in the conductor rail are of 1 sq. in. section, paper insulated, vulcanised bitumen sheathed, taped and braided. They are laid solid in Key's fibre conduit filled with Trinidad bitumen. The conduits are 4⅛ in. external diameter and about 5 ft. long, the joints between conduits being made by fibre sleeves. The cables are supported in the conduits by fibre bridges. A creosoted plank is laid above the conduits.

The telephone system installed in connection with the electrification works provides communication between the power station and the sub-stations, the car sheds and the signal cabins in the electrified area. Twenty-two wire exchanges of the Sterling automatic type are installed at Victoria and at the power station.

Traction Sub-stations.

The line at present electrified is served by three traction sub-stations situated respectively as follows:—

San Fernando sub-station, about 1½ miles from the outer end of the line; Olivos sub-station, about midway along the line; Palermo sub-station, about 2½ miles from the city terminus (between Palermo and the terminus four tracks are equipped electrically).

The buildings are all of the same general design, being steel-framed structures walled with brick covered with armoured cement plaster. Each building is divided into three main aisles, the centre one containing the rotary converters and transformers and the side ones containing the high-tension and direct-current switchgear respectively. There is a loading bay at one end into which a siding comes, so that railway trucks can be brought under the overhead crane which traverses the whole building. Provision is made for extension of the building at the end away from the loading bay, when it is necessary to install further converter sets. The basement contains the main transformers, the potential and current transformers, the high and low-tension feeders, rotary field rheostats and battery. On the first floor are situated the rotaries, the 800 volt switchgear, a motor-generator, and on a raised gallery the high-tension operating gear.

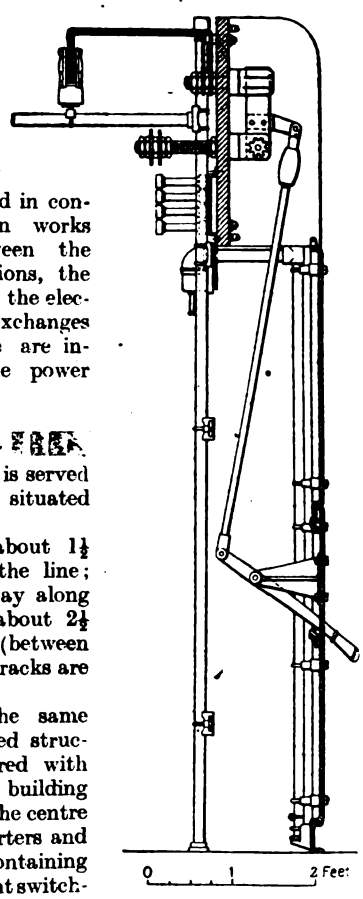

Fig. 9.—Side View of Rotary Converter Panel, showing Lever Switch, 800-volt D.C. Switchgear.

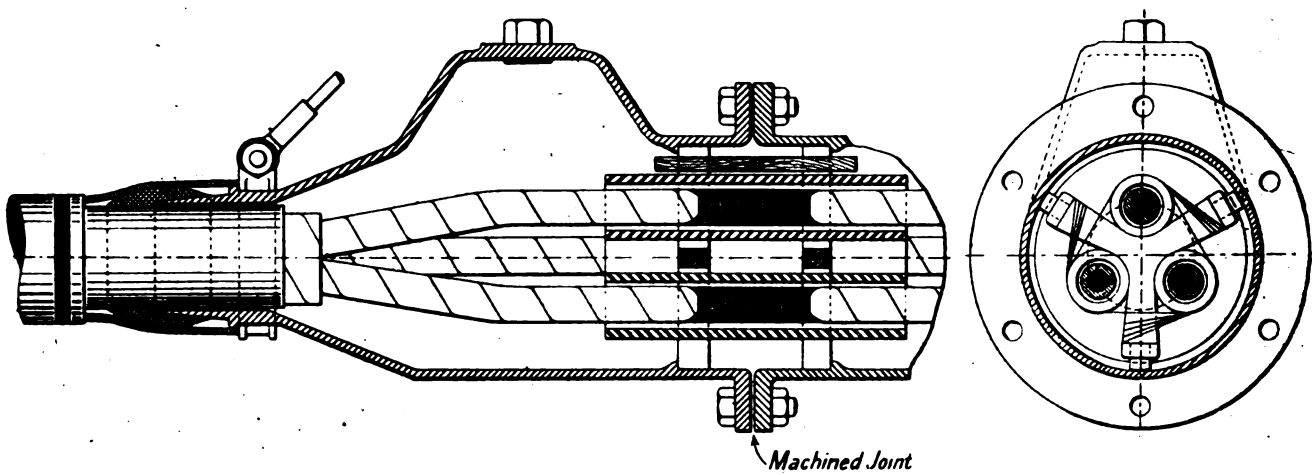

Fig. 8.—Joint in 0·1 sq. in. 3 core Paper Cable in Gunmetal Box, 20,000 volt. Scale, 1 : 5.

All joints in the high-tension cables were made in gun-metal sleeves (Fig. 8) wiped to the lead of the cable, the sleeves themselves being surrounded by a creosoted wooden box with an iron cover. The sleeves were filled with compound, great care being taken to avoid producing cavities in the filling. Wherever the armouring is interrupted the joint is spanned by a copper bond of 0·05 sq. in. section.

After laying and jointing, the high-tension cables were tested by applying for 15 minutes a pressure of 40,000 volts between any core and the lead and between any two cores.

Table IV.—*Details of Plant in Traction Sub-stations.*

Number of rotary converter sets at present installed.—In sub-station at Canal San Fernando, 3; Olivos, 3; Palermo, 3.

Type of rotary converters.—British Thomson-Houston Co.'s; compound-wound; commutating pole; six-phase diametrically connected.

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Output of rotary converters.—1,000 kw. at 800 volts, normal rating; 1,500 kw. for two hours; 2,000 kw. for ten minutes; 3,000 kw. momentarily.

Type of rotary converter transformers.—British Westinghouse Co.'s; single-phase; oil immersed; naturally cooled.

Capacity of transformers.—375 k.v.a.

Type and capacity of station transformers.—British Westinghouse Co.'s; three single-phase; oil immersed; naturally cooled.; each of 20 k.v.a. capacity; ratio of transformation 20,000 to 440 volts.

Type and capacity of station lighting transformer.—British Westinghouse Co.'s; one single-phase; oil immersed; naturally cooled; 10 k.v.a. capacity; ratio of transformation 440 to 110 volts.

Type and capacity of motor generator.—British Thomson-Houston Co.'s; 5 kw. capacity; alternating-current voltage 440; direct-current voltage 110.

Type and capacity of air compressor.—Alley & McLellan; 39 cubic ft. of free air per minute at a pressure of 60 lb. per square inch.

Type and capacity of ventilating fans.—Blackman; 25,000 cubic ft. of air per minute.

Type and size of secondary battery.—Tudor Accumulator Co.'s; 50 ampere-hours.

The high-tension gear is similar to that in the power station; the bus bars are sectioned and interconnected by an oil sectioning switch, the two halves of the bars being fed by different cables.

one-half gold size and one-half linseed oil. In addition, screens are fixed between the brush holders to prevent flashing round the commutator. By these and other means the number of flash-overs was reduced from an average of six per month during the first six months of operation to an average of two per month for succeeding months.

The transformers are mesh-connected on the high-tension side, with tappings on the high-tension side to compensate for variations in the supply voltage and on the low-tension side for starting. The tanks are $\frac{3}{4}$ in. boiler plate with external tubes to give increased cooling surface. They are mounted on rollers, so that when the core has been lifted by the overhead crane the tanks can be run out of the chamber and the core set down on a drip tray for examination. The chambers are ventilated by ducts carried up to the roof to Barrol ventilators; cooling air is drawn from outside the station by motor-driven fans and passed round the foundations of the converters into the transformer chambers through an expanded metal opening in the door.

The auxiliary equipment of each sub-station includes a bank of three single-phase transformers, which gives a supply to the motor-generator, air compressor used for cleaning purposes, ventilating fans, and the lighting transformer. The motor-generator gives a

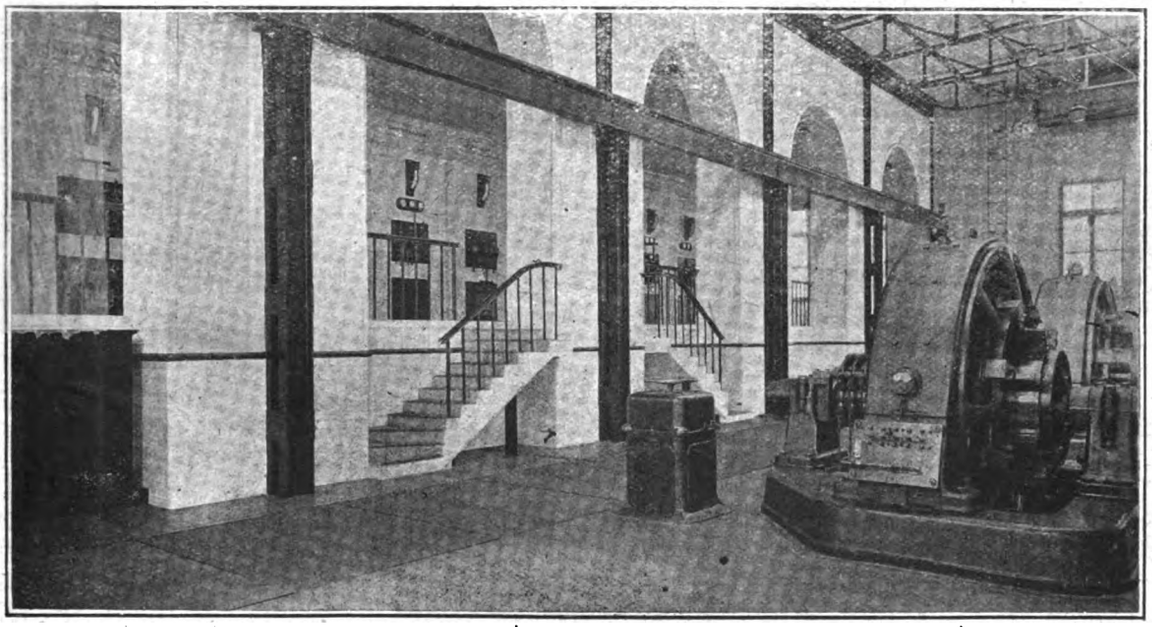

Fig. 10.—View of Rotary Converters.

The direct-current switchboard (Fig. 9) is built up of panels supported on a pipe framework. A single-pole circuit-breaker with overload and reverse current tripping coils and a knife switch which isolates the circuit-breaker from the bus bars, are mounted on a marble panel at a height of about 8 ft. from the floor. Marble partitions between adjacent panels form separate cubicles, and prevent the arc from a breaker which opens on a fault from travelling to adjoining switches. The switches are operated through wooden rods and porcelain insulators by handles which project through cast-iron panels mounted about 14 in. in front of the marble slab. In this way all live metal in front of the board is placed out of reach of a person standing on the floor. The generator panels carry handwheels for operating the rotary field rheostats which are mounted in the basement directly below the board. Differential relays are provided to prevent a circuit-breaker being closed when the polarity of its rotary is reversed. These operate in conjunction with indicating lamps which light up in such circumstances.

Table IV. gives particulars of the principal plant in the traction sub-stations. The rotary converters (Fig. 10) are self synchronising, and are started from tappings on the low-tension side of the transformers by an oil-immersed controller. Provision is made for coupling negative boosters to the ends of the shafts when the traffic increases to such an extent that the drop in the track rails becomes higher than desirable.

Special precautions have been taken to reduce to a minimum the flashing over which is liable to be caused by heavy short-circuits on the track. With this object the commutator cones have been covered with projecting fibre sleeves and all earthed metal near the commutators has been painted with a composition made up of

direct-current supply at 110 volts for charging the battery used for the tripping and indicating circuits and emergency lighting.

Negative Bus-bar Pilots.—In Olivos sub-station a panel is installed carrying two centre zero voltmeters connected to pilot wires running to the negative bus bars of the three sub-stations. A permanent deflection of one of the pointers indicates to the sub-station attendant that there is a difference of potential between the bus bars in two adjoining sub-stations and that one sub-station is "motoring" the other. He can then instruct one of the sub-stations to raise or lower its voltage of supply till it is taking its proper share of the load, and the transference of current ceases.

(To be continued.)

An Integrating Hemisphere.—In view of the tendency towards expressing the illuminating value of light sources in terms of the total flux of light in lumens, the design of "integrating spheres," capable of giving this value by a single measurement, deserves study. A recent contribution by Mr. F. A. Bensford to the "Transactions" of the American Illuminating Engineering Society, describes in detail some tests on one of the hemispherical halves of such a sphere. It appears that the use of such an hemisphere presents certain advantages, and, according to the author, the error, with a diameter of only one metre, can be reduced within 1 per cent.

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Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

(*Continued from page* 497.)

Summary.—In the first part of the article the inertia characteristic of a 10,000 lb. cylindro-conical drum winder hoisting 114 tons per hour from a depth of 4,170 ft. is determined. From this the accelerating and retarding moments are found, and these are combined with the resultant static torque diagram. In the second part of the article the question of unbalanced operation is considered, and the torque diagram is drawn for the 10,000 lb. winder previously studied.

Inertia.—The same method as that described in Example 5 will be used. The masses are divided into four parts, namely, the drums and coupled rotating parts, the loads and ropes depending from the drums, the ropes wound on the drums, and the pithead sheaves.

The total inertia of the drums and motor armature is stated to be 250,000+27,000=277,000.

Loads and Ropes Depending from Drums.—A summary is given in the table of the calculations that have been made for determining the inertia of the loads and ropes depending from the drums. The inertia of each side is plotted in Fig. 45, and the total inertia of this section is found by combining the two. It should be mentioned that we cannot use the torque

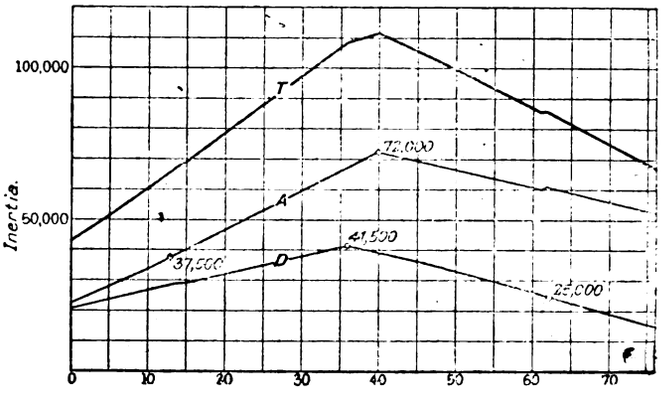

Fig. 45.—Inertia of Load and Ropes depending from Drums.

diagram, Fig. 43, for finding the inertia of the loads and ropes depending from the drums, because of the allowance made for friction.

Inertia of Loads and Free Ropes.

Ascending.				Descending.			
Turns.	*W* lbs.	ρ ft.	$I=\frac{W}{g}\rho^2$	Turns.	*W* lbs.	ρ ft.	$I=\frac{W}{g}\rho^2$
0	28,995	5·0	22,500	0	6,500	10·1	20,600
10	27,935	6·25	33,800	15	9,350	10·1	29,500
20	26,635	7·5	46,400	15	9,350	10·0	29,000
30	25,105	8·75	59,500	36	13,325	10·0	41,350
40	23,325	10·0	72,400	46	15,105	8·75	35,850
61	19,350	10·0	60,000	56	16,635	7·5	29,000
61	19,350	10·1	61,300	66	17,935	6·25	21,700
76	16,500	10·1	52,200	76	18,995	5·0	14,730

Rope on Drums.—In the upper part of Fig. 46 the thick lines represent the parts of the drums covered by the two ropes after *N* turns have been made. By means of this key, the reader should have little difficulty in constructing the inertia curves, shown in Fig. 46, for the ropes coiled on the drums.

Pit-head Sheaves.—At the beginning of the wind the equivalent inertia of the pit-head sheave, on the ascending side, is $4,000\times5^2\div6^2=2,780$, and after 40 turns of the drum it is equal to $4,000\times10^2\div6^2=11,120$. Towards the end of the wind, the rope begins to coil on the second layer of the cylindrical portion of the drum, and the drum radius is increased to 10·1 ft. The equivalent inertia of the sheave after 61 turns of the drum is, therefore, increased from 11,120 to 11,350. Remembering that the inertia curve is parabolic during the time the rope is on the cone it is a simple matter to draw the curve "A," Fig. 47, for the ascending side, and to turn this curve round in order to get the inertia curve "D" for the sheave on the descending side. The total inertia of the sheaves, represented by the curve "T" in the diagram, is obtained by combining the "A" and "D" curves.

Inertia Characteristic.—In Fig. 48 the several inertia curves are plotted to the same scale on a common base and combined to arrive at the total inertia of the moving masses. From

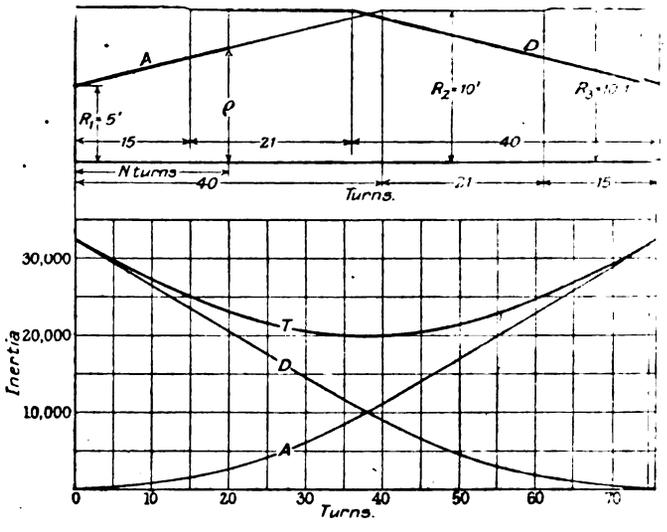

Fig. 46.—Inertia of the Ropes Coiled on the Drums.

this diagram it will be noticed that not only the sheaves but also the ropes coiled on the drums have little effect on the total inertia and, without appreciable error, approximations may be made which simplify the work.

Torque Diagram.

The static torque determined above has been re-plotted in Fig. 49. To the static torque, shown dotted in Fig. 49, must be added the torque required to accelerate the masses during

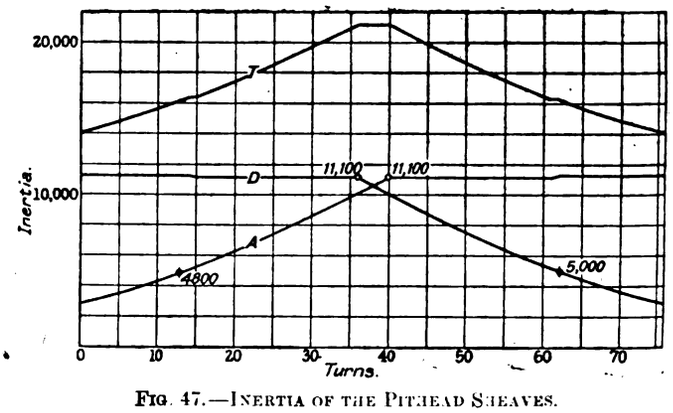

Fig. 47.—Inertia of the Pithead Sheaves.

the first part of the wind, and the retarding torque must be subtracted from the static torque during the stopping period. Furthermore, allowance must be made for the linear acceleration of the masses on the ascending side when the rope is on the cone and after the drum has attained maximum angular speed; similar allowance must be made for the linear retardation on the descending side when the rope starts unwinding from the cone and before angular retardation begins.

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Angular Acceleration and Retardation.—Starting from rest, the drum, after 28 seconds, under uniform angular acceleration, attains a speed of $55 \div 60 = 0{\cdot}918$ rev. per sec. The acceleration, therefore, is $0{\cdot}918 \times 2\pi \div 28 = 0{\cdot}206$ radian per sec. per sec., and during the accelerating period the drum makes $28 \times 0{\cdot}918 \div 2 = 12{\cdot}85$ revolutions.

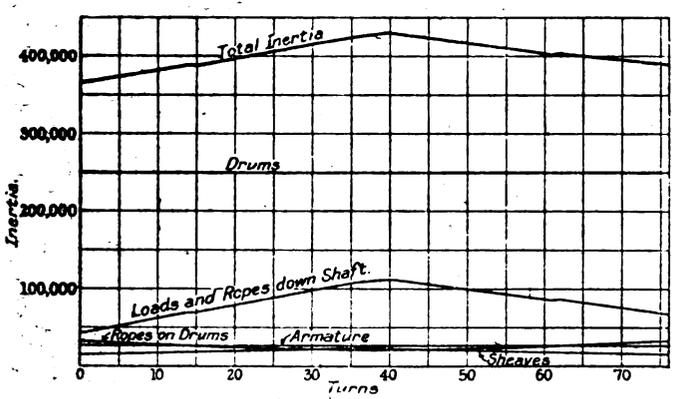

Fig. 48.—Inertia Characteristic and its Components (Figs. 45 to 47) for Balanced Winding.

At the beginning of the wind the inertia is seen, from Fig. 48, to be equal to 366,000. Hence

$$\text{Accelerating moment} = 366{,}000 \times 0{\cdot}206 = 75{,}400 \text{ lb. ft.}$$

This torque when added to the static torque at the commencement of the wind gives the total torque required for starting.

After 12·85 turns, the inertia is 387,000 and the accelerating moment = 79,700 lb. ft. This added to the static torque

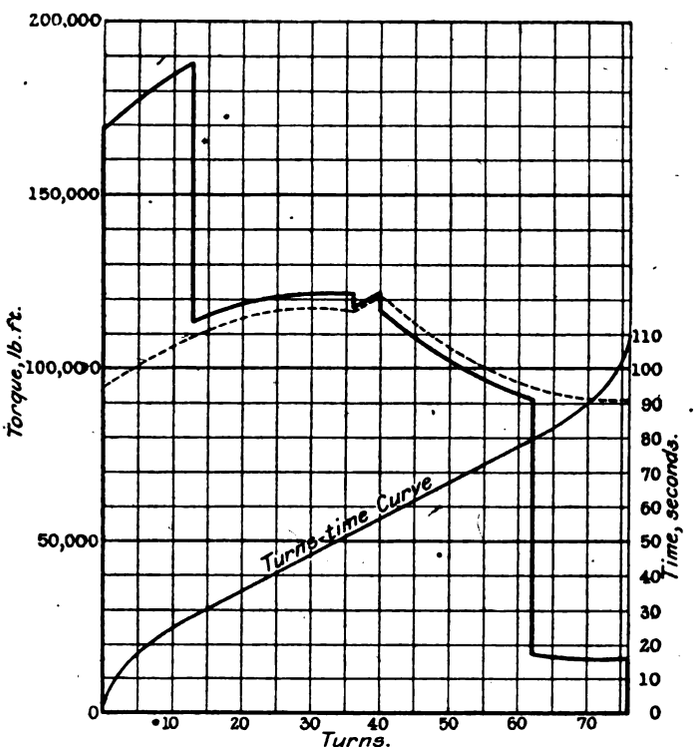

Fig. 49.—Torque-turn Diagram for Cylindro-Conical Drum Winder.

which exists when the drum has made 12·85 turns gives the total torque immediately before angular acceleration ceases.

In like manner other points during the period of angular acceleration are determined and through these points the total torque curve is drawn.

Similarly, the angular retardation is $0{\cdot}918 \times 2\pi \div 30 = 0{\cdot}192$ radian per sec. per sec., and during the retarding period the drum makes $30 \times 0{\cdot}918 \div 2 = 13{\cdot}77$ revolutions. Scaling the inertia from Fig. 48 it is found that when angular retardation begins the retarding moment $= 403{,}000 \times 0{\cdot}192 = 77{,}400$ lb. ft., and just before the end of the wind the retarding moment $= 390{,}000 \times 0{\cdot}192 = 74{,}900$ lb. ft. These, when combined with the corresponding values of the static torque, give another part of the total torque diagram.

Linear Acceleration and Retardation.—When the drum has made 12·85 turns a constant angular speed of 0·918 rev. per sec. is attained. At this instant, namely, 12·85 turns since the beginning of the wind, the drum radius is 6·6 ft. and the corresponding rope velocity $= 2\pi \times 6{\cdot}6 \times 0{\cdot}918 = 38{\cdot}08$ ft. per second. During the next $(40 - 12{\cdot}85) = 27{\cdot}15$ turns, or $27{\cdot}15 \div 0{\cdot}918 = 29{\cdot}57$ secs., the radius of the drum increases uniformly till the cylindrical portion is reached, when the radius is 10 ft. and the rope velocity is $2\pi \times 10 \times 0{\cdot}918 = 57{\cdot}65$ ft. per sec. Thus, during 29·57 secs. the rope velocity has been uniformly increased from 38·08 to 57·65 ft. per sec., or by 19·57 ft. per sec.; hence the linear acceleration is $19{\cdot}57 \div 29{\cdot}57 = 0{\cdot}69$ ft. per second per second. The masses undergoing acceleration, namely, the loaded skip, the rope

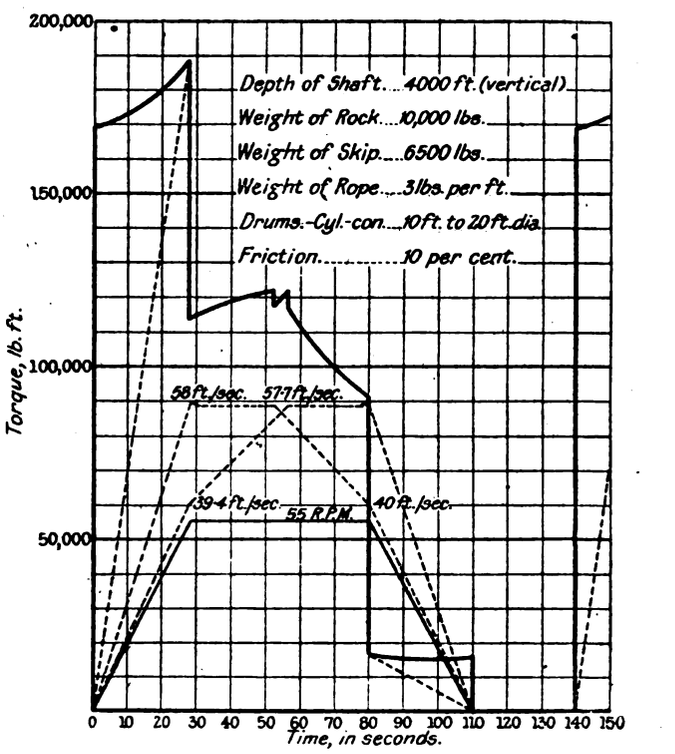

Fig. 50.—Torque Diagram of Cylindro-Conical Drum Winder (Balanced Operation).

and sheave are all on the ascending side, and the inertia values can be scaled direct from the "A" curves of Figs. 45 and 47, the values referred to being clearly indicated on the curves.

The accelerating torque is the product of mass, acceleration and drum radius, or, symbolically

$$m_t = \frac{W}{g} \times a \times R,$$

hence, at any instant, the accelerating torque is found by multiplying the inertia at the instant by the acceleration and dividing by the instantaneous drum radius.

Thirty-six turns after the commencement of the wind the rope on the descending side begins to uncoil from the conical portion of the drum, and during the next $(40 - 13{\cdot}77) = 26{\cdot}23$ turns, or 28·57 seconds, the velocity is uniformly decreased from 57·65 to 42·2 ft. per second. The linear retardation, therefore, is $15{\cdot}45 \div 28{\cdot}57 = 0{\cdot}54$ ft. per second per second. The inertia values of the loads undergoing linear retardation are scaled from the "D" curves of Figs. 45 and 47, the values being indicated on the curves. Finally, the retarding moments are found as described above.

The several steps in the calculations which lead to the

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evaluation of the accelerating and retarding moments are set out in the accompanying table.

Period.	Inertia $WR^2 \div g$.	Radius R.	$WR \div g$.	Acceleration a.	Torque $\frac{W}{g} a R$.
Beginning of linear acceleration	42,300	6·6 ft.	6,409	0·69	4,422
End of linear acceln. ...	83,100	10·0 ft.	8,310	0·69	5,734
Beginning of linear retardation	52,500	10·0 ft.	5,250	−0·54	2,835
End of linear retardn. ...	30,000	6·8 ft.	4,412	−0·54	2,382

The moments given in the last column of the above table suitably combined with the corresponding values of the static torque, as shown in Fig. 49, give the remaining points on the

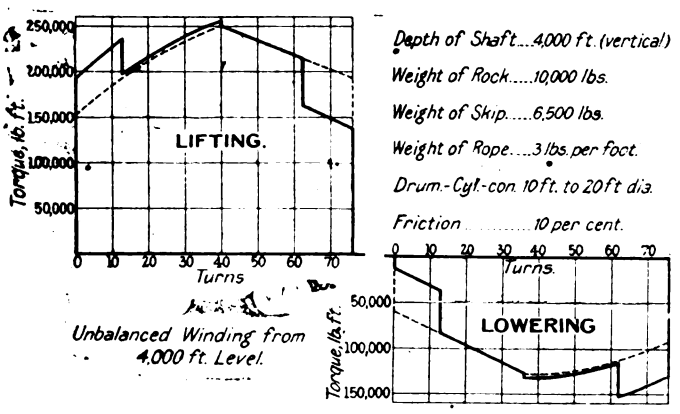

Fig. 51.—Torque Diagram for Cylindro-Conical Drum Winder.

total torque diagram. This diagram, which is represented by a thick black line in Fig. 49, has been plotted to a time base in Fig. 50.

Unbalanced Winding.

Remembering that the curves, Figs. 43 to 48 inclusive, when correctly interpreted, give all the information that is needed for drawing the total torque diagram either for balanced or unbalanced winding; the construction of the diagram for unbalanced winding follows the lines already laid down for the balanced diagram.

Static Torque.—When working unbalanced, the static torque during the lifting period is represented by the curve *feg* in Fig. 43, and during the lowering period the static torque is represented by *jklm*. Neglecting the kinks, or steps, both curves have been transferred to Fig. 51, the diagram for the lowering period being plotted on the negative side of the axis.

Accelerating and Retarding Moments.—To determine the accelerating and retarding moments the "A" inertia curves of Figs. 45 to 47 are used for the lifting period and the "D" curves for the lowering period. In the hope that those of his readers who are interested in this side of the subject will take the trouble to draw the diagrams for themselves, the author

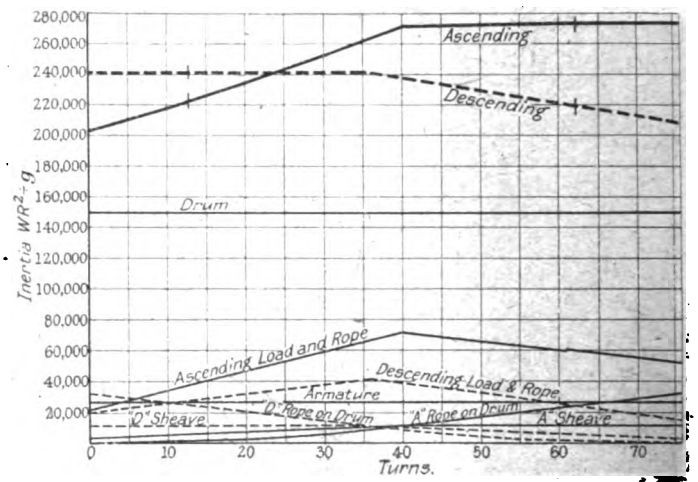

Fig. 52.—Inertia Characteristics and their Components for Unbalanced Winding.

has plotted the inertia characteristics and their components for unbalanced winding in Fig. 52. In plotting these characteristics the inertia of one drum has been taken at 60 per cent. of the inertia of the two drums so as to make some allowance for the inertia of the clutch which operates the idle drum.

Having found the inertia characteristics, the accelerating and retarding moments for unbalanced winding are determined in the manner described above for balanced winding. These, when combined with the static torque diagram, give the total torque diagram shown in Fig. 51.

(To be continued.)

The Electrical Equipment of Keadby Bridge.

(Concluded from page 517.)

Generator Equipment.

Owing to the absence of power in the neighbourhood, a special plant for the generation of current was installed, consisting of two 70 B.H.P. four-cylinder petrol engines, running at 700 revs. per min., and direct coupled to two B.T.-H. direct-current six-pole shunt-wound generators of 50 kw. capacity at 220 volts. A storage battery of 128 cells is provided, capable of supplying the motors with current for about 30 operations of the bridge before re-charging is necessary. The arrangement of the generating plant and switchboard is shown in Fig. 4.

Electrical Control Equipment.

The whole of the operations involved in the lifting and lowering of the moving leaf are normally controlled by electrical equipment designed and installed by the British Thomson-Houston Company Ltd., of Rugby.

The moving leaf is worked by means of two-direct-current 115 H.P. 220-volt motors, having a normal full-load speed of 380 revs. per min. and an overload capacity of 100 per cent. These motors are compound wound with shunt starting fields, and are carried on the leaf itself; they are coupled back to back, and arranged so as to work either singly or in parallel.

The method of control is such that by operating suitable switches either of the two motors can be used independently of the other, and all safeguards apply to either arrangement, thus, in the event of the breakdown of one machine, it is possible to use the other under all but the most abnormal conditions.

The driving power is transmitted through independent trains of gearing to the main pinions on each side of the moving leaf. The angle of maximum elevation of the bridge when fully open is 81°–51′, and the time taken to open or close it electrically is less than two minutes.

Owing to the very exacting weather conditions to be met, and to the fact that it is essential to interlock the railway signal system with the operating gear for the bridge leaf, the control gear is somewhat complicated. In a bridge of this description it is essential that the interlocking arrangements shall obviate all possibility of either rail or road traffic using the bridge in any position but completely down. Further, it is essential that all safety devices shall be operated in such a manner that they act automatically in the event of failure of the power supply.

Arrangements are made so that when a circuit breaker opens, either in the operating cabin or in the main machinery house, all brakes are applied automatically.

The conditions to be met in the actual operation of the bridge leaf itself are very stringent. The leaf must be under the full control of the operator at all times and in all wind conditions, and it must be possible for an unskilled operator to open or close the bridge

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without causing any damage. The system of control adopted enables these conditions to be met quite easily in spite of the great mass of moving elements.

Lowering the Bridge.

The method of control adopted when lowering the bridge comprises series resistance control for the greater portion of the travel and diverter control with limited power for the last few feet of the travel. For this purpose limit switches are arranged in such a manner that at a pre-determined angle of the bridge when lowering certain contactors are opened, thereby inserting series resistance in the armature circuit of the driving motors, while at the same time a diverter circuit is made to give a positive slow speed, practically independent of the load on the machines. At a slightly later period of the travel another limit switch operates, cutting off power entirely and causing the bridge to stop a few feet away from the ground

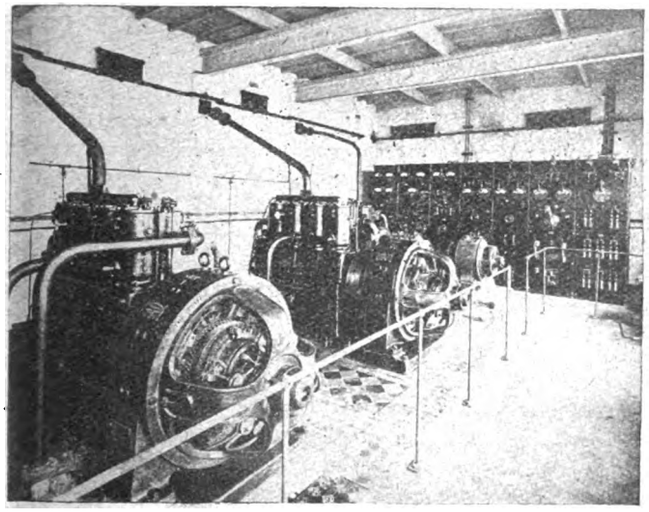

Fig. 4.—Interior of Power-House, showing B.T.-H. Generators and Switchgear.

level. The operator can then, by means of a special pedal switch equipment, inch the bridge down under diverter control with a limited amount of power; the provision of an oil buffer ensures that the leaf can be brought to the fully closed position without a perceptible jar. Further provision is made so that, by moving the controller handle at the same time as operating the pedal, it is possible to vary the amount of braking effect given by a special motor operated brake, thus giving a variation in speed corresponding to the limited power already mentioned.

The braking arrangements are very complete and comprise two sets of brakes operated by a direct current 1-h.p., 220-volt, series wound motor and two sets of solenoid brakes operating on drums, geared to the driving motor shafts. All brakes are arranged to set automatically in the event of voltage failure irrespective of the position of the controller handle.

Raising the Bridge.

The method of control for raising the bridge is similar to that already described for lowering, except that no diverter control is provided; this is unnecessary, as the bridge is not usually opened to the full extent of its lift, and consequently the amount of over-run allowed is much in excess of that actually required.

There is one important factor in connection with the lifting however, which has to be taken care of, namely the effect of wind pressure. Under certain conditions a strong wind will actually run the bridge backwards, and special limit switches are arranged so that when this happens all brakes are applied when the bridge reaches a pre-determined angle. This safeguard also comes into operation when starting to lower the bridge from the fully open position. This is essential, as under certain conditions a strong wind may take control and run the bridge backwards when the brakes are released, and before power is applied. This can be stopped, of course, by the operator applying power, but should he lose control and allow the bridge to continue to coast, the matter is automatically taken care of when the pre-determined angle previously mentioned is reached.

Contactor Gear.

The contactor equipment for the control of the bridge movements is located in the machinery house. It consists of a panel for each separate motor, containing the various line and resistance contactors, over-load relay and isolating main switch and fuses. This panel is controlled by a special controller comprising two parts, the first operating the contactor gear which makes the connections for raising and lowering the bridge, and the second varying the amount of resistance in series with the motor operating the brakes. Thus, by moving the controller handle, it is possible first of all to free the solenoid brakes, and then to vary the effect of the motor brakes from maximum near the off position to zero when the first power position is reached. A coasting point is provided between the last braking position and the first power notch, so that if desired, wind pressure can be used to lift the bridge, the motor and solenoid brakes being brought into action when it is desired to stop.

With the controller is incorporated a special locking magnet, operated from the signal circuits, which ensures that the controller handle cannot be moved to open the bridge until the signals are set to "danger." Further, the signals cannot be set clear until the bridge is in the fully closed position A special motor is used in connection with the locking bolts between the rails on the moving leaf and those on the fixed span. These rails are locked in the down position by means of steel bolts controlled from the signal cabin. The bridge itself is locked in the down position by two heavy forged steel bolts worked electrically by means of a direct current 1½-h.p. 110 volt series wound motor operated from the control cabin. These steel bolts engage with castings anchored to the pier, and arrangements are made so that it is impossible to operate the contactors for lifting until these bolts are withdrawn; the bolts cannot be closed when lowering until the bridge is right down and control has been cut off from the contactor panel.

Provision is made for reversing the motors by means of a special reverser situated on the moving leaf, and the special limit switches referred to in the foregoing description, are operated by means of sprocket gearing which is driven from the main motor shaft. These limit switches are situated in the machinery house on the moving leaf.

Electrically operated gates, opened and shut by a direct current 4½-h.p., 220-volt compound wound motor, are provided for the

Fig. 5.—Interior of Operator's Cabin, showing Master Controller in Background.

protection of the railway traffic. These gates are interlocked with the railway signals which, in turn, are interlocked with the control gear on the bridge.

This bridge was built to the designs, and under the supervision, of J. B. Ball, Esq., M.I.C.E., Chief Engineer of the Great Central Railway, by Sir Wm. Arrol & Company, Ltd., of Glasgow; the electrical equipment was supplied by the British Thomson-Houston Company, of Rugby.

Meter-Testing in Germany.—The "Physikalisch-Technische Reichsanstalt" has recently issued new regulations relating to the testing of electric meters. During the period of testing all auxiliary apparatus such as are actuated by the transformer in practice must be included in the circuit or replaced by resistance coils of equivalent energy consumption and power factor. An equivalent resistance must also be substituted for the secondary leads of a current transformer if these exceed 0·15 ohm.

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The Electrician.

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The British Designer of To-morrow.

In our last issue we dealt with the Designer of Yesterday, and pointed out that in many ways the designer of electrical machinery in pre-war days was in an unsatisfactory position. Not only so, but the work of British designers did not reach the standard that was desirable.

It may be asked, What was the reason for this unsatisfactory state of affairs? First and foremost is the fact that there are more would-be designers than there are positions to be filled, but it is also largely due to the fact that there are good, bad and indifferent designers, all of which have their influence. We need scarcely say that the bad and the indifferent designers are two evils, but of the two the bad designer is the less serious, because he is not likely to survive his bad designs for very long. In other words, having found that bad designing is not a suitable career, he seeks some other means of existence, and the engineering industry benefits accordingly. Whether the other chosen industry benefits also we do not know, but in all charity we must hope that it does so. The indifferent designer, however, is a positive evil. He will certainly not follow the path of progress; he will have little faith in striking out into new lines, and his designs could be developed by anyone who possessed the necessary rules. They are just sufficiently good for commercial purposes and sufficiently bad to prevent his firm from turning out really good plant. They have probably met the need for many years, and for that very reason the employer does not care to dispense with his services, and so the indifferent designs continue. But it will be seen that such a designer is a source of great weakness to the electrical industry.

There were faults, however, on the side of the employer also, to which the position must be mainly attributed. It is quite useless to expect to have good designers unless they can have good salaries and reasonable prospects. In other words, for the short ladder of promotion hitherto in view must be substituted a much longer ladder, which the ambitious designer may climb and find some serious reward at the top, in tead of the mere privilege of earning a small salary for large responsibilities. On the Continent the designer knows that there is always the possibility of becoming a technical director of his firm, with a recognised position; whereas in this country the layman has looked upon the designer as a sort of draughtsman of little consequence. There is no reason why the technical director should not also find a place in British companies. At present there is a tendency to develop consulting designers, and this course has certain advantages—at least, in the case of the smaller firms. If a firm prefers to employ a man as chief designer for all his time then he should be encouraged to keep alert, instead of being frequently discouraged to undertake anything in the nature of research or the leaving behind of well worn lines. Stated bluntly, there is no need for firms to encourage indifferent designers. Whatever the causes in the past that created this class—whether due to inferior training facilities, or small concerns handicapped by keen or unfair competition—no such excuses are admissible at the present day, with our well-equipped colleges and large electrical amalgamations. Neither the designer nor his prospects must ever be allowed again to get into the rut.

Another question is that of agreements. Many firms, when they find a good man, attempt to keep him by some binding agreement. This is seldom a good method to follow, for the simple reason that it means the designer loses all prospect of anything better, and therefore he inevitably, sooner or later, loses the incentive to produce the best work. It is better that there should be freedom on both sides, without the fear that the particular designs which have been evolved will go elsewhere. It is good for a young man to move about, as this is the best antidote for staleness—some of our best men are those who have worked for several firms. After all, the value of a man of this kind does not consist so much in his knowledge of other firms' methods and designs as in his own experience, and in his ability to look forward and see what should be the designs to meet the conditions of the near future.

We hope that the enlightened board of directors, when the war is over, will deal liberally with their designer. We can imagine an interview with Mr. A.B.C., the designer in question. The chairman remarks that there is keen competition ahead; that there is no good in having good salesmen unless the design of the plant that is to be sold is thoroughly up to date; that the board expect Mr. A.B.C. to look to the future; that they will support all reasonable innovations in design, and will provide facilities for such experimental work as may be necessary; and last, but not least, that they will give good remuneration and prospects for work on whose quality the ultimate success of the firm must largely depend.

With an enlightened policy, the Designer of To-morrow will differ markedly from the Designer of Yesterday, and the progress of the British electrical industry will in every way be the gainer.

Reviews.

Decimal Money Tables. By A. M. Pooley, B.A. (London: The Syren & Shipping, Ltd.) Pp. 47. 2s. 6d. net.

In view of the interest taken since the outbreak of war in decimal measures, and their probable adoption in some form in the near future, this series of conversion tables is opportune. In the Introduction it is recalled that the Institute of Bankers, the Associated Chambers of Commerce, and the Decimal Association have proposed the decimalisation of the sovereign, and that a Bill has been introduced to give effect to this proposal, and it is remarked that a number of firms have already commenced keeping their books in decimalised pounds. The tables comprise ready reckoners for converting English into foreign money; conversion tables for fractions and decimals; interest tables, &c.; and should be specially useful to firms who habitually deal with money and accounts.

Soldiers of Labour. By Bart. Kennedy. (London: Hodder & Stoughton.) Pp. 114. 1s. net.

This is a picturesque and popular account of the contribution of Labour to the present world struggle in various fields of activity. The short chapter on "Labour Physiology" is opportune, and rightly sarcastic. Briefly, the theme of the author here is that more work can be got from men by working them 54 hours a week than by working them 80 or 90, and still more by working them 48 hours a week. We agree.

Workmen's Time and Balance Book. 1s.

A handy workman's time and balance book has reached us from Mr. W. F. Chalker (of 64, Copelston-road, Dulwich). It consists of a series of printed forms with columns for order number, name of job, time worked and money drawn, &c., and can be easily slipped into the pocket. Copies (1s. plus postage, presumably 1½d.) can be obtained on application to the above address.

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Mr. H. I. Rogers' Address to the I.E.E. Western Section.*

I want to speak to you this evening more particularly on what appears to me to be the lessons of the war to us electrical engineers. I am going to approach the subject from the manufacturers' point of view, which, in my opinion, is the basic one and that from which the whole industry should be controlled.

All industry should be treated in the future entirely from the national point of view—indeed, not only as a national question, but as an imperial one. The want of guidance of our electrical industry has been the principal factor in its want of success. Instead of each individual working as if he were guarding a great national trust, there has been unnecessary and destructive competition. Moreover, the best minds and organising ability have been frittered away in a vain attempt to bolster up most inefficient methods of power distribution. Too many consulting engineers vied with power distribution engineers to force manufacturers to depart from well-established practice. Manufacturers instead of being prepared freely to exchange the results of their experience and knowledge amongst themselves were engaged in fratricidal war. They have now learned the advantages of Government co-operation and the importance of standardising their products. It will be a most difficult reconstruction problem to teach the worker that if he wants higher wages, shorter hours, and consequently improved conditions of life, he must produce to the utmost of his capacity. The industry before the war was in a very poor state financially. In evidence given to the Committee on the position of the electrical trades after the war it was shown that 32 electrical firms with an aggregate initial paid-up capital of just over £15,000,000 had had to write off no less a sum than £3,125,000, and that few of such companies had ever earned a satisfactory return on their capital.

Turning to the Coal Conservation Committee's report we find described a most chaotic state of affairs. We have 600 undertakings supplying power, and of these, those which have power stations, have an average generating plant capacity of 5,000 H.P., or about one-fourth of the capacity of one single generating machine of what the Committee consider of economical size; eight power stations have been added in the last few years to the 21 already existing in London, because no large central supply was available, and these are badly situated as regards water facilities. In the great manufacturing districts of Lancashire the average charge for electric power in 23 areas is 1·32d. per unit, whereas the price paid for electrical energy is less than ½d. per unit in the less densely populated North-east coast district, supplied by a group of power companies from one inter-connected electrical distribution system. (This concern supplies 15,000 H.P. to one motor, and another of 20,000 H.P. is being installed.)

The causes of this extremely unsatisfactory state of affairs may be summarised thus: (1) The extremely unsatisfactory method of power distribution to which I have already referred led to high cost of power, thus crippling the industry; (2) the policy of free imports; (3) the disadvantages of municipal control; (4) the status of the engineer; (5) the divorce of science from industry; (6) the harm often done to the industry by the consulting engineer; (7) the criminal folly of allowing merchants to compete with the home industry by selling cheap foreign manufactures; (8) the want of proper education of the worker.

As regards power distribution and manufacture, we have been engaged in pioneer work. Development has had to be dearly bought because discoveries and improvements have made obsolete much of the material that great expenditure was incurred upon quite justifiably a few years back. Moreover, we in Britain have been heavily handicapped electrically because of the cheap cost of coal and the highly developed state and efficiency at the inception of the industry of the steam and gas engine—disadvantages which our foreign competitors had not to the same degree.

The policy of municipal control of the electric supply has proved disastrous. The control of a vital part of the industry cannot be allowed to remain in the hands of local electrical committees practically entirely composed of people who are ignorant of the subject with which they have to deal. Engineers must control their own affairs with, perhaps, Government co-operation, thus releasing many of our best men for industry. The cost of power must be enormously reduced. Where in Britain £33 value of home-made electrical machinery is consumed per 100 people, £70 is used in Germany; the power used per worker in America is twice that used here. The war has proved the enormous importance and, indeed, the indispensability of the engineer. We must see that the country does not forget it in the future. We must inculcate into the budding engineer a better idea of the enormous importance of his work to national life; he must take more interest in the national life, but, above all, we must see that he is very much better educated, not only from a technical point of view, but from that of a man of the world. I believe there is not nearly enough ambition among engineers. A great effort ought to be made in Bristol and other cities to start a club or institution where engineers and scientific people might gather together for exchange of views and meetings, and where a good reference library and all the technical papers, both British and foreign, might be available for the members.

In future there should be two paths open to the scientific man. First teaching and scientific research in universities and Government Institutions. But even here the industry must to a great extent control the teaching and to some extent the research work. This, perhaps, will come about by manufacturers adopting the sandwich system of education and so being brought more closely in touch with the teaching profession. The higher branches of scientific research no doubt will always be carried on in the universities, but there is a great opening for scientific research with a more practical bias in the workshops of the country. The scandal of the low pay of the scientific worker must be removed, and from the fact that a great number more of them will be employed in industrial work they should be enabled to demand much higher remuneration, perhaps through the instrumentality of their professional organisation, I would not call it their trade union.

This brings me to the subject of the consulting engineer. With the highly developed technical side of the industry manufacturers will be practically invariably able to properly advise and engineer their contracts. Consulting engineers of the future will fulfil similar functions to the consulting physician or surgeon. This will lead to a great increase of standardisation. My firm has been engaged for the last 3½ years in the manufacture of shells, and we have found that while the wages per head have rather more than doubled, the output per head has quadrupled in value; this is not due to war prices, as shells are one of the few commodities the price of which has been greatly reduced since the war began. The best example of such successful repetition work in the engineering world is the Ford car, the price of which has been down to practically £90, and they now hope to get down after the war to £75. Meanwhile the firm pay £1 a day minimum wage, have £17,000,000 in the bank and have 38,000 contented workers.

I have left, perhaps, the most important cause of the failure of the industry to the last, namely the excessive and unnecessary competition between different manufacturers. Electrical apparatus is inherently cheap if manufactured under right conditions. All parts should be produced on a repetitive basis, and if so quality can be of the highest and conditions of the workers can be of the best; but this can only be done if the purchasing public will buy the resulting apparatus. The consumer must standardise his requirements. The manufacturer must produce apparatus which will stand the acid test of service. The best designed appliances, under proper conditions of manufacture, cost no more than apparatus of poor design. Under these conditions the industry would be profitable to the workers and ensure good wages; it would be profitable to the manufacturer and ensure financial stability, and it is profitable to the consumer because it would ensure him machinery of good quality at a reasonable cost.

A matter of vital importance to the industry has been the want of proper educated workers in it. Much more interest in educational matters should be taken by the engineer. Since the commencement of the war the manufacturing engineers in Bristol requested the Educational Committee to afford better facilities for giving technical education to prospective employees, and in September, 1917, a junior technical school was started, which will be of great value to the industry in future. The boys go to the school after leaving the elementary school and have two years' whole-time education with a considerable technical bias, and at the same time general education is by no means neglected. The manufacturers have undertaken to absorb these boys in their works when their time expires, and this has had an excellent effect on the boys. With the spread of education amongst the workers and the awakening thereby of a fuller realisation of the importance to the nation of each man giving his best for the good of the community, industrial unrest will be greatly reduced.

* Abstract.

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Industrial Coal Economy.*

By D. WILSON.

It has been my good fortune to travel all over the world in connection with the scientific combustion of coal, and this, in conjunction with the general survey which I am making for the Coal Controller, enables me to take a broader view of the situation than those whose experience has been confined to a more limited radius. I attach the greatest importance to the value of travel, which often reveals the fact that amidst the maze of side paths which many are following, there is a broad main road along which the army of progress will eventually march. By obtaining collective first-hand information one can more accurately gauge the limitations of the side paths and the better standardise the main effort. There has been too much selfish pride in individual effort, and there is yet much co-operative work to be done by engineers-in-charge visiting power stations and works all over the country, and ascertaining exactly what is going on.

It is my desire to confine myself mainly to suggestions which might materialise in the immediate future. The total consumption of coal in the British Isles during the year 1917 was approximately 180 million tons, and of this amount, approximately 7,500,000 tons were consumed by the electrical industry, or, say, 4 per cent. The total number of units generated during 1917 were approximately 5,000 millions, so that the average efficiency is represented by a figure of 3·36 lb. per kw.-hour generated. The total coal used by industrial firms, exclusive of railways, coasting steamers, gas-works and domestic purposes, is approximately 100 millions per annum, of which about 80 millions are used per annum directly for power production. Since the electrical industry is collectively the most efficient consumer of coal so far as steam raising is concerned, we cannot expect from this industry any great reduction in total tonnage as a result of further economy, but as the last man may decide the war, so may the last ton of coal be of supreme importance.

Now you naturally ask me, what more can you do to help? and I will endeavour to answer you.

1. *Find out definitely what you* ARE *doing.*—Before I joined the Coal Controller, I knew that the absence of detailed information was responsible for a great wastage of coal—a belief which subsequent experience has confirmed. The electrical industry has done well in establishing detailed records, but the want of definite knowledge regarding the working of steam plants in many industrial undertakings is deplorable. We sent out a simple questionnaire to all industrial firms in the country. If the answers had been even approximately correct, I could have put my finger on each inefficient works. What happened? The efficiency information in most cases was inaccurate, and it appeared that many firms had simply asked the boiler contractors or insurance companies what number they should multiply the coal tonnage by, to get the evaporation figure. Now it should be possible for all industrial firms to at least approach the methods of the best managed electrical undertakings in obtaining records.

No one should be allowed to use up one of the country's most valuable assets unless he can show that it is being used efficiently. The Coal Controller's records show that even the electrical industry can do much more in this direction. Coal consumptions vary from 2 lb. per unit to 18 lb. per unit, and the thermal efficiency from 3 per cent. to 16 per cent. The common reply from the inefficient station is that the bad results are due to poor load factor, obsolete plants, &c., whilst some engineers are too ready to attribute the whole of the inefficiency to these conditions. If not only the correct average steam consumption of his station, and the average efficiency of the boiler house, but also the individual steam consumption of any engine or turbine, or the efficiency of each individual boiler were obtained regularly, it would often be found that after making due allowance for poor load factor, obsolete plant, &c., there is a large unaccounted loss which should not exist. Therefore the first thing to do is to establish definitely what each section of the plant is doing.

2. *Staff.*—Close co-operation between engineers and managers and the men who actually fire the coal, is essential. In many establishments no interest whatever is taken in the fireman or his work. Engineers should devote more time to the boiler house. America has done much in this direction, and the late Mr. Stott, engineer of the Rapid Transit Railway, New York, was, before he died, seriously considering the employment of trained engineers to actually control the individual furnaces. No boiler house of any size should be without some staff fully trained in the scientific combustion of coal. I know of one power station where the engineer-in-charge is giving weekly lectures to the firemen, which are greatly appreciated and producing improved results in the boiler house. A course of such lectures should be given to every boiler house staff.

3. *Boiler House Equipment.*—Much good can be done with simple and obtainable apparatus. Relatively few works possess even the pyrometer, draught gauges, &c., necessary for intelligently controlling efficiency. If the average efficiency is going to be raised, the daily performance of each individual boiler should be very closely watched, and every boiler should be equipped with a draught gauge so that the fireman can correctly adjust the air supply and the fire bed to give the best results. Every plant should have some simple form of CO_2 analyser for obtaining a knowledge of the conditions existing within the furnace, and one or two "Orsat" sets should be in daily use in every boiler house—an inexpensive piece of apparatus and reliable. Much can be done with a few pyrometers, and no works should be without some fairly reliable data as to the temperature of the escaping gases.

4. *Engine Room Equipment.*—Here again arrangements should be made for more accurately determining the actual steam consumption of the individual plants. In too many cases do I find that the figures are simply based upon contractors' original guarantees.

There is apparatus on the market for correctly recording the hourly consumption of each plant, and some stations, such as the L.C.C., Greenwich, have installed such apparatus on each individual unit. There are other simple methods which can be introduced by using existing tanks, &c.

5. *Coal.*—I know that here I touch dangerous ground. There is no question that the highest thermal efficiency is obtained when burning the highest quality of coal, but the commercial economic result may be in favour of the low grade fuel at works where it can be obtained at a low enough price. I have obtained the same thermal efficiency on test with low grade fuel as with high grade coal, but with the latter, the good results are maintained automatically after the proper conditions are established; but with the low grade fuel the fire requires constant attention if the same high efficiency is to be maintained. Many of you may be called upon to burn low grade coal for the period of the war. It is therefore necessary that the engineer should devote as much time as possible to the boiler house. Some of the best stations in the country have established high thermal efficiencies when using low grade fuel. For instance, an electric power station in the north of England obtains an overall thermal efficiency of 16 per cent., using coal having an average calorific value of 10,000 B.Th.U. per lb. Again, the Victoria Falls and Transvaal Power Company use coal having a low average value, and a large quantity having a value of only 7,000 B.Th.U., and their results are also excellent. Low grade fuel is not a complete explanation of the serious inefficiency of many works. Our main object at the moment is to "Carry on," and the allocation of different coals has for the present, unfortunately, to be largely governed by that factor. There is barely sufficient quantity of the high grade coal to supply the full requirements of the most essential industries.

6. *Anthracite.*—There is a considerable quantity of anthracite rubbly culm available for those who can use it. Anthracite fuel has a high calorific value, but it requires more draught to burn it, and a big allocation can only be made to firms who have ample boiler margin, or special furnaces fitted with forced draught. Probably many firms could take a small percentage of this fuel to mix with the more bituminous fuel, irrespective of the boiler margin or type of furnace. You can all assist the Coal Controller by using as large a quantity of anthracite fuel as possible.

(To be concluded.)

* Abstract of an address to the Association of Engineers-in-Charge.

Dielectric Loss in Condensers.—In a contribution to the "Zeitschrift des Oesterr. Ingenieur und Architekten-Vereines," Dr. Grünberg describes some tests on glass, hard paper and mica condensers at a low frequency. With glass the efficiency diminishes with increasing frequency. A rise in temperature also causes a marked increase in the losses, which increase rather more rapidly than the square of the pressure applied. With hard paper a more marked drop in power factor occurs with diminishing frequency than in the case of glass, while with mica the contrary effect is noted

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Correspondence.

COAL CRISIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is now universally realised among business men that only the most rigid economy on the part of all users of coal will stave off a perhaps serious shortage, which shortage, of course, would affect public utility undertakings.

The section which least realises the importance of economy is, perhaps, the public, and the Coal Controller is doing all he can to drive the truth home. In order to assist in this endeavour, my committee is asking their member companies to help in the distribution of a circular on Coal Economy, got out by the Coal Controller. They would enclose this with their correspondence, accounts, &c., and the batch of circulars would be delivered post free to the undertakings.

As every little helps, I put it forward as a suggestion that other sections of the supply industry might, perhaps, offer similar assistance.—I am, &c.,

T. W. COLE, Secretary.
The Provincial Electric Supply
Committee of the United Kingdom.

London,
Oct. 22.

The Labour Outlook.*

(BY OUR LABOUR CORRESPONDENT.)

THE GOVERNMENT AND THE TRADE UNION PLEDGES.

The heartfelt wish of the general public is that the cessation of hostilities will find us better prepared for peace than Aug. 4, 1914, found us prepared for war. How well the Government has prepared for peace remains to be seen. But at least one great problem still awaits solution, a problem which is disturbing the mind of labour at the present time, and which lies at the very foundation of industrial reconstruction—the question of the fulfilment of the Government's pledges to the trade unions.

The Government, faced with the urgent need for an enormous increase in production, agreed with the trade unions over 3½ years ago that if the trade unions would place no obstacles in the way of dilution, and assist in promoting production, the Government would use every effort to see that the trade unions were not prejudiced at the end of the war. No Government ever committed the nation so deeply as the Government in March, 1915, and by the speeches of responsible Ministers they have on many occasions since, committed the people of this country on the question of the "war pledges," as they are called. The position broadly was that the skilled workers for the period of the war set aside the code of rules and regulations which during the nineteenth century they had after infinite effort obtained as a means of self protection.

The Government's pledges were given the force of law in some respects in the Munitions of War Acts which, however, do not apply everywhere where the process of dilution has been put into operation. It is obvious that any attempt to restore trade union customs in some firms whilst not doing it in others is futile. Therefore, as the law stands at present the pledges given by the Government are worthless. All observers are agreed that this state of affairs is an ever present factor in industrial unrest. The troubles of the last two years are all in varying degrees traceable to the feeling of insecurity on the part of the skilled workpeople as to their future. That the situation is unsatisfactory has been recognised by the Government itself, and over 15 months ago legislation was promised to remedy it. It has not been forthcoming. Question after question has been asked in the House of Commons; usually only to receive the answer that no statement can be made.

It may be argued that if the Government gives statutory sanction to its solemn promises, industry has moved so far that they cannot be fulfilled; or on the other hand, that the skilled men would be in a position to spike the guns of industrial progress. Leaving aside the question of the undesirability of treating a solemn promise as a mere scrap of paper, we may point out that the two arguments above neutralise each other. If the first be true, the skilled workers are helpless; if the second is true then the industrial charges are not so fundamental as the first article would appear to make them.

But how does the skilled worker regard the question? Naturally enough, he feels in his heart that the Government, owing to its inaction, does not intend to make good its word. In consequence he mistrusts the Government, and every step it takes he views with deep suspicion. What this attitude of mind may result in when the war is over, none can say. But unless it is profoundly modified, it bodes ill for industrial peace.

The skilled artisan realises the extent of the new developments in industry during the war, and he knows that the new economic laws are beyond his control. He appreciates the fact that if the old order were restored, it could only be for a time, and therefore, literal restoration of trade union regulations would only postpone the evil day. On the other hand, he is aware of the fact—which many people overlook—that his skill is indispensable, and that in many trades and processes, he is a "key" man. In other words he has not been altogether dislodged from his niche in industry.

In face of this situation, why do the skilled unions insist on being given legal rights to restore their pre-war customs? The answer is briefly that he wants those rights because they strengthen his bargaining power in the negotiations which must be entered into regarding post-war arrangements. With a satisfactory statute conferring the rights of the skilled trades to the restoration of their pre-war customs, they can enter into conference with employers; without it, their bargaining power is seriously undermined

Far-sighted employers themselves realise the wisdom of an amendment of the Munitions Acts, which will do what the first Munitions Act was largely introduced to do, viz., give statutory effect of the Government's promises to the unions. They appreciate the difficulties which are likely to ensue if a settlement is not reached without delay.

Demobilisation of the army and the war workers and their restoration to the permanent ranks of peace industry are impossible until the question of the war pledges is disposed of, if only because it will not be known what groups of workers are, by general agreement, to be eligible for particular kinds of jobs. The question is, therefore, one which does not brook delay. Delay may mean industrial disaster.

* We do not necessarily endorse the views expressed by our Correspondent.—ED. *E.*

Batti-Wallahs' Society.

MR. WORDINGHAM'S VIEWS.

At the monthly luncheon of the Batti-Wallahs' Society on Monday, Mr. C. H. Wordingham (Director of Electrical Engineering, the Admiralty, and President of the Institution of Electrical Engineers) said he had been asked to attend and address the members on the subject of Germans. They might make any allowance they liked for bias on his part; but he would say this for his opinions—they had not been altered by the war; he had always had an intensive loathing for anything German. His instinct against the Germans was very strongly developed. Other people had totally different opinions; they found their spiritual home in Germany, and they liked Germans. With regard to the logical basis upon which their dislike of Germans ought to rest, he said the German was a coward, because he used cowardly methods in fighting, oppressed the weak and defenceless, and soon threw up his hands when faced with superior numbers; he cringed before his officers, though he would shoot them in the back if he got the chance. He was also essentially a thief, and was dishonest in his bargains. Many of those who had bought German plant had found to their cost what the German's idea of a contract was. He hoped also the bestiality and horrible cruelty of the German would not be forgotten. It had been said they were not fighting against the German nation, but the German army was composed of the men of the German nation, and no power on earth could compel soldiers and sailors to act in the way the German soldiers and sailors had acted, and no part of the German nation, from the scientists downwards, had dissociated itself from the acts of which the Germans had been guilty. Then again they were told the Germans ought not to be humiliated or crushed, but he said humiliate them as much as possible, so that they should be harmless, if possible, in the future. Mealy-mouthed people said we ought not to take vengeance upon the Germans, and quoted the text "Vengeance is mine saith the Lord"; but God worked through human agency, and in showing a forgiving spirit to the Germans we should be largely forgiving other people's injuries—an easy thing to do. The Englishman (who was often a Scotchman, Irishman or Welshman), whether from a cockney slum or a public school, was generally found in the thick of the fight, but he had an exaggerated idea of what he called "playing the game," and also he had such a firm conviction of his own superiority over anybody else that he looked upon most other nations with contempt. We could not afford to have contempt for the Germans, however much we despised their character. The moment the war was over we should be assailed again by the German, who would take advantage of another failing of the Englishman, who was apt to take the article that cost 19s. 11½d. rather than the British made article that cost £1. Years before the war he (Mr. Wordingham) had made a practice of asking whether an article was made in Germany or not. In spite of the revelations of the horrors of this war, there were few people here who evinced any real indignation against the Germans. He could hardly control himself when he read about some of the acts of the Germans. He hoped

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the propaganda which he understood the society had started against the Germans would result in bringing Englishmen to see how vile the Germans had been, and to be determined that they would no more have dealings with them than they would allow their sons and daughters to sit down with pickpockets, burglars and murderers. Our children should be taught about the conquest of the Germans, and warned against their evil character. A boycott of the Germans had always seemed to him a simple remedy. If every Englishman were determined never knowingly to buy anything from a German no legislation would be needed. It had been argued that the Germans could not pay any indemnity unless they were allowed to trade with other nations. But that was rather a disgraceful attitude of mind—very much like living upon immoral earnings. Pen the Germans up in their sty and let them stay there. He would like to see the Germans precluded from trading with any of the Allies or Neutrals. He could not understand why a high opinion of the Germans had been entertained. They were very fond of getting hold of other people's brains and exploiting them to get trade for their country. The German had trusted to force and to long preparation, but they had failed him and truth and right were now showing that they were going to prevail.

Mr. F. Pooley (hon. secretary) then gave some information regarding the steps taken by the committee in regard to the matter under discussion, and intimated that further details would be given at a luncheon which would take place after further communication with the Merchant Seamen's League.

Legal Intelligence.

Re A.E.G. Electric Company, Ltd.

On Thursday last Mr. Justice Younger made an order for the winding up under the Trading with the Enemy (Amendment) Act, 1916, of the A.E.G. Electric Company, Ltd., on a petition by the Board of Trade.

Mr. Austen-Cartmell said that was the last survivor of the group formed by the A.E.G. of Berlin. There had been complicated arbitration proceedings with the Rio Tinto Company, and when that matter was before his Lordship last sitting it was thought by the Company that an order for winding up might embarrass them in these proceedings. Now that point of fact had been dealt with by the arbitrator, and the points of law by the official referee, and their decisions had been given. So far as the arbitration was concerned, therefore, there could be no objection to the order he asked for. No appeal from the award had been lodged. The Board of Trade felt that the decision in the arbitration proceedings having been given there could be no harm done to the Company by a winding up order. But he asked for two indulgences under the new Act—the appointment of the Controller, who was versed in the whole matter, as liquidator, and to dispense with the meetings of creditors and contributories and with the usual statement of affairs under Sec. 152.

Mr. Stuart Bevan (for the Rio Tinto Company) said apart from the question of the arbitration, the litigation between the Company and his clients was not at an end. All that had to be found in those proceedings was what was the amount of damages to which the Rio Tinto Company was entitled. But the Rio Tinto Company were plaintiffs in an action against the company in which they were claiming a large sum of money.

Mr. Austen-Cartmell said it looked as though a sum of about £7,000 would eventually be found due to the Rio Tinto Company, and the winding up order would not prejudice that.

His Lordship said he was not sure that the Rio Tinto would not be safer under a winding up.

Mr. Bateman (for the A.E.G. Electric Company) said he had a list of salaries now being granted to employees of the Company at their request and with the consent of the Board of Trade. These would automatically cease upon the appointment of a liquidator. It was desired that these payments should be continued.

His Lordship said so long as the liquidator was satisfied that the funds in his hands were sufficient to meet all prior claims there would be no difficulty over that point.

Mr. Austen-Cartmell: There are large surplus assets in any case now, and there was no consent to this on the part of the German owners.

His Lordship said in the case that had come before him there had been no reluctance on the part of the German owners to continue these payments under similar circumstances.

Eventually the Court made the winding up order asked for, and gave the Rio Tinto Company leave to continue their proceedings against the Company.

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On Tuesday a Divisional Court enlarged the time by three weeks for appealing against the recent decision of the arbitrator in the A.E.G. Electrical Company and Rio Tinto case. There will be cross-appeals.

Volunteer Notices.

London Army Troops Companies Volunteer Engineers.

Headquarters: Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.

Orders for the Week.

Captain of the Week.—Capt. W. Hynam.
Next for Duty.—Capt. W. Darley Bentley.
Sunday, Oct. 27.—Commandant's Parade for work, "Obstacles," at Esher; parade Waterloo Station 9 a.m. Drill order. Greatcoats. Midday and tea rations to be carried.
Monday, Oct. 28 to Saturday, Nov. 2.—Drills as usual.

Parliamentary Intelligence.

Alien Enemy Companies.—In the House of Commons last week Sir A. Stanley stated in reply to a question that the business of the Armorduct Manufacturing Company, Ltd., was sold as a going concern 12 months ago to British-born subjects unconnected with William Small or Schmahl, and they registered another company under the title of the Armorduct (British) Company, Ltd., to carry on the business. Small is a director of the Anglo-Scandinavian Box Company, Ltd. In August, 1917, a resolution was passed by the shareholders of Magic Appliances, Ltd., for the change of the name of that company to the Westminster Trading Company, Ltd., but sanction to the change was refused, and the name of the company remains the same as before."

Commercial Topics.

Empire Metal Trade.

A new company is being formed with the object of promoting and developing Empire trade in non-ferrous metals, particularly copper, lead, tin and antimony, and also to replace British for German pre-war control of the metal markets of the Empire. "The Times" states that the promoters have received influential support from those associated with the metal trades and metallurgical industries, and also from the Government. The capital of the company will be £5,000,000. The gentlemen closely identified with the scheme include Mr. Charles Vincent Sale, Sir Charles Fielding, Mr. Andrew Wilson Tait, Mr. Cecil Budd, Mr. A. Hugh Smith and Mr. C. W. Tennant.

* * * *

Relations of Employers and Employed.

Mr. F. Huth Jackson, who presided at a dinner of the National Alliance of Employers and Employed last week gave an account of the work and policy of the Alliance. He said the nearest approach to action on the lines the Alliance had already recommended was the setting up by the Ministry of Labour of local advisory committees to employment exchanges, consisting of equal numbers of employers and employed. They had been informed subsequently that those committees were to be given certain executive powers in connection with demobilisation. The responsibility for the treatment of industrial problems and difficulties both during demobilisation and afterwards ought, to begin with, to fall upon employers and workmen, and, he might say, workwomen, through representatives elected by them from their own federations and trade unions. The Alliance asked that employers and employees should be allowed to settle their domestic affairs without intervention, or as far as possible without control from an authority outside their own ranks. It was hoped that it would do away with industrial unrest. The more they saw of the Alliance the more they were convinced of the necessity of the extension of their principles in every direction. They wanted to create a better feeling between capital and labour, and they wanted the employer and employed to recognise that their interests were identical and not antagonistic.

* * * *

U.S.A. Electrical Exports.

During the fiscal year ended June 30 electrical merchandise was exported from the United States of America to the value of $54,527,570, compared with $51,903,823 in 1917 and $30,256,778 in 1916. The figure for batteries jumped from $685,640 in 1914, when they were first listed, to $3,351,838 in the last fiscal year. A part of the increase is due to an advance in price, but there has been a large demand for batteries owing to the warring nations, particularly dry cells. The value of generator exports is about the same as before the war. Insulated wire and cable exports have grown greatly since 1914 (from $1,992,304 to $5,716,275), but there was a perceptible falling off last year. The decrease in volume, however, was probably slight, owing to the drop in price of wire and the settlement of a Government price which holds for allied-country purchases. Metal-filament lamp exports have grown from $394,692, representing 1,363,493 lamps, in 1913 to $3,183,021, or 14,865,899 lamps, in the last fiscal year. Motor exports have doubled in value in the last six years, but a large part of this represents increased prices. The value of the exports of magnetos was $3,167,325, and there were also large increases in telegraph and telephone apparatus and in transformers. There was only a slight advance in the figure for dynamos, and switches and accessories are recorded in the list for the first time at $2,229,023.

Electricity Supply.

Ayr Council is increasing its charges for current to 50 per cent. over pre-war rates.

Hereford Corporation has received sanction to borrow £9,894 for plant and cable extensions.

Dublin Electricity Committee has increased the charge for private lighting by 1d. per unit. The charges for power have also been increased.

King's Lynn Corporation has decided to apply for a provisional order to enable them to give a supply of electricity in West Lynn and Gaywood.

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CHORLEY Guardians have applied to the L.G. Board for sanction to borrow £5,750 for a new heating system, electric lighting plant, &c., at the workhouse.

DENBY AND CUMBERWORTH URBAN COUNCIL has decided not to oppose the application of the Electrical Distribution of Yorkshire for a provisional order.

LEEDS Electricity Committee has received sanction to borrow £23,330 for a 6,000 kw turbo-alternator, &c., on condition £16,670 of the cost be met out of revenue.

The EGHAM & STAINES ELECTRICITY COMPANY is extending its electric supply cables from the county boundary near Bishopgate to the entrance to Windsor Great Park.

The employees of the EDINBURGH and LEITH electricity supply departments have secured a further bonus of 5s. per week, making a total bonus of 23s. 6d., plus 12½ per cent.

FLEETWOOD electricity department has increased the wages of drivers and firemen 10s. per week and of trimmers from 7½d. to 8d per hour from the first full pay day in April.

The HALIFAX Borough Engineer and Borough Electrical Engineer are preparing plans and specifications for a new electricity generation stations by the riverside at Copley.

BLYTH HARBOUR COMMISSIONERS have decided, in order to increase the facilities for discharging cargoes at the South Harbour Quays, to order three additional electric cranes of the latest type.

HAMILTON Corporation has agreed to the proposal of Edmundson's Electricity Corporation to increase its charges for current in the town by 20 per cent., making 50 per cent. over pre-war rates.

Dr. J. A. Hosker, previously vice-chairman of the BOURNEMOUTH & POOLE ELECTRICITY SUPPLY COMPANY, LTD., has been elected chairman of the Company, and Mr. H. B. Renwick has been elected deputy chairman.

WALSALL Corporation require tenders by Nov. 5 for one year's supply of stores and materials, including trolley wheels, castings, oil, grease, &c, to the tramways department. Forms of tender from the Tramways Manager, St Paul's-buildings, The Bridge, Walsall.

WOLVERHAMPTON Corporation has applied to the L.G. Board for sanction to a loan of £10,000, in order to bring the contingency amounts contained in certain loans for extensions at the electricity generating station up to a sum representing 11 per cent. of the total of the loans.

PEMBROKE (DUBLIN) URBAN COUNCIL has passed a resolution in favour of the scheme of the Dublin & Lucan Electric Railway Company for generating electric energy from the River Liffey, and urging the Government to help in carrying it out as a work of urgent national importance.

The Lighting Committee of KINGSTON-ON-THAMES Corporation is appealing to electric light consumers to restrict their demands between 4 p.m. and 7.30 p.m. They are asked to refrain from using motors and radiators between these hours, except on Saturdays and Sundays, and to reduce to the lowest practicable limit their lighting consumption.

ST. PANCRAS (LONDON) Borough Council has received sanction from the L.C.C. to borrow money for the provision of two 3,000 kw. Ljungstrom turbines and the necessary foundations, switchgear, pipework, &c., Of the sum applied for, £23,000 is for one turbine, for which loans may be sanctioned at present. From this amount there must be deducted £5,924, representing outstanding loan on displaced plant, leaving £17,076, which has been sanctioned for repayment within the usual period of 15 years.

A report on the recommendations of the Board of Trade Electric Power Supply Committee by the Parliamentary Committee of NEWCASTLE-UPON-TYNE CORPORATION states that the effect of carrying out the committee's proposals would be to maintain private monopolies while public services might pass into private hands. A reasoned statement, setting out the objections to the committee's recommendations, is to be issued to other local authorities on the North-East Coast area, in order that joint action may be taken.

The progress of the LIVERPOOL ELECTRIC SUPPLY DEPARTMENT during 1917-18 has been satisfactory. The chairman of the Tramways Electric Power and Lighting Committee, Ald. E. Russell Taylor, reported that during the year 1917 70,784,695 units were supplied for lighting, power and traction, an increase over 1916 of 10,000,000 units. During the first eight months of this year an increased output of over 4,000,000 units had been supplied, being 9·7 per cent. more than in the corresponding period of 1917.

The accounts of the ABERDEEN ELECTRICITY SUPPLY DEPARTMENT for the year ended July 31 show that £194,405 of the borrowed capital of £449,812 has been repaid. The year's revenue was £103,316, compared with £76,994 in previous year, and the net surplus carried to reserve fund, after meeting working expenses, capital charges, &c., was £10,580. Units generated were 20,276,880, an increase of 3,423,640, and sold 17,408,147, increase 3,320,856. Mr. J. Alex. Bell, city electrical engineer, states in his report that total costs were 0·767d. (against 0·761d.) per unit sold, exclusive of capital charges, and the net profit was 0·165d. (0·015d.). Load factor was 26·64 (26·10) per cent., and maximum load, including traction, was 7,459 (6,162) kw. Connections increased from 650,115 to 734,171 (equivalent) 33-watt lamps, not including tramways, and total horse-power of motors connected increased from 14,028 to 16,855. Price of coal increased 6s. 6d. per ton, but the reduction of consumption by 0·12 lb. per unit saved 932 tons. The number of heating and cooking utensils hired out is 1,598, an increase of 193. A 5,000 kw. generating set is expected to be delivered next spring.

Electric Traction.

As the result of a collision on Saturday between two COVENTRY tramcars a passenger named Frederick W. Pinfold was thrown off the upper deck of a car into the roadway and killed.

London United Tramways, Ltd., has applied to the Board of Trade for permission to charge fares during the war at the rate of 1d. per mile for ordinary passengers and ½d. per mile for workmen, with a minimum of 1d.

GLASGOW TRAMWAYS COMMITTEE recommend that, as an experiment, a special car be run on the Glasgow-Uddingston route for the conveyance of parcels. The Corporation have Parliamentary powers to carry parcels on the tram-cars.

By an award of the Committee on Production women employees of the BRADFORD CORPORATION TRAMWAYS DEPARTMENT are given an advance of 2s. per week. The award raises the pay of the women to 18s. above pre-war rates, but they contend that they ought to have at least 21s.

BRADFORD TRAMWAYS COMMITTEE has accepted the following tenders: Dick, Kerr & Company, one pair of special traction motors; Cole, Marchant & Morley, 60 tons of brake shoes, at 5 per cent. advance on previous price; Hadfields, Ltd., point fittings, &c., £73; Clay & Atkinson, parts of automatic point controllers, £54.

Last week the LONDON COUNTY COUNCIL Tramways Department distributed a bonus of £1,614 among their tramcar drivers and conductors. This sum represents half the price of fuel for power saved during the quarter ending Sept. 25. During the quarter 1,175 tons of coal, which would cost £3,228, have been saved, representing a reduction of nearly 5 per cent. on the average consumption.

A report on the BRADFORD TRAMWAYS for the six months ended Sept. 30, prepared by Mr. C. J. Spencer (who recently resigned the managership), shows that the receipts were £243,280, increase £39,688 over the corresponding period of last year, largely accounted for by the increased fares during four months. Car miles run were 2,573,434, decrease 284,910, and passengers carried were 40,136,206, decrease 2,756,970. Receipts per car mile rose from 16d. to 21·18d. Wages increased £23,377.

Ald. E. Russell Taylor stated at last week's meeting of the LIVERPOOL Tramways, Electric Power and Lighting Committee, that the tramway traffic returns for the past nine months had exceeded all previous records as regards total receipts and number of passengers carried. The receipts for 1918 were £705,816, an increase of £102,497 compared with 1917 passengers carried were 146,006,029, increase 18,586,835, and car miles run were 9,176,861, decrease 237,767. Earnings per mile were 1s. 6·46d., increase 3·03d. Owing to the advance in wages and cost of materials it had been necessary to shorten the stages and to increase the fares. The number of employees who had joined H.M. Forces was 2,290. Unfortunately over 200 had been killed and 350 wounded. The allowances to employees in H.M. Service of the difference between Army pay and allowances and standard rate of pay amounted to approximately £30,000 per annum. Since Jan. 1 3,103,007 free passes to the military and nurses had been granted, equal to £14,532, while the total since the commencement of the war was 16,643,050, equal to £77,945.

Imperial and Foreign Notes.

LONGREACH (Australia) Municipality is borrowing £100,000 for establishing an electric supply undertaking.

The City of Brisbane Electric Light is seeking authority to supply electricity within the shire of TOOMBUL.

The HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO propose to expend $1,250,000 in the erection, at Ranney's Falls, Campbellford, of hydro-electric power plant capable of generating from 8,000 to 10,000 H.P.

Mr. H. R. Mackay, general manager of the MELBOURNE ELECTRIC LIGHT DEPARTMENT, reporting recently to the Council on the question of possible installation of new generating plant without awaiting the two 12,000 kw. turbo-alternators on order from the British Westinghouse Company, stated that a Sydney company was prepared to undertake the making of the generating plant, and believed that it could ship it in 14 months.

Decreasing shipping facilities have thrown the Australian States more and more upon their own local resources for the production of everyday articles of use. In WESTERN AUSTRALIA the manufacture of railway telephone instruments at the State workshops, has, it is stated, proved quite a success, and Prof. Payne, of the Melbourne University, has recently looked into the methods adopted with a view to employing returned soldiers upon the work. The Australian Glass Manufacturers, Ltd., of Victoria, which has factories in several States is about to extend its operations to Western Australia, and will employ a considerable number of workers in the making of bottles of various kinds. But perhaps the most important industrial development at present under way is the extension of the ceramic industry to the West. A model pottery kiln has been built and scientific tests are now being made of the local clay deposits.

A company is to be formed to erect an electric power-house at Laprida, Province of Buenos Ayres, ARGENTINA, for public and private lighting.

A Spanish technical review publishes statistics which show that during 1917 hydro-electric works of a capacity of 500,000 H.P. were in operation in SPAIN.

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A concession for the installation and working of an electricity works at Cosquin, Province of Cordoba, Argentina, has been granted to Señor Facundo Escalera

At a recent meeting of residents at Santa Elena, Province of Buenos Ayres, Argentina, it was decided to take steps to secure the installation in that town of an electricity supply station.

It is announced that the British Government has authorised the shipment of material required for a radio-telegraph station at Veronica, Argentina, which will be able to get into direct communication with practically every country.

A company entitled the "Norsk Marconikompani," with a capital of 900,000 k., is being formed in Christiania for the purpose of carrying on the manufacture, sale and hire of wireless telegraph apparatus, &c., in Norway. 300 of the shares are held by Marconi's Wireless Telegraph Company.

The receipts of the Compania de Tramways Electricos del Sud, Buenos Ayres, for the year ended June 30 were $1,055,527 m./n. (against $1,057,553 in previous year), working expenses were $1,024,505 m./n., and net profit was $31,682 (including $619 m./n. brought forward). Passengers carried were 8,029,527 (8,286,835).

The Swedish Railway Dept., which has been investigating since 1915 the question of the electrification of Swedish railways, has now presented its report. According to the "Board of Trade Journal," the department considers that the abnormal cost of fuel, and the desirability of expanding the railway system, make the introduction of electric services necessary. They estimate that the work of electrification would take 10 years. They propose that separate conduits should be established for lighting along the railways and for the distribution of power to agriculturists. In time of war Sweden is shut off from coal supplies, whereas damage to power stations and conduits are easily repaired.

Miscellaneous.

The Admiralty proposes to establish schools in various shipbuilding centres for the training of electric welding operators.

The Tin and Tungsten Research Board invite proposals from firms or others associated with metallurgical chemistry, who are in a position to undertake research work with a view to increasing the extraction of tin and tungsten from Cornish ores. Communications to the Secretary of the Board, 15, Great George street, Westminster, S.W. 1.

We have received a copy of a pamphlet explaining the work of the County of London R.E. Volunteers (London Army Troops Companies). Recruits are required, and those who wish to join should apply to the adjutant at headquarters, Belderton-street, Oxford-street, W. 1. Some technical knowledge is an advantage to recruits, but a high degree of scientific knowledge is not essential. Subscriptions to the funds are also urgently required.

In the House of Commons last week the Chancellor of the Exchequer stated that an application by the New Transport Company for permission to increase its capital had been refused by the Fresh Issues Committee because it was not considered in the public interest that the proposed issue of capital should be made at the present time, and, pending the report of the Select Committee on Transport, he saw no reason to interfere with the decision arrived at.

We are informed that the Smoking Concert of the Midland Division of the Electrical Power Engineers' Association, which took place at Birmingham on the 16th inst., was very successful, the attendance numbering nearly 100. The chairman (Mr. Legge) said the progress of the Association was so successful and so rapid as to excite considerable jealousy in certain quarters. That deplorable situation was not desired nor caused by the E.P.E.A. The next concert is fixed for Nov. 6.

The annual report of Dr. F. M. Alexander, M. O. H. to Poplar (London) Council, gives particulars of the electrolytic disinfectant department in 1917 :—At the seven depots the fluid was still in great demand. 27,900 gallons were manufactured and 55,800 broken down and distributed (against 53,580 in 1916). The cost included electricity (6,484 units at 1½d., with 10 per cent. advance) £44. 11s. 6½d., chloride of magnesium (3 tons) £39, salt (3 tons 6 cwt.) £11. 11s., caustic soda (6 tons 3 qr. 12 lb.) £22. 8s., water £2. 11s. 4d., total (with £1. 0s. 2d. for electric motor for stirring, 148 units) and £5 for corks £126. 2s. 0½d. The total of £120. 1s. 10½d., excluding cost of motive power and corks, compares with £114. 7s. 1d. in the previous year. From October, 1915, the charge for the fluid to manufacturers and trading concerns has been 8d. per gallon, and the charge being collected by the electricity department, which is allowed 10 per cent. for establishment charges.

"The Principles of Reconstruction" formed the subject of an address by Dr. Addison, Minister of Reconstruction, at the Saddlers' Hall (London) last week. Dr. Addison advocated the use of an economic weapon for punishing the crimes of Germany, but it was difficult to forge one. Many mills and machinery in houses had been removed into Germany apparently for the deliberate purpose of destroying in part the economic producing power of France. The object of that was to do away with France as a competitor in the world's trade for some time to come. The aim of reconstruction in France and Belgium would be to restore the means of production. The burden of the restoration of the machinery must fall on those who destroyed it. The economic weapon could easily be used to secure the administration of justice, for it would be within the power of the Allies to withhold from Germany cotton or other goods until the enemy had made good the machinery which they had destroyed. In the economic question civilisation had a great weapon for securing international justice.

Educational.

At his own request Prof. W. A. Bone has been relieved of his duties as consultant to the Fuel Research Board in order to be free to devote his attention to plans under consideration for the post-war development of the department of chemical technology at the Imperial College of Science and Technology.

The Governors of the Royal Technical College, Glasgow, propose to re-open the School of Wireless Telegraphy. The school was closed in 1916, when the instructor joined the Army, but in consequence of the demand for wireless telegraph operators Marconi's Wireless Telegraph Company has since carried on a course of instruction. The company now proposed to discontinue its classes, but the Committee on Engineering recommended that the college should make arrangements for carrying on the department as formerly, and this has been agreed to. The number of students, past students and staff of the college on active service is 2,757, of whom 1,128 were officers, including 307 in the Navy. Of the total 508 have been killed, 21 are missing and 33 are prisoners of war. The 378 honours awarded include 3 Victoria Crosses.

Tenders Invited and Accepted.

Bedford Corporation require tenders by noon Nov. 13 for the supply and erection of two water-tube boilers, mechanical stokers and induced draught plant. Specifications, &c., from the Engineer, Electricity Works, Cauldwell-road, Bedford.

The directors of the North-Eastern Railway Company are prepared to receive tenders for six or 12 months' supply of (1) telegraph apparatus, (2) telegraph wire and line stores. Forms of tender from Mr. C. H. Ellison, the company's telegraph superintendent, York. Tenders to the Secretary at York by 9 a.m. Friday, Nov. 1.

The directors of the North-Eastern Railway Company also require tenders by 9 a.m. Nov. 1 for six or 12 months' supply of various stores and materials, including electric wires and cables, electric lighting sundry fittings, signal wire and signal cord, castings, iron pipes, oils, &c. Forms of tender, &c., from Mr. E. H. Clark, stores superintendent, Gateshead.

The Great Northern Railway Company (Ireland) require tenders by 10 a.m. Nov. 7 for six or 12 months' supply of stores and materials, including electrical fittings and lamps, electric cable and wire, carbons, rubber goods, signalling materials, oils, &c. Forms of tender from the Secretary, Amiens-street Terminus, Dublin.

The Chinese Government has executed a contract with Marconi's Wireless Telegraph Company for the erection and equipment of three wireless telegraph stations each of 25 kw. capacity.

Wolverhampton Council has accepted the tender of the Staveley Coal & Iron Company for water piping and special piping, and that of J. Hopkinson & Company for steam and water valves.

Johannesburg (Transvaal) municipality require tenders by noon Nov. 27 for supply of 2,000 copper ribbon bonds and 2,000 copper solid bonds (contract No. 424). Specification, &c., from the Town Clerk.

Bradford Electricity Committee has accepted the tender of the Clay Cross Company for c.i. water pipes for two turbo-generators; Heenan & Froude, three wet air filters; Bertram Thomas, one auxiliary switchboard for transformer chamber.

The Australian Navy Department has accepted the tender of Noyes Bros. (Sydney) for the following control gear for pumping-motors for the Dockyard, Cockatoo Island, Sydney: Two Igranic automatic starting panels for 450–550 b.h.p. motor at £1,232, and five panels for other motors with one set of spare parts for Igranic equipment at £305, or a total of £1,537.

Government Contracts.—The following tenders were accepted by the British Government Departments during September:—

War Office.—Butters Bros. & Co., Chatteris Engineering Co., Clarke, Chapman & Co., H. Morris, Royce, Ltd., Smart & Brown and Whitakers (Engineers), Ltd., cranes; J. Sankey & Son and H. Heaton & Sons, cable drums; H. T. Boothroyd, Ltd., and Phœnix Dynamo Mfg. Co., dynamos; R. A. Lister & Co. and Petters, Ltd., generating sets; Fellows Magneto Co., magnetos; Bullers, Ltd., insulator pins; British Westinghouse Elec. & Mfg. Co., switchboards; British Rubber Mfrs., Ltd., insulating tape; General Electric Co., fans; E. Brook, Ltd. and General Electric Co., motors, &c.

India Office.—C. Macintosh & Co., cable; Bullers, Ltd., and Taylor, Tunnicliffe & Co., insulators; Bullers, Ltd., stalks; British Insulated & Helsby Cables, Shropshire Iron Co., Dorman Long & Co. and F. Smith & Co., wire.

H.M. Office of Works.—H. Morris, Ltd., cranes; Waygood-Otis, Ltd., reconstruction of lifts at New Science Museum, S. Kensington.

Post Office.—Automatic Telephone Mfg. Co., telegraph and telephone apparatus; British Insulated & Helsby Cables, British L. M. Ericsson Mfg. Co., Peel-Conner Telephone Works and Western Electric Co., telephone apparatus; British L. M. Ericsson Mfg. Co., testing and protective apparatus; Bayliss, Jones & Bayliss, Bullers, Ltd., and Portland Bolt & Nut Co., arm bolts; Bullers, Ltd., and D. Willetts, c.i. brackets; Telegraph Construction & Maintenance Co., submarine cable; British Insulated & Helsby Cables, General Electric Co., Hackbridge Cable Co., W. T. Henley's Telegraph Works Co., Johnson & Phillips, Siemens Brothers & Co., H. W. Smith & Co., Telegraph Construction & Main-

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enance Co. and Yorkshire Cable Co., telegraph and telephone cable; Siemens Brothers & Co., dry cells; Pritchett & Gold and Electrical Power Storage Co., secondary cells; London Electric Wire Co. & Smiths and Peel-Conner Telephone Works, telephone cords; J. Bourne & Son, Bullers Ltd., Doulton & Co. and J. Macintyre & Co., insulators, bodies and covers; British Thomson-Houston Co., Edison Swan Electric Co., and General Electric Co., glow lamps; H. White & Co., fuse mountings; Henry Brindley, telegraph spring ratchets; Eyre Smelting Co., zinc rods; Bayliss, Jones & Bayliss, Bullers Ltd., Guest, Keen & Nettlefolds, Ltd. and T. W. Lench, Ltd., telegraph spindles; British L. M. Ericsson Mfg. Co. and Peel-Conner Telephone Works, telephones; British Insulated & Helsby Cables, bronze wire; London Electric Wire Co. & Smiths, enamelled and silk-covered and flame-proof wire; Western Electric Co., flame-proof wire; Pritchett & Gold and Electrical Power Storage Co., repair of battery at Manchester (City) Telephone Exchange.

Appointments Vacant and Filled.

A large manufacturing company advertises for three engineers. Commencing salary £250 per annum.

St Helens Corporation invite applications for the post of chief electrical engineer, at a commencing salary of £650. Applications, with full particulars as to age and qualifications, are to be sent to the Town Clerk by Friday, Nov. 8.

A superintendent of evening classes is required for the Merchant Venturers' Technical College, Bristol. Salary £300, rising by increments of £25 to £400 per annum. Particulars and application forms from the Registrar

Wigan Corporation requires a rolling stock and works superintendent for its tramways department. Salary £250, rising by annual increments of £25 to £300 per annum. Applications to town clerk (Mr W. H. Tyrer) by Nov. 16.

Applications are invited for the position of professor of physics in the University of Cape Town. Salary £800 per annum. Applications by Jan. 1 to the High Commissioner for the Union of South Africa (32, Victoria street, London, S.W.1), from whom particulars can be obtained.

Mr. J. C. Connell, of Blackburn, has been appointed charge engineer at Accrington.

Mr. D. D. Davies, of Nantwich, has been appointed manager of the Herne Bay Gas & Electricity Company in succession to Mr. C. V. Bennett.

Mr. A. H. Pott has resigned the position of manager of the Metropolitan Electric and London United Tramways, Ltd., in order to take up an appointment under the Board of Trade Tramways Control Committee. Mr. C. J. Spencer, manager of the Bradford Corporation Tramways department, succeeds Mr. Pott, who retains his connection with the company in a consultant capacity.

Mr. E. M. Hollingsworth, chief electrical engineer of the St. Helens Corporation Electricity works for 16 years, has accepted a position on the staff of the chief engineer of the United Alkali Company, and will leave the service of the Corporation in January next. Mr. Hollingsworth has been appointed to take charge of the new power station to be erected near the river Mersey and the extra high tension transmission service in connection therewith.

For the position of second technical assistant at Newport (Mon) there were 41 candidates and five of these were selected for interview, viz.: Messrs. W. J. Carter, chief assistant engineer, Loughborough; T. H. Wood, chief draughtsman and clerk of works, Battersea; L. H. Harrison, resident engineer, Kidderminster; Ward Holmes, technical assistant, British Thomson-Houston Company, and W. J. Batchelor, works superintendent, Uxbridge & District Electric Supply Company. Mr. T. H. Wood was appointed, Messrs. Carter and Batchelor having previously withdrawn their applications.

Business Items.

The New Switchgear Construction Company, Ltd., Sutton, Surrey, has issued its provisional catalogue, which gives particulars and prices of the various forms of oil-break switches, mining switchboards, isolating switches, &c., manufactured by the company.

The control of the Power Plant Company, Ltd., West Drayton has passed into purely British hands, the whole of the share holding of Mr. B. R. Wingfield having been purchased along with that of other shareholders. Mr. R. J. McLeod is managing director in place of Mr. Wingfield and Mr. W. E. Sykes is assistant general manager.

By an Order of the Minister of Munitions every person engaged in the production of ferrous forgings or castings must furnish to the Controller of Forgings and Castings such particulars as to output, plant and workpeople employed by him, and as to orders and contracts, in such form and at such times as the Controller shall direct.

Benjamin Electric, Ltd., of Tariff road, Tottenham, notifies that, owing to constant rises in the price of raw material and to recent Government labour awards, it has been compelled to make a further advance in prices on all Benjamin lines. The new advances scheduled cancel and include all previous advances and came into effect on the 18th inst. The company's terms as regards payment of carriage on goods have also been revised.

Bankruptcy.

A receiving order has been made against E. C. Sparkes, electrical and manufacturers' agent, 118, Wardour-street, London, W. The first meeting of creditors will take place at Bankruptcy-buildings, London, W.C., on Oct. 30, and the public examination at the same place on Dec. 3.

Companies' Meetings and Reports, &c.

Eastern Telegraph Company, Ltd.

The ordinary general meeting was held on Wednesday, October 23, Sir John Denison-Pender, K.C.M.G., presiding.

At the outset the CHAIRMAN paid a tribute to the late Sir John Wolfe Barry, chairman of the company for 18 years. Proceeding, he said: For the same reasons as those given last year, it was not possible to present the report and accounts in May. My remarks on the accounts will be brief, as you will no doubt consider it unnecessary for me to endeavour to compare in detail the various items of expenditure. Our total revenue from all sources for the year under review is £2,901,579, which is £382,296 more than the previous highest record, attained in 1916. Our total working expenses were £1,262,316, or £202,373 more than for last year. The amount payable for income tax and excess profits duty is £659,581, or an increase of £213,292. There is an increase in the balance brought forward from last year of about £28,000, the result being that we are able to make the same contribution to the general reserve fund as we did in 1916—viz., £500,000—while maintaining the payment of a dividend and bonus on the ordinary stock amounting together to 8 per cent., free of income tax. Our share of special contribution to the pension and superannuation funds towards depreciation of investments is £36,163. The investments of which these funds are constituted have, in common with most other gilt-edged securities, greatly depreciated in value during recent years, and, although some recovery may be hoped for after the war, the directors of the associated companies considered it desirable in the interests of the staff that a fund should be provided to make good this shortage. It was deemed advisable to spread the required contribution over a period of years, and the amount appearing in the accounts represents this company's proportion for the four years 1914-to-1917. Payments to staff and other expenses in connection with the war were £170,744, or an increase of £92,310. This is a large figure, but your directors, knowing full well that the stockholders would fully approve of their action, considered that the extra allowances granted for 1916 should be materially augmented owing to the exceptional circumstances under which our staff are now working. I may remark that a still further increase has taken place during the present year. I cannot say too much in favour of our staff both at home and abroad, on land and on sea. Their work throughout the war has been of a most strenuous nature, and they have been called upon to work long hours, sometimes under circumstances of discomfort and danger: but they have always responded with cheerfulness to the demands of the Government, with a full knowledge of the vital importance of the service due to the Empire and to our Allies. £40,000 has been taken from reserve as a further provision on account of investment fluctuations. This makes a total provision of £640,000, and the amount of £3,271,988, appearing in the balance-sheet as the value of our investments, may be taken as approximately the value as at the date of the accounts.

Our general reserve fund now amounts to over 2½ millions. The fund is principally required to meet the cost of renewals of cables and for additional sections to meet the ever-growing demands for extra capacity to enable us to deal with the increasing volume of traffic. We have expended for this purpose during the 17 years prior to the war on an average a sum of nearly £300,000 per annum. Although we have incurred considerable expenditure on account of repairs to cables since the war started, the conditions have been such as to prevent the carrying out of renewals or the laying of new commercial sections. At times it seems almost impossible to get through the work, but so far we have been able to maintain a satisfactory Government service; but it is not surprising if on occasions considerable delay takes place in the receipt, transmission and delivery of commercial correspondence. As soon as normal conditions again prevail we must be prepared to incur heavy expenditure and at once proceed with the work which has been suspended during the last four years, in spite of the greatly increased cost of cable which will continue for some time. Owing to the death of Sir John Wolfe Barry, the directors did me the honour of electing me to the position. I have been connected with the associated cable companies since 1881, and as managing director of this company since 1893, later also as vice-chairman. The growth of the various companies and the increase in the work thus involved necessitated the appointment of some one to assist in the administrative work of the Eastern Company. In the course of our relations with the Admiralty I had many opportunities of realising the particular qualifications of Capt. H. W. Grant. In December last year your board applied to the Admiralty for permission to offer that gentleman a position of managing director. Our application was favourably entertained, and Capt. Grant was appointed a managing director of the company on March 13 last. The condition of affairs set up by the war is wholly unprecedented. The demands of the State for the prompt treatment of its telegrams are at times almost overwhelming, but I think it is the unanimous opinion that its interests must be the first consideration. The claims of the general public through the medium of the Press during these stirring times also impose upon us an additional burden. The formalities of censorship must affect the prompt despatch of press and commercial telegrams to a considerable extent. These adverse conditions, together with the difficulties of maintaining our cables, seriously reduce the promptitude of a service which in normal times was proverbial for speed and accuracy. The staff are most willing, and have exerted themselves to the utmost, but they are overworked, and many of them need rest. We are doing everything that is humanly possible to carry the exceptional traffic thrown on our

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system through war conditions, which include the interruption of two very important systems to the East—viz., the total closing down of the Indo-European line through Germany and Russia to India, and the interruption of the Great Northern system through Russia to China and Japan. In pre-war times these two Companies, although in no way under our working control and not included in the cable association under this roof, worked with us in such a manner that, when one of us forosaw delay owing to a partial temporary interruption of its service, it handed traffic over to one or both of the others if they happened to be in a more fortunate position at the time, thus ensuring regular and speedy transmission in the interests of the telegraphing public.

The report and accounts for the year were unanimously adopted, the retiring directors re-elected, the dividends approved, and the auditors re-appointed. In acknowledging a vote of congratulation on his succession to the chair of the largest cable company in the world, the chairman said that the problems which would confront them on the conclusion of peace would demand a great deal of energy and concentration on the part of the whole of the staff.

Eastern Extension, Australasia & China Telegraph Company, Ltd.

At the 84th ordinary general meeting, held on Oct. 22, the CHAIRMAN Sir John Denison-Pender, K.C.M.G., after referring to the great loss which the Company had sustained by the death of their Chairman, the late Sir John Wolfe Barry, said that he regretted that, for the same reasons that operated last year, they were unable to hold the annual general meeting as formerly in the month of May. This had not, however, prevented the payment of the usual dividend of 6 per cent. and the usual bonus of 2 per cent., free of income tax.

The gross receipts for the year 1917 amounted to £1,508,000, against £1,221,000 for 1916, an increase of £287,000, due to the greatly increased traffic all over the company's system during the past year. The working and other expenses for 1917 amounted to £552,000, against £430,000 for 1916, an increase of £122,000, which is accounted for by the heavier cost, showing an increased net revenue of £165,000 for 1917. Interest on the 4 per cent. mortgage debenture stock absorbed £30,096, excess profits duty and income tax payable in England £427,056, and contributions to the general reserve fund £250,000, leaving a balance, after payment of the dividend and bonus, amounting to £240,000, of £72,000 to be carried forward to the current year's account, against £63,000 for 1916.

The company's holding in War Loan and National War Bonds amounts to a total of £1,668,000. The 20 years' concession granted to the company by the Spanish Government in 1897 for providing and maintaining, under a subsidy arrangement, cable communication between Manila and the islands of Iloilo and Cebu (Visayas), expired in November last, when the company's stations in those islands were closed. The reason for this action was that the United States, having taken over the Philippines from Spain after the war between the two countries, soon after the concession was granted, and having subsequently laid a network of Government cables between the principal islands, considered the renewal of the concessionary arrangement unnecessary. The company's cables between Iloilo, Cebu and Manila had since been picked up for utilisation elsewhere, after being renewed at the Company's cable depot at Singapore. The company's traffic greatly expanded in the early days of the war through the Government restriction of coding facilities—all private codes being suspended and only public codes being used—and later on, when the postal delays caused by the withdrawal of shipping for war purposes made cabling more necessary than ever, an additional strain was placed upon the cables, which was accentuated by the troubles in Russia preventing the Great Northern Company from carrying—as in pre-war days—their share of the China and Japan traffic. Nevertheless, their capable and hardworking staff had sucessfully coped with this extra work, although heavy delays were unavoidable owing to circumstances quite beyond their control. He did not think there was any more information he could give at the present time. When the war was over he might be able to go more closely into some details which would be of the greatest interet.

Replying to questions, the CHAIRMAN said that he was not going to prophesy about wireless telegraphy or what it would do. He had seen the report that a message sent by cable as well as by the wireless was delivered more quickly by the wireless. It was very easy for the wireless system to send messages with an absolutely free hand, because they are cabling no traffic. The cable companies would be very glad—at least, at the present time—if the wireless system would come in and relieve them of some of their traffic. That would be a great boon to the public, both as regards commercial and private messages. The past year had been a good one, but he would like to see some reduction in the delays that occur. He added that the companies had not raised a single cable rate. The revenue had been made under the old rate, and that was saying a good deal, because many of the Governments, both at home and in other countries, had increased their rates very materially.

The report and accounts were received and adopted, and the meeting terminated with a hearty vote of thanks to the Chairman, Directors and staff.

West African Telegraph Company, Ltd.

At the thirty-third ordinary general meeting held on Friday last, the chairman, Sir John Denison-Pender, K.C.M.G., said the gross revenue for the year 1917 amounted to £59,041, against £53,214 for the previous year, or an increase of £5,827, representing in net message receipts £5,105 more and in interest and dividends £722 more. Against that improvement in the revenue there was an increased expenditure of £7,716. The normal working expenses showed a reduction of £664, but the expenses attending maintenance of cables were £4,909 in excess of those of the previous year. He had repeatedly drawn attention to that important item of expenditure, and had explained how liable to extreme fluctuations it was; and, as he stated at their last meeting, their cables got older, and consequently required repairing more frequently, added to which there was the ever increasing cost of the repairing ships and of the cable used for the repairs. The cables must be fully maintained to ensure their revenue, and expenses attending labour and the cost of material had increased enormously of late. Sundry differences in exchange showed an increase of £1,162, while special war payments to staff and other abnormal expenses in connection with the war totalled £1,311 more than in last year's account. The investments constituting the staff pension and superannuation funds had, in common with other securities, considerably depreciated in value in recent years, and the directors of the associated companies (the West African Company being one) decided to make a substantial contribution towards that depreciation, and the amount appearing in the accounts represented the company's share of such contribution, and might to a smaller amount recur in future years. The net result of the year's working was a profit of £9,840, or £1,889 less than last year, in spite of increased earnings. It was only due to the interest and dividends on the reserve fund investments that they had been able to maintain the payment of the usual dividend of 4 per cent. Under present conditions it had been very difficult to relieve their men who had been on the coast for some considerable time, and it had also been difficult—almost impossible—to strengthen stations when circumstances had for a time, owing to the war, doubled or trebled the work, which had been the case at many of the stations in West Africa. To that had been added an epidemic of influenza considerably worse than we had had even in this country, and at times practically nearly the whole of our staff had been down. In spite of all that the traffic had been carried, although certainly with some delay, but the work had been exceedingly well done.

The report and accounts were then adopted. Col. the Hon. A. G. Brodrick was re-elected a director. It was stated that Mr Brodrick, who had been for over three years in Mesopotamia without a break, was on his way home.

The directors of Callender's Cable & Construction Company, Ltd., have declared an interim dividend of 5s. per share (5 per cent.).

The report of the Nairobi Electric Power & Lighting Company, Ltd., for 1917 states that the outstanding debentures have been reduced to £16,000. The net profit amounted to £8,021, and £1,017 was brought forward. Interim dividends amounting to 10 per cent. have been paid and £1,230 is carried forward. Units generated numbered 1,637,990, against 1,495,281.

At the recent meeting of Palmer's Shipbuilding & Iron Company, Ltd., the chairman (Mr. G. Mure Ritchie), in the course of his remarks, said that the first part of the scheme of reorganisation of the iron and steel works was approaching completion, despite the heavy handicap of carrying it out under war conditions, some of the work being two years overdue. Within two months they hoped to be supplying nearly all their own electric power from waste gas. The reconstruction had been nothing short of marvellous considering the conditions. Two additional shipbuilding berths were being laid down at Hebburn.

The report of the Electric Supply Company of Victoria, Ltd., for the year ended March 31 last states that the lamps connected to the electric supply department's mains were 211,746, against 188,402 in 1917 and 166,253 in 1916. The passengers carried were 4,881,924, against 4,803,895 and 4,877,325 in 1917 and 1916 respectively. The revenue was £95,009. 6s. 4d. and the expenditure £63,566. 14s. 11d., leaving a gross profit of £31,442. 11s. 5d. The balance to credit of profit and loss account is £29,730 and with £16,426 14s. 10d. brought forward the total is £46,156. 18s. 8d. Deducting debenture interest (£7,026. 7s. 6d.) and amount transferred to debenture stock redemption account (£7,257. 17s. 9d.) and amount written off cost of debenture issue (£450) the balance is £31,422. 13s. 5d. The directors propose to pay on account of arrears of preference dividend £10,500 and to carry forward £20,922 13s. 5d.

Thirty-Seven Years Ago.

[From The Electrician, October 22, 1881.]

The Electric Light and Military Operations.—The electric light was made use of last week at some night operations carried out at Chatham. Bodies of men were discovered with ease by its aid at over 1,000 yards distance.

Water Power at Poole.—Mr. Ponton, surveyor, of Poole, has sent a communication to the Mayor of that town in which he estimates the power to be obtained from the rise and fall of the tides in Poole Harbour to be equivalent to 30,000 H.P. per 24 hours. He proposes to use a portion of this vast power to generate electricity for lighting the town of Poole, which needs a little more light, being, we believe, still attached to oil lamps as a means of street illumination.

The Electric Light for Chelsea.—In his annual report to the vestry, which has just been issued, Mr. G. H. Stayton, the surveyor, says: "The question of electric light still continues to receive my best consideration, but I am yet unable to recommend a trial of the system, as I cannot obtain any definite or reasonable terms for its adoption in Chelsea. It is, however, making considerable progress, and the results of the experiments which are now being made in the City of London and elsewhere will be quite as valuable to this parish as if a large expenditure or a similar trial had been incurred by your vestry."

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CONTENTS.

Notes 547
Arrangements for the Week 549
Electric Traction on the Central Argentine Railway. Illustrated. —*Continued* 550
Electric Winding Engines and Mine Hoists. By H. H. Broughton. Illustrated.—*Continued* 553
The Production of Electricity by Steam Power. By Alex. Dow... 555
The Labour Outlook. By Our Labour Correspondent 557
The Ultimate Economy of the Power Station 558
Review 558
Industrial Coal Economy. By D. Wilson. Illustrated.—*Concluded.* 559
Correspondence 560
Coal Economy Campaign 561
Electricity Supply on the North-East Coast 561
Legal Intelligence 562
Volunteer Notices 562
Commercial Topics 563
Electricity Supply 564
Educational 565
Tenders Invited and Accepted 565
Companies' Meetings and Reports 566

Notes.

Works Schools.

Our Labour Correspondent this week raises a point of some importance, namely, whether works schools which are recognised by the Education Act as continuation schools are desirable, and he takes the view that such schools will introduce another bone of contention in industry. This is due to the idea that any steps taken by employers outside their economic functions are in the interests of the employer rather than in the interests of the workers, and that educational matters should be handled by the local authority. In considering this question we think it should be borne in mind that the employer has no wish to add education to his other duties if this can be avoided; he has taken up education simply because other people would not do it for him. From the point of view of the small firm it would be better for some outside authority to carry on this part of the work, as the small firm has not the necessary facilities. Large firms, however, not only know precisely what education is desirable, but they are able to provide this to great advantage; in fact, the education so provided is likely to be more efficacious than that supplied by a local authority. In this respect, we do not think that any hard and fast line can be laid down. We feel, however, that it will be very unfortunate if any steps taken by employers for the benefit of the workers are considered to be suspect. Take, for example, the question of canteens; these are run by a number of employers, and in many cases they are probably run at some loss, yet we do not know how arrangements of this kind could be handled by any outside body. Are the workers going to refuse anything that will benefit themselves if there is a chance that there will also be an indirect benefit to the employer? We hope not. We come back to the standpoint that what is good for the worker is generally good for the employer also, and it is quite possible to do great harm by attempting to divorce these interests. There should be an increasing realisation of the fact that the prosperity and well-being of the workers are bound up with those of the employers, and *vice versa*.

Pensions for Teachers.

We are glad to see that the Government has come to the conclusion that teachers in State-aided schools should receive something like reasonable pensions on retirement, and that Mr. Fisher, President of the Board of Education, has introduced a Bill with this object in view. The general principle of provision for old age will do much to make the teacher feel that he has a very much improved position. It appears that the lines of the Civil Service are to be generally followed, and that the maximum pension will be at the rate of half the salary during the last five years together with a lump sum, depending upon the extent of the service. It also appears that the pensions are to be on a non-contributory basis. As to whether this is desirable or not depends, of course, upon the salary given. If the salary is not on the high side, it seems to be unreasonable to expect the recipient to contribute towards a pension. The more important point, however, is the effect upon teachers who may wish to change from one school to another. Pensions will not apply to non-aided schools. It is, nevertheless, very desirable that teachers should be free from restrictions to move from one kind of school to another. Such movement is probably good for both teachers and pupils. We are, therefore, glad to see that this mobility is secured, and that no impediment will be placed in the way of a teacher moving away from a State-aided school. Very naturally, the only periods of service that will be taken into account towards a pension will be those spent in the State-aided schools, for it would be too much to expect that these pensions should be given to teachers in schools which are run for personal profit. On the other hand, it is possible to insist on too rigid a form of control. We think that this Bill marks a new era in the scholastic profession, but we hope that in future all salaries will be fixed upon a reasonable basis apart from any scheme for pensions.

British Industrial Art.

The movement initiated at the meeting at the Royal Society of Arts last Monday for the development and improvement of industrial art is not without interest from the technical standpoint. Much has been said since the outbreak of war on the need for closer relations between science and industry. The movement referred to aims at establishing a closer connection between industry and art. We think it would be shortsighted to assume that there is necessarily a divorce between art and science. The intention is to establish a British Institute of Industrial Art, with the co-operation of the Board of Trade, the Board of Education and the Royal Society of Arts. A permanent exhibition is to be organised at the Albert Museum, machinery is to be created for the better training of designers and craftsmen of all kinds, scholarships are to be instituted and a special relation established with the British School at Rome to facilitate the study of Roman Art. Briefly, the movement aims at the more general application of artistic methods to common things. Mr. Fisher, President of the Board of Education, who presided, was inclined to think that people in this country depreciated our artistic abilities. The other speakers, who included Lord Leverhulme, Sir Frank Warner, Mr. Gordon Selfridge and others, dealt

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with the subject mainly from the industrial standpoint, a point made by Mr. SELFRIDGE being that success was essentially dependent on a fuller education of the public to appreciate beautiful things. Manufacturers, in short, are "a laxy lot." They will not create artistic things until they are sure of a demand. Sir WM. MCCORMICK pointed out that in many respects the movement was parallel to the work of the Department of Scientific and Industrial Research. It aimed at doing for art what that body was doing for science. He mentioned several instances, such as the design of decorative porcelain, where scientific researches on the treatment of material went hand in hand with decorative design. Similar instances occur in the electrical industry, notably in connection with fittings, street lamp standards, &c., which certainly have not been greatly studied from the artistic standpoint. Moreover, every electrician is acquainted with fittings which are excellent from the artistic standpoint, but which from the electrical point of view are sadly deficient, because they have far from sufficient room for the wiring. The designer must realise the use to which his design is to be put. We wish the movement success, but we are confident that in this field, as in the application of science to industry, much patience will be required and adequate support necessary to secure the required continuity of effort.

Ramsay Memorial Fund.—The Million Shilling Appeal has so far realised £2,496, and the total of the fund to date is £39,500. The Greek Government has decided to make an annual subvention of £300 to the fund in order to found one Ramsay Memorial Fellowship, tenable in the United Kingdom by a Greek chemist.

Industrial Reconstruction Council.—A conference on "The Place of Conciliation and Arbitration in the Whitley Scheme" will be held under the auspices of the Industrial Reconstruction Council on Tuesday, Nov. 5, at 6 p.m., in the Hall of the Institute of Journalists, 2 and 4, Tudor-street, E.C. 4. The subject will be introduced by Mr. E. H. C. Wethered, president of the Bristol Association for Industrial Reconstruction, after which the discussion will be open. No tickets are necessary.

War-time Lighting Economies.—At the convention of the Illuminating Engineering Society, which was held in New York on Oct. 10, the Committee on War Service presented "War-time Lighting Economies," which has been prepared for the United States Fuel Administration to serve as the basis of the Fuel Administration's propaganda for economy in lighting. Advance copies may be obtained upon application to the general offices of the Society, 29, West 39th-street, New York City.

French Metal Filament Lamp Works.—In a communication to the "Bulletin" of the Société Internationale des Electriciens, Mr. A. Larnaude states that the present capacity of French incandescent lamp factories is 15-20 millions of lamps per annum, but this figure might be doubled in the near future. The tonnage required for the transport of materials needed in this industry is small, and one ton of the ore will provide sufficient material for 3,000,000 lamps. The argon required for the smaller types of gas filled lamps is now being made in considerable quantity by the process of M. Claude.

The Coal Shortage in Russia.—While most European countries are suffering severely from the coal shortage, the conditions in Russia appear to be particularly bad. According to "Stahl und Eisen," attempts are being made to revive the Ukrainian iron industries, but shortage of coal has so far prevented work being resumed except on a very small scale. One factor in the shortage is the unrest in the Donetz basin, greatly impeding production of coal, while in the Ural district and in the coal-producing areas round Moscow the output only suffices for local needs. Transport difficulties have prevented Caucasian supplies being obtained in any quantity. As a result of these conditions, it is feared, many of the factories now feebly working in Russia will again be brought to a stoppage. The railways are mainly dependent on wood for fuel.

Training in Aeronautical Engineering.—In conjunction with the O.U.T.C. scheme for the education of officers unfit for general service and discharged officers, an arrangement has been made with the Aeronautical Institute of Great Britain, whereby special courses in aeronautical engineering have been initiated with a view to fitting such officers for suitable appointments in civil life. The subjects dealt with will include: (1) Practical mathematics and mechanics, (2) mechanical drawing and design, (3) the elements of practical aerodynamics, (4) the internal combustion engine, (5) the air-screw and its adaptation to aircraft, (6) the design and construction of aeroplanes, (7) strength of materials applied to aeroplane construction. The courses will be under the direction of Mr. L. Blin Desbleds, hon. director of the Aeronautical Institute, and will extend over a period of three months. Enquiries should be addressed to Capt. Lisle Watson, Adjutant O.U.T.C., London branch office, 11, Commercial-road, Peckham, S.E. 15.

The Oldest British Industry.—"What is the oldest British industry"? According to the "Journal" of the Royal Society of Arts it is probably that of the flint "knappers" of Brandon, in Suffolk. It is believed that the process was carried on in neolithic times, and as it was one of the most essential "munitions industries" of this prehistoric period, interruption for any prolonged period is improbable. There was still, before the war, a trade in gun-flints to Africa and South America, and even now it is probably shortage of labour rather than cessation of demand that has stopped work at Brandon. The process seems to be almost unchanged from prehistoric times. The flints were quarried by sinking short shafts and no mechanical power, not even a windlass, was used in bringing the flints "to bank." The splitting and chipping of the flints was also substantially that of past ages—indeed, recent practice has thrown much light on the methods by which the old flint implements were prepared.

Determining the Mean Power of a Waterfall.—The variability of power derivable from a waterfall is a most important factor, and it seems very desirable that there should be some common practice in defining what is commonly spoken of as "mean power." The question is discussed in "Technique Moderne" by an author who is closely in touch with water power projects in France, and who has acquired systematic data on the fluctuation in volume of certain falls in that country. The periods of extreme low water are most important. It is suggested that the most essential factor is the discharge below which the river never falls for more than 10 days per annum. The mean discharge, it is suggested, should be defined as that volume below which the discharge does not descend on more than 180 days per annum. It would appear, however, that such factors can only be obtained with certainty when the fall has been studied for a considerable length of time. The conventional term "mean power of a waterfall" is useless for classification and should not be employed.

Improvements in Electric Contacts.—Several recent French patents refer to interesting developments in electric contacts. Patent No. 484,271, of the French Westinghouse Co., relates to contacts in relays, circuit breakers, &c. Tungsten and molybdenum have been used as substitutes for platinum, but have certain drawbacks. For example, they oxidise easily and the oxides when formed are practically non-conducting. On the other hand, silver, when used as the cathode, is apt to become roughened owing to the low fusing point of the metal. In this patent it is accordingly suggested that the anode should be of silver, platinum or iridium—metals whose oxides conduct relatively well—and the cathode of tungsten or molybdenum which have a high fusing point. Another device, described in a patent (No. 484,287) taken out by the Oerlikon Co., has for its object the automatic reversal of the polarity of contacts, so as to prevent the tendency for metals to be transferred

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from one pole to the other. The passage of the current automatically brings about the reversal, the period of which is determined by an ampere-hour meter.

A Bibliography of Electric Welding.—So much attention is now being given to electric welding that it is useful to have available a bibliography of recent literature on the subject. We observe that a very complete series of references is included in the bibliography published in a recent issue of the "General Electric Review" (U.S.A.); this, we understand, formed a portion of a "Report on the Application of Electric Welding to Ships," by Capt. James Caldwell, R.E., Deputy Assistant Director of Materials and Priority to the British Admiralty, who has worked in conjunction with the U.S.A. Shipping Board Emergency Fleet Corpn. This list of references applies to the years 1914–1918, and thus illustrates the very considerable progress made since the outbreak of war. Although mainly concerned with marine applications, many Papers of general interest are included. A bibliography covering the earlier stages of the art of electric welding, namely, the period 1886–1913, was compiled by Mr. W. B. Gamble, of the New York Public Library, and was published by the library in 1913.

Maintenance of Accumulators in War Time.—In "Elektrotechnik und Maschinenbau," an account is given of some special difficulties leading to the breakdown of some cells in a buffer battery installed in the generating station of an Austrian tramway system. The trouble was due to faulty maintenance, which is attributed to war conditions. Several cells were known to be in a bad way, but could not receive immediate attention, and ultimately one of them "blew up," shooting out long flames, which could only be put out after the battery had been disconnected. The breakdown, which was repeated shortly afterwards on another cell, was due to the destruction of the plates which fell away from the upper lead frame. The level of the acid had sunk below this line of fracture, the whole supply of 600 volts being thus interrupted; an arc ensued and volatilised the lead. The author quotes this example as a warning to take great care to keep the upper edge of battery plates well immersed in the electrolyte. If the story had not appeared in a technical contemporary we should have said that such circumstances could not have arisen in a civilised country. But that raises other reflections.

Permeability of Balloon Fabrics.—An article in "Aviation" discusses the procedure of testing the permeability of balloon fabrics—a matter of very great importance at the present time. The investigations described were made under the supervision of the Bureau of Standards. Most balloon envelopes comprise two plies of rubber coated silk or cotton, with a gas-tight rubber film between them. Sometimes the fabric is also protected by an outer rubber coating. Gas may escape through leaky valves, through imperfections in the fabric, or by actual passage through minute holes in the same. The gas may either diffuse or dissolve in the rubber film. Usually both processes occur simultaneously, which is proved by the fact that the rate of escape is not inversely proportional to the square roots of the densities of gas and rubber film. Moreover, the effect of temperature is greater than could be accounted for on the diffusion theory alone. Gases, in fact, penetrate mainly by solution. Permeability is defined as the rate at which the fabric is penetrated by gas (usually hydrogen) expressed in litres per square metre during 24 hours, corrected to 0°C. and 760 mm. pressure. Several methods of testing this quantity are described. A number of curves are given illustrating the effect of temperature.

Obituary.

JAMES O. CALLENDER.—In our last issue we referred briefly to the death of Mr. James Ormiston Callender. We learn that Mr. Callender, who was born in London on June 26, 1863, was educated at the Glasgow Academy and in Paris, and received his technical training at the City and Guilds of London Institute, South Kensington. On its completion he joined the testing staff of the Callender's Telegraph & Bitumen Company, at Erith, and was in charge of that department for some years. During that period he made several journeys to France and Italy, returning in 1886 with impaired health, which necessitated a lengthy voyage to South Africa. On his return in 1886, he went (under medical advice) to New Zealand. In the following year he started as a consulting engineer in Sydney, where he was one of the pioneers in the electrical industry, and a founder and early president of the Electrical Association in that Continent. During his 14 years in Australia he made many voyages, visiting all parts of the Australian Continent, and also China, Japan and the United States, besides coming home on several occasions. During that time he represented the Callender Company's interests in Australia, and in addition to his consulting work carried out several important contracts for the home firm. In 1900, the Callender's Cable & Construction Company having been formed, and its business so largely increased, he returned, and the rest of his life was spent as one of the management of the Company in London. He had charge of the overseas department as well as the general management of the extensive contracts which were carried out at home. In 1903 the Callender Company acquired control of the Anchor Cable Works at Leigh, and Mr. Callender took the keenest interest in the progress of the Anchor Works, which were entirely re-organised under his direction, and which under his personal supervision developed into one of the most important factories dealing with rubber insulation in the country. The Picardy Works, recently constructed for the manufacture of war material, was designed under his personal care and supervision. For several years past he has suffered from indifferent health. In July, 1914, he was in Carlsbad, and only reached Switzerland a few days before the declaration of war. As he was still an invalid, he suffered much during the difficult journey home in August of that year, but he regained his strength and was most active in his work, until a few months ago, when he had a breakdown which necessitated a lengthy rest. His recovery was, however, anticipated by his friends, but a sudden relapse, after an operation, took place on Oct. 18, and he passed away in his sleep the following day at Swanage. He married in 1902 Miss Catherine Isabel Cockerton, who survives him. He was an Associate of the Institution of Electrical Engineers, and a member of Council, and represented his Company on the Committee of the B.E.A.M.A.

At the hour of the funeral last Tuesday, the Anchor Works closed down for half an hour, when 900 of the workpeople and staff attended a memorial service in the works canteen, conducted by the Rev. L. S. Murdoch, vicar of the parish. Mr. J. Bowyer, works manager, represented the Anchor Works at the funeral. Two large wreaths, one taking the appropriate form of an "Anchor," were sent by the workpeople and staff

J. F. L. CROSLAND.—The death took place on 21st ult. of Mr. James F. L. Crosland, late chief engineer of the Vulcan Boiler Insurance Company. He was a member of the Institutions of Civil, Electrical and Mechanical Engineers.

MAJOR-GENERAL F. B. MAINGUY.—The death recently took place of Major-General Ferdinand B. Mainguy, R.E., who was responsible for the inauguration of the Guernsey State telephone system.

The late Col. FREDERICK J. G. MURRAY, who was a director of the Calcutta Electric Supply Corporation, left estate valued at £902,333.

Personal.

Mr. Will Thorne, M.P., and Mr. W. H. Hutchinson, vice-president of the Labour Party, have consented to join the Council of the Boys' Welfare Association.

Last week the members of the Bradford Tramways Committee presented the retiring manager (Mr. C. J. Spencer) with a silver flower vase on the occasion of his leaving the service of the Corporation to take up a post as manager of the Metropolitan and London United Tramways. Ald. Enoch Priestley, chairman of the committee, presided and made the presentation, and among those present were the Lord Mayor (Mr. H. H. Tetley), Sir James Hill, Bart., M.P., and the newly-appointed manager (Mr. R. H. Wilkinson).

Arrangements for the Week.

FRIDAY, Nov. 1st (to-day).

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. 1. Paper on "Engineering as Applied to Cinemas," by Mr. W. E. Dines.

TUESDAY, Nov. 5th.

INSTITUTION OF CIVIL ENGINEERS.

5.30 p.m. At Great George-street, London, S.W. 1. Presidential Address by Sir John A. F. Aspinall.

INSTITUTION OF ELECTRICAL ENGINEERS (SOUTH MIDLAND CENTRE)

6 p.m. At Birmingham University, Edmund-street, Birmingham. Presidential Address by Mr. S. T. Allen.

NATIONAL ASSOCIATION OF SUPERVISING ELECTRICIANS.

7 p.m. At St. Bride Institute, Bride-lane, London, E.C. Paper on "Automatic Telephone Switchboards," by Mr. C. Bowman.

RÖNTGEN SOCIETY.

8.15 p.m. At the Royal Society of Arts, 18, John-street, Strand, London, W.C. Presidential Address by Dr. G. B. Batten, C.M.

THURSDAY, Nov. 7th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Tenth Kelvin Lecture on "The Dynamical Theory of Electric Engines," by Mr. L. B. Atkinson.

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Electric Traction on the Central Argentine Railway.

(*Continued from p.* 533.)

POWER AND LIGHTING EQUIPMENT

Two sub-stations are provided in the electrified section to give a supply for general purposes, one situated at the Retiro terminus and the other at the Victoria workshops. The former is designed to deal with the power and lighting requirements of the terminal station, train-yard and offices, and to give a supply for pumping and for operating the compressors of the pneumatic signalling system; the latter supplies power and light to the workshops, locomotive sheds, car sheds and repair shops at Victoria Station. Details of the principal apparatus are set out in Table V.

Space is reserved in Retiro sub-station for two traction rotary converters, which will be installed when the goods traffic in the yard and at the docks is handled electrically. The high-tension switchgear is similar to that in the traction sub-stations; the direct-current board consists of slate panels supported on a pipe framework. Battery charging boosters are mounted on the bedplate of the motor-generators and direct-coupled to the armature shafts. A battery regulating switch of the single-sided remote control-type is installed to control the end cells of the lighting battery.

The lighting of wayside stations along the electrified track is taken from the third-rail, the circuits being arranged to take four 200-volt lamps in series. Vulcanised-bitumen sheathed, paper-insulated cables of 0·1 sq. in. section are taken from the third-rail and track rails respectively to a "casilla," a small brick chamber, in which the switches are housed. The main panel is of slate, and carries a single pole knife-switch operated by a handle, which projects through the panel, a fuse and a voltmeter. The circuits are controlled by double-pole knife-blade switches, each circuit being protected by a double-pole fuse.

Table V.—*Details of Plant in Power and Lighting Sub-stations.*

Retiro Sub-station:

Type and output of motor-generators.—British Thomson-Houston Co.'s; asynchronous 440-volt motors; output 400 kw. at 240 volts direct current.

Type and capacity of step-down transformers.—British Westinghouse Co.'s; three-phase; oil immersed; naturally cooled; 600 k.v.a. capacity; ratio of transformation 20,000 to 440 volts.

Type and size of secondary battery.—Chloride Electrical Storage, 4,000 ampere-hours capacity at 240 volts.

Type of battery regulating switch.—Bertram Thomas.

Victoria Sub-station:

Type and capacity of transformers.—British Electric Transformer Co.'s, Berry type; three single-phase transformers; 375 k.v.a. capacity; ratio of transformation 20,000 to 440 volts.

ROLLING STOCK.

As the passenger service on the lines to be electrified is frequent and suburban only, the rolling stock equipment was naturally laid out on the multiple unit system. The stock ordered was as follows:

55 motor coaches, each equipped with two motors.
12 motor coaches, each equipped with four motors
50 trailer coaches.

All the coaches are of the saloon type with cross-seats. There are two classes of seating accommodation on the suburban trains in Buenos Aires, first and second, but the distribution of passengers between them differs from that obtaining in this country, inasmuch as the ratio of higher to lower class tickets sold is of the order of 1·4 to 1. Consequently a larger proportion of first-class coaches is required, and the numbers ordered for the electric service were:—

First Class: 52 motor, 37 trailer coaches.
Second Class: 15 motor, 13 trailer coaches.

All the coaches equipped with four motors are first-class coaches; these will be used for hauling trains made up of a motor-coach at each end and, between them six first-class trailer coaches taken from the old steam stock and equipped only with control wiring to allow of the train being operated from either end by one man. These trains will be used on days of specially heavy traffic, the principal of which is Tigre Regatta day, when 9,000 people have been moved by steam trains from Tigre in two hours.

The limiting features in designing the coaches were:—

(*a*) The high standard of comfort to which suburban passengers in Buenos Aires are accustomed.

(*b*) The provision of vestibule connections between coaches.

(*c*) The existence of low platforms necessitating steps up into the coaches.

(*d*) The provision of a driving compartment at each end of every coach.

(*e*) The use of vacuum brakes.

As is particularly desirable in a hot climate, the coaches are large and airy, the capacious loading gauge adopted by the broad gauge lines in the Argentine allowing more latitude in this respect there than in this country. The height from floor to centre line of the semi-elliptical ceilings of the saloons is 8 ft. 7⅛ in., and the width between pillars is 9 ft. 7½ in. Eight 6 in. ventilators are fitted in the roof, and four 38 in. fans are installed in the first-class coaches. The lower side-lights slide upwards, and all windows are provided with upper and lower louvered shutters in place of blinds to keep out the sunlight. The shutters are covered with fine mesh copper wire gauze, to prevent the entrance of mosquitoes. (Fig. 11.)

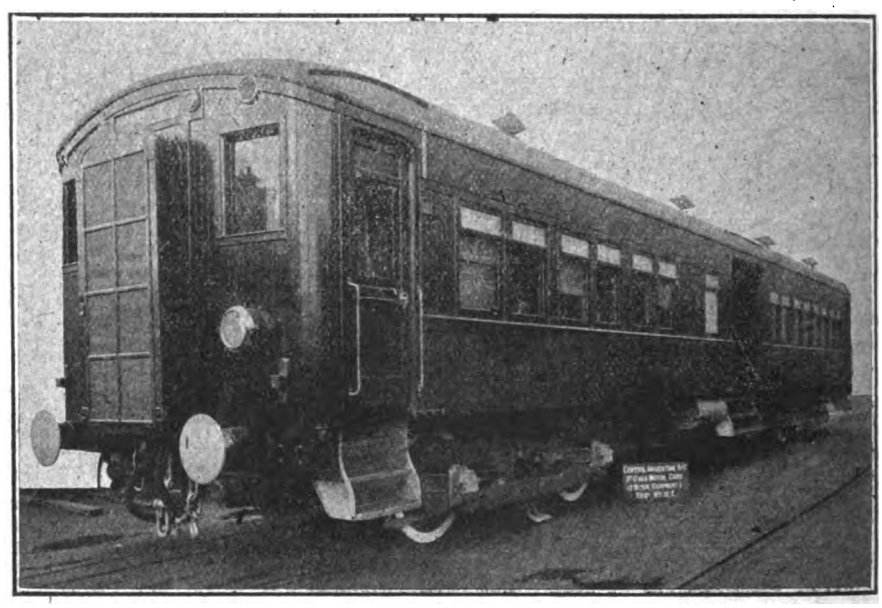

FIG. 11.—EXTERIOR OF FIRST-CLASS MOTOR COACH.

The minimum space which must be provided for each seated passenger is definitely set out in the Government Regulations, the requirements being that the distance between seats set *vis-à-vis* shall not be less than 15¾ in., and that the length of seat shall be at least 18⅛ in. and 15¾ in. per passenger in first and second-class coaches respectively. Further, the gangway between seats shall be not less than 21⅝ in. wide.

Besides the provision of two classes of accommodation the Government Regulations call for at least one w.c. compartment on every local train. Space had also to be reserved in a certain number of coaches for compartments for the use of the postal service and for luggage. These requirements were met by providing a w.c. compartment in each first-class motor-coach, and postal, luggage and w.c. compartments in the second-class motor and trailer coaches.*

The height above rail level of the platforms on the Tigre line varies from about 6 in. to 20 in. The height above rail level of the motor coach floor is 4 ft. 2 in., and the Government regulations call for three intermediate steps. A door is provided at each end of the coach, and also one in the middle. The latter is double, the

* Since the service started the Government has agreed to the removal of the w.c. compartments from the first-class coaches.

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doorway being 5 ft. wide, and intended to take two persons abreast, the streams being separated by the central door-post. As the doors have to be set back from the side line of the coach it was not possible to arrange the sills to run beneath the body sides from headstock to headstock or even between bolsters. In the case of the motor coaches the main longitudinals are therefore spaced at a width of 7 ft., and consist of built-up fish-bellied steel girders

The trailer coach floors are pitch pine in two layers ¾ in. thick.

The end vestibules of the coaches are arranged to serve either as entrance ways for passengers or as driving compartments for the motormen. They are 4 ft. wide, and contain the driver's brake valve, master controller and hand brake wheel. As the English rule of the road is observed on the railways in Buenos Aires, and the wayside platforms are not of the "island" type on the Central

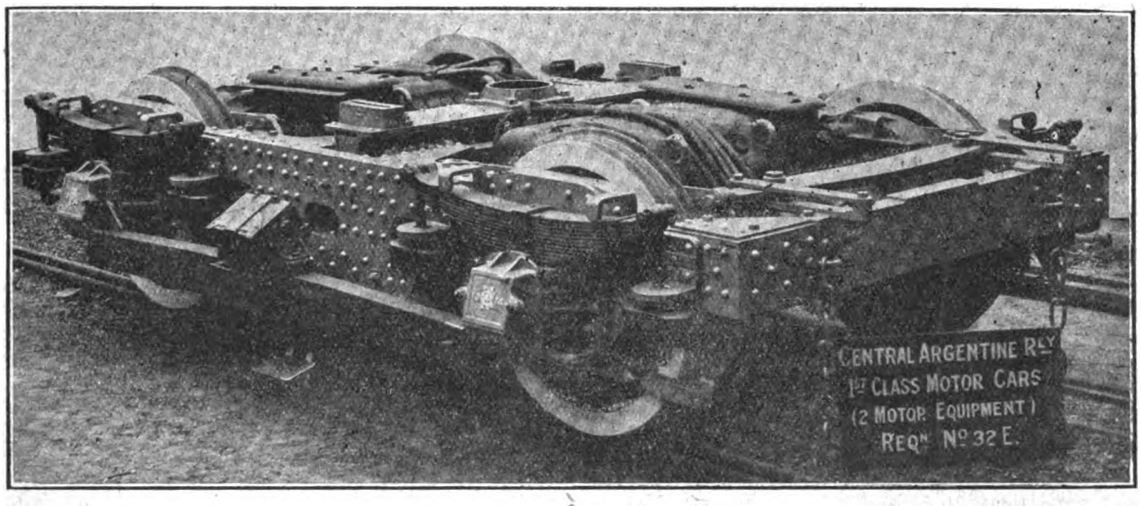

FIG. 12.—VIEW OF MOTOR BOGIE.

2 ft. 6 in. deep in the centre, with holes cut out of the web for lightness and to facilitate access to the electrical equipment. These main longitudinals run from headstock to headstock; they support the angle bar sills, which are interrupted to clear the footsteps, by means of pressed steel brackets. The main members of the trailer underframes, which are of the Livesey-Gould type, are two 12 in. channels spaced 3 ft. apart and running from headstock to head-

Argentine Railway's suburban lines, the driving position must be on the left-hand side of the train, in order that the motorman may see the guard's signals without leaving his position; accordingly, the brake and master controllers are mounted on the near (or left-hand) side of the vestibule—the hand brake, which is normally operated only when entering termini, is reached by walking across the vestibule. Duplicate doors are provided, so that when the

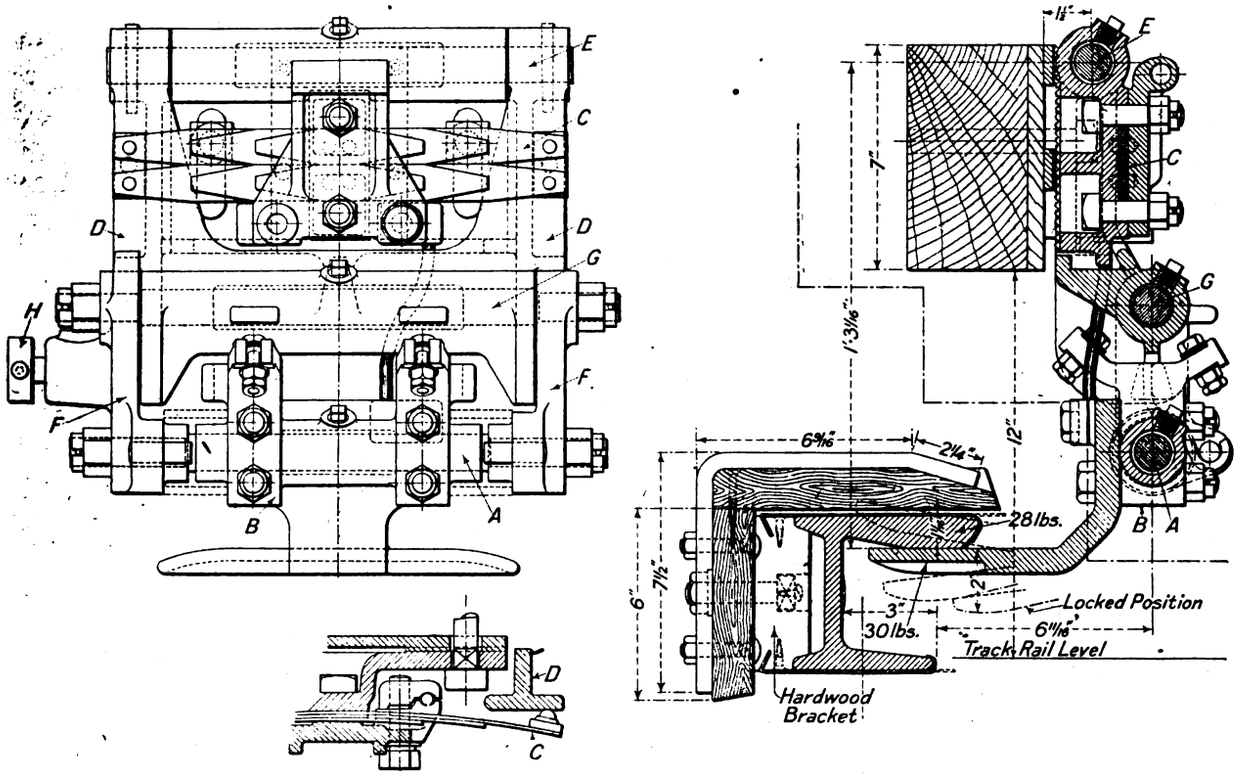

FIG. 13.—DETAILS OF COLLECTOR GEAR AND CONDUCTOR RAIL.

stock; they are stiffened with king and queen trusses, and support the body sills by means of transverse cantilevers.

The motor-coach floors are of steel plates 7/64 in. thick, stiffened with indentations; the plates are covered with "Induroleum," a non-inflammable composition which was laid at the builder's works, the whole underframe being shipped in one piece with the floor in position.

vestibule is used for passengers the electrical gear is all closed off; when used as a driving compartment the step-well is covered by a 3/16 in. thick chequered fall-plate hinged to the door closing the opening in the side of the coach. A removable circular seat of the "music stool" type is carried by the fall-plate, the end of the leg being placed in a hole in the plate.

In the motor coaches the vestibule also contains the panels

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carrying the switches for auxiliaries—*e.g.*, lighting, control circuits, brake circuits, relays, &c.—and also sundry tools—viz., short-circuiting bar, hammer, pliers, rubber gloves, &c.

The coaches are lighted by three two-light fittings, with Holophane glass globes down the centre of the ceiling, and eight pendants down the sides of each saloon. A single light pendant is fixed above each entrance and a headlight, two signal lights and an illuminated destination indicator are provided on each end of each coach.

Brake Equipment.—The service duty required the provision of a pump for each two-motor equipment capable of exhausting 50 cubic ft. of free air per minute. Under working conditions of joint and valve leakage this equipment produces a 20 in. vacuum in the train system within 22 seconds after complete destruction. The brake equipment is laid out to provide a braking force of 105 and 95 per cent. of the tare weight of the motor and trailer coaches respectively. The two brake cylinders on each motor coach are 24 in. diameter, and the capacity of each is augmented by a vacuum reservoir.

Motor Bogies.—A view of the motor bogie is given in Fig. 12. The side frames are built up of $\frac{5}{8}$ in. plate reinforced at the top by angles and at the bottom between wheel centres by channels. The headstocks are 10 in. bulb angles and the central cross-member consists of two channels, 15 in. deep superposed on two 6 in. channels, the latter forming a step or ledge $4\frac{1}{2}$ in. wide beneath the suspension springs of the motors. Diagonal stiffness is ensured by the insertion of upper, lower and intermediate sets of horizontal gusset plates riveted to the central cross-member and to the channel and

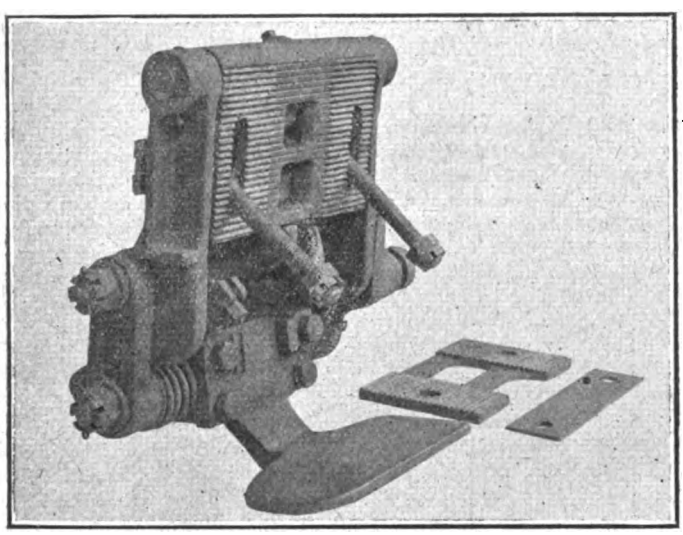

Fig. 14.—Collector Shoe

angle-bar stiffeners of the side frames. The bolster is built of two 10 in. channels with top and bottom cover plates 7/16 in. thick. The axle boxes are of cast steel fitted with gunmetal bearings lined with white metal and with malleable iron centre-bearing keys.

The arrangement of brake rigging is such as to ensure a uniform force being exerted on all blocks with pressures evenly distributed along each pin without any tendency to cross-bind or produce torsional stresses in the levers. The leverage of this rigging is 8 to 1. In order to provide automatic compensation for wear of the brake blocks three sets of six coaches each were fitted with three different types of slack adjuster—the Monarch, Hills and the nut-and-ratchet type. The latter consists of a tubular nut fitted in the main pull rod and rotated by a pawl and ratchet; the box which carries the pawl is formed with a segment of a toothed mitre wheel which gears with a similar portion carried on a vertical stud attached to the cross-head at the end of the pull rod. The periphery of the second mitre wheel is anchored to the underframe by means of pitch chains which thus cause it to rotate in response to the travel of the pull rod. The range of the gear is sufficient to allow the brake piston to make a full stroke when operating through a badly-adjusted brake rigging, and thus to gather the slack till the normal condition is reached. When the brake is released the pawl will cause a partial rotation of the nut whenever the working stroke is sufficient to turn the mitre gears through an angle of 60 deg.

The collector gear consists of an under-running shoe (Fig. 14), which makes contact with the under surface of a channel-shaped conductor rail. The shoe casting is carried on an oak beam fixed to lugs on the axle boxes. The collecting skate has two motions:—

(*a*) An up-and-down movement to follow the level of the conductor rail; this is controlled by helical springs on a horizontal axle A passing through the block B to which the skate is bolted.

(*b*) A sideways movement to allow for the end play of the axle-boxes and want of alignment of the rail; this is controlled by leaf springs C bearing on the suspension links D, which rotate round the axle E. The locking down is done by rotating the links F round the axle G till the spring control pin H engages with a hole in the link D.

The difference in the heights of the top of the skate in its extreme positions is $2\frac{1}{2}$ in.; its horizontal movement is 3 in. The average upward pressure is 28 lb., and sideways 30 lb. The shoe body and suspension links, Fig. 13, are cast steel, machined to gauge; the skate is cast iron, and is designed to break when it strikes an obstacle. If desired, the skate can be locked down in such a position that it clears the conductor rail altogether, thus enabling the equipment of a coach to be isolated. Skates run about 130,000 miles before becoming worn out.

Table VI. gives details of the rolling stock:—

Table VI.—*Details of Rolling Stock—Gauge of Rails, 5 ft. 6 in.*

Coaches.	Motor coach.	Trailer coach.
Length over buffers	65 ft. 3 in.	65 ft. 3 in.
,, headstocks	61 ft. 11 in.	61 ft. 11 in.
,, body	63 ft. 3 in.	63 ft. 3 in.
External width of body	10 ft. $3\frac{1}{2}$ in.	10 ft. $4\frac{1}{4}$ in.
Height from rail to centre of buffer	3 ft. 5 in.	3 ft. 5 in.
Height from rail to top of roof	13 ft. $2\frac{3}{4}$ in.	13 ft. $2\frac{1}{2}$ in.
,, ,, ,, floor	4 ft. $2\frac{1}{8}$ in.	4 ft. $1\frac{1}{2}$ in.
,, ,, floor to ceiling	8 ft. $7\frac{7}{8}$ in.	8 ft. $7\frac{1}{4}$ in.
Distance between centres of bogies	40 ft. 0 in.	40 ft. 9 in.
No of first-class passengers seated	72	68
,, ,, ,,	66	63

Bogies	Motor bogie.	Trailing bogie	Trailer bogie
Wheelbase of bogie	9 ft. 0 in.	8 ft. 6 in.	8 ft. 6 in.
Diameter of wheels	3 ft. 6 in.	3 ft. 3 in.	3 ft. 3 in.
,, of axle at centre	0 ft. 7 in.	0 ft. $5\frac{1}{2}$ in.	0 ft. $5\frac{1}{2}$ in.
Size of journal	10 in. by $3\frac{1}{2}$ in.	$9\frac{1}{2}$ in. by $4\frac{1}{2}$ in.	8 in. by $4\frac{1}{2}$ in.
Distances between centres of journals	7 ft. 6 in.	7 ft. 3 in.	7 ft. 3 in.
Width over slide frames	6 ft. $10\frac{1}{4}$ in.	6 ft. 9 in.	6 ft. 9 in.
Length over headstocks	14 ft. 8 in.	13 ft. 9 in.	13 ft. 9 in.

Note.—The design of the trailer cars has been slightly modified in the case of subsequent deliveries, the spacing of the body partitions and the detail of the bogie having been made similar to those of the motor coaches.

Weight of Rolling Stock, Empty.

	Two-motor coaches.	Four-motor coaches.	Trailer.
Coach body, underframe and bogies	Tons. 39·0	Tons. 40·5	Tons. 33·2
Electrical equipment	11·5	20·5	1·3
Total weight	50·5	61·0	34·5
Weight per passenger seat	0·74	0·84	0·48

(To be concluded.)

Luminescence Due to Radio-activity.—A contribution to the "Journal" of the Franklin Institute, by Dr. E. Karrer and Dr. D. H. Kabakjian, discusses a number of interesting luminescence phenomena characteristic of radio-active substances, or such substances mixed with luminescing materials, such as zinc sulphide. Special interest attaches to the effect of heat on these materials. It is well known that the zinc sulphide preparation, which owes its luminescence to the excitation of α-particles from the radium constituent, is destroyed in course of time, the brightness gradually diminishing. Unfortunately, as yet no means has been discovered of "rejuvenating" such zinc sulphide. When the brightness has diminished to a certain point the radium must be extracted and new compound prepared from fresh zinc sulphide. On the other hand, radium bromide apparently can be rejuvenated by heating, and the same applies to a less degree to barium platinocyanide. Most of the contribution is devoted to an analysis of the momentary "flashing up" of radium salts under the action of heat. It is suggested that this might be made the basis of pyrometric measurements, but in view of the complexity of these phenomena the matter requires very careful investigation.

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Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

(*Continued from page 536.*)

Summary.—The author deals with the spiro-cylindrical drum. After considering the influence of drum profile on performance, and noting briefly the great advantage often obtained by the use of spiro-cylindrical drums, an example is fully worked out for balanced operation.

Spiro-Cylindrical Drums.

By adopting a drum consisting of cylinder, scroll and cylinder, or cone, scroll and cylinder, of suitable dimensions, it is possible to smooth out the peaks without materially

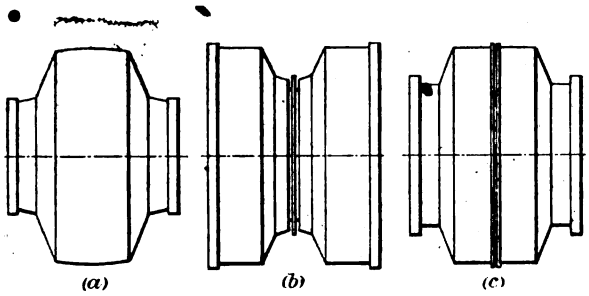

Fig. 53.—Spiro-cylindrical Drums.

adding to the mass to be set in motion. These drums were originated by Mr. E. M. Hann, who introduced them at Aberamann and other collieries. They have since been used for a number of heavy winders. In those cases where the

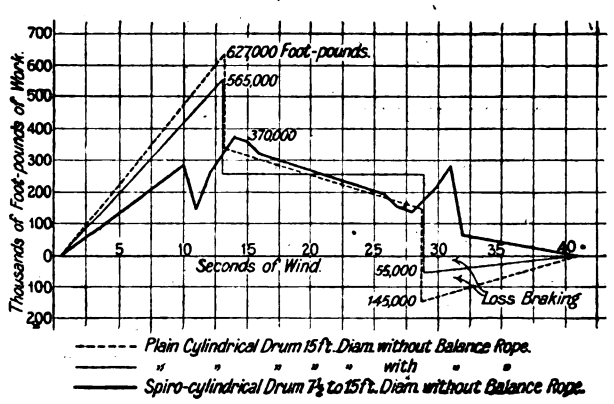

Fig. 54.

angular acceleration of the drum has ceased before the rope leaves the small part of the drum, the diagram can be improved, as first pointed out by Mr. H. Bramwell,† by arranging the spiral to rise at a varying rate, increasing the diameter rapidly at first and afterwards more slowly.

Typical spiro-cylindrical drums are shown diagrammatically in Fig. 53, the drums (*a*) and (*b*) being those used by Mr. Bramwell for two of the electric winders installed by the Great Western Colliery Co., the first at the Maritime Pit and the second at the Cwm Colliery.

Influence of Drum Profile on Performance.

The winder at the Maritime Pit was designed for an output of 175 tons per hour from a depth of 1,110 ft., and the markedly improved performance of the spiro-cylindrical drum is evident from Fig. 54 wherein are superimposed the diagrams of cylin-

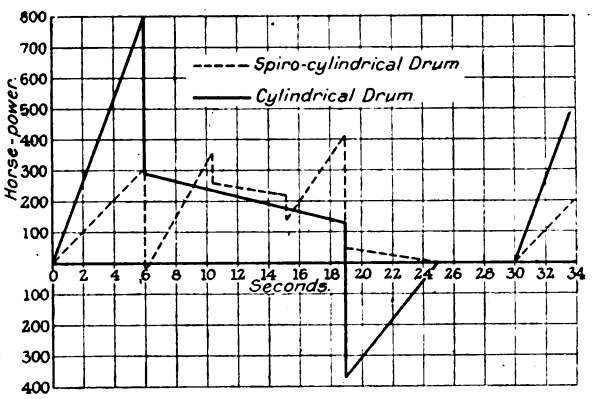

Fig. 55.—Diagrams for Spiro-Cylindrical and Cylindrical Drum Winders for the same Duty.

drical drum winders (with and without tail ropes) for the same duty. In this winder the static torque on starting is 7,350 lb. ft. in favour of the descending cage, which means that the torque ordinarily required for the first few revolutions is partly transferred to a later period of the wind when the accelerating torque has dropped out. At the end of the wind it also provides the negative torque for retardation. Of the 26·5 turns on the drum, three are dead on the small end of the drum, four are coiled on the part varying from 7½ ft. to 8 ft. in diameter, three are coiled on the scroll varying from 8 ft. to 15 ft. in diameter, and the remaining 16·5 turns are coiled on the cylindrical part.

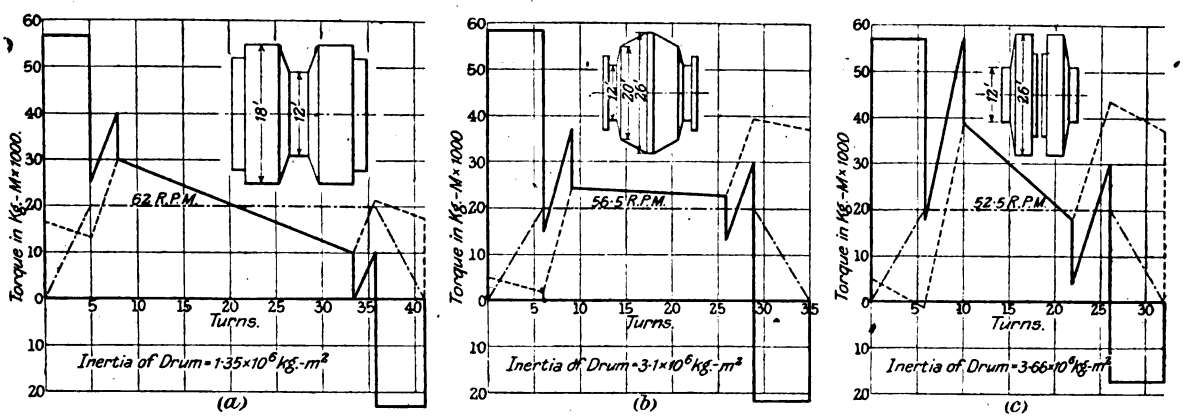

Fig. 56.—Diagrams Showing the Influence of Drum Profile on the Performance of a Winder for a Given Duty.

That very great advantage may often be obtained by the use of spiro-cylindrical drums is well shown in Fig. 55, which is due to Mr. R. S. Sage.* This hoist was for a coal mine with a depth of 650 ft., hoisting at an average speed of 2,600 ft. per

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† "Proceedings" South Wales Inst. of Engineers, Vol. XXVI.

* "General Electric Review" (U.S.A.), June, 1917.

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min. The special drums had a minimum diameter of 5 ft. and a maximum diameter of 9 ft. There were 4·15 turns on the smaller cylindrical portion, 6·5 turns on the scroll, and 15·62 turns on the larger cylinder.

It will be noted that the peak at starting has been reduced from 800 H.P. to 310 H.P., the size of motor from 600 H.P. to 300 H.P., and the power consumption per trip from 12,000 H.P.-seconds to 6,000 H.P.-seconds. The overall efficiency in the first case is about 25 per cent., and in the second about 50 per cent. But, as Mr. Sage points out, the saving effected in this particular case is greater than is usually gained by the use of special drums.

Mr. A. E. du Pasquier* has discussed the question of the influence of drum profile on the performance obtained, and of the many examples he has given, those depicted in Fig. 56 (*a*), (*b*) and (*c*) are thought to be of particular interest. They refer to 6-ton winders, all designed for the same duty, namely, an output of 360 tons from a depth of 2,250 ft.

An unusual feature of the drum, Fig. 53 (*b*), of the 12-ton Cwm winder is that the small diameter is at the centre. This diabolo-arrangement of drum was adopted on account of the considerable distance between the pit-head sheaves. With the ordinary arrangement of drum this centre-to-centre distance, 9 ft. 10 in., would have necessitated greater overall width or two separate drums. Another interesting feature is the lapping of the rope on itself on the cylindrical portion of the drum. We shall have occasion to deal with the question of such overlapping in a later section of the article, but it may here be mentioned that in this case it was a choice between a drum of 30 ft. or more in diameter, and over 100 tons in weight, without overlapping, and that decided on, namely, 18 ft. in diameter and weighing 75 tons, with overlapping.

TORQUE DIAGRAM.

The construction of the torque diagram of a spiro-cylindrical drum winder follows the lines laid down in previous articles, as the following example will show.

Example 6.—Particulars are given below of a 12-ton winder designed to wind 360 tons of coal per hour from a depth of 2,250 ft. It is required to determine the torque diagram for balanced operation.

General—

Nett load	26,880 lb.
Depth of shaft	2,250 ft.
Output per hour	360 tons.

Cycle—

Duration of cycle	120 seconds.
Net winding period	108 ,,
Accelerating period	21 ,,
Constant angular speed period	66 ,,
Retarding period	21 ,,
Decking period	12 ,,

Speeds—

Maximum winding speed	1,650 ft. per min.
Maximum speed of drun	28·6 revs. per min.

Cages and Tubs—

Weight of each cage and chains	27,500 lb.
Number of decks per cage	2
Number of tubs per deck	4
Weight of each tub	1,200 lb.

Rope—

Diameter	2¼ in.
Weight	8·38 lb. per ft.

Drum—

Type	Spiro-cylindrical.
Diameter	12 ft. to 18 ft.
Inertia, $WR^2 \div g$	265,000

Pithead Sheaves—

Diameter	18 ft.
Inertia, $WR^2 \div g$	2×6,500

Motor Armatures—

Inertia, $WR^2 \div g$	2×26,500

Friction—

5 per cent. of the loads depending from the ropes.

* "Proceedings" South Wales Inst. of Engineers, Vol. XXVIII.

The drum is depicted in Fig. 57, and the length and weight of rope coiled on each section of the drum are determined as shown below :—

Section	Turns.	Length of rope.	Weight of rope.
Starting cone	5	196 ft.	1,640 lb.
Scroll	3	146 ft.	1,220 lb.
Cylinder, First layer	20	1,130 ft.	9,460 lb.
,, Second layer	13·5	778 ft.	6,510 lb.
Turns per wind	41·5	Total	18,830 lb.

The loads and ropes will be treated separately as in previous examples. To lessen the likelihood of arithmetical errors the drum profiles are superimposed as shown in Fig. 58.

Ascending Loads.—These consist of the cage and full tubs.

Load		26,880 lb.
Cage		27,500 lb.
Tubs	8×1,200=	9,600 lb.
		63,980 lb.
Plus 5 per cent. for friction		3,199 lb.
Total		67,179 lb.

Torque at beginning of wind = 67,179 × 6·0 = 403,000 lb. ft.
,, after 5 revs. of drum = 67,179 × 6·5 = 436,000 lb. ft.
,, ,, 8 ,, = 67,179 × 9·0 = 604,600 lb. ft.
,, ,, 29 ,, = 67,179 × 9·2 = 618,000 lb. ft.

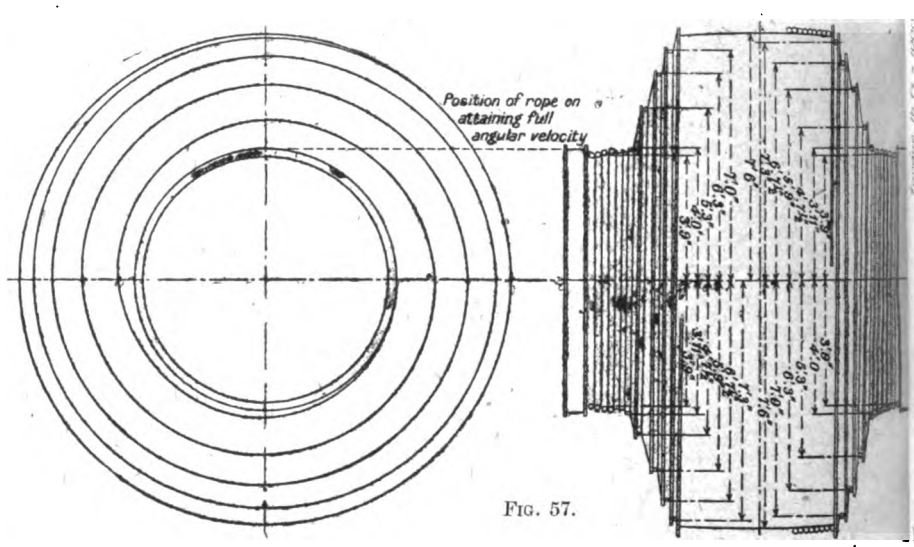

FIG. 57.

These points are plotted, to a convenient scale, and the torque line *ab*, Fig. 58, drawn through them.

Descending Loads.—These consist of the cage and empty tubs.

Cage		27,500 lb.
Tubs	8×1,200=	9,600 lb.
		37,100 lb.
Minus 5 per cent. for friction		1,855 lb.
Total		35,245 lb.

Torque at beginning of wind = 35,245 × 9·2 = 324,000 lb. ft.
,, after 13·5 revs. of drum = 35,245 × 9·0 = 317,000 ,,
,, ,, 36·5 ,, ,, = 35,245 × 6·5 = 229,000 ,,
,, ,, 41·5 ,, ,, = 35,245 × 6·0 = 212,000 ,,

These points give the torque line, *cd*, Fig. 58.

Ascending Rope.—The several steps are set out in tabular form below, and from these the torque line, *eE*, for the ascending rope is determined.

Point.	Weight, lb.	Drum radius, ft.	Torque, lb. ft.
Beginning of wind	18,830	6·0	113,000
After 5 revs.	17,190	6·5	111,700
,, 8 ,,	15,970	9·0	144,000
,, 28 ,,	6,510	9·0	58,500
,, 29 ,,	6,031	9·2	55,500
End of wind	0	9·2	0

Descending Rope.—The points used for the ascending rope serve for the descending rope. By transferring the origin from *B* to *E* and working from right to left, the torque line *Bf* is obtained.

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Resultant Static Torque.—This is represented by the curve *gh* in Fig. 58, and is obtained by combining the torque curves for the ascending and descending loads and ropes.

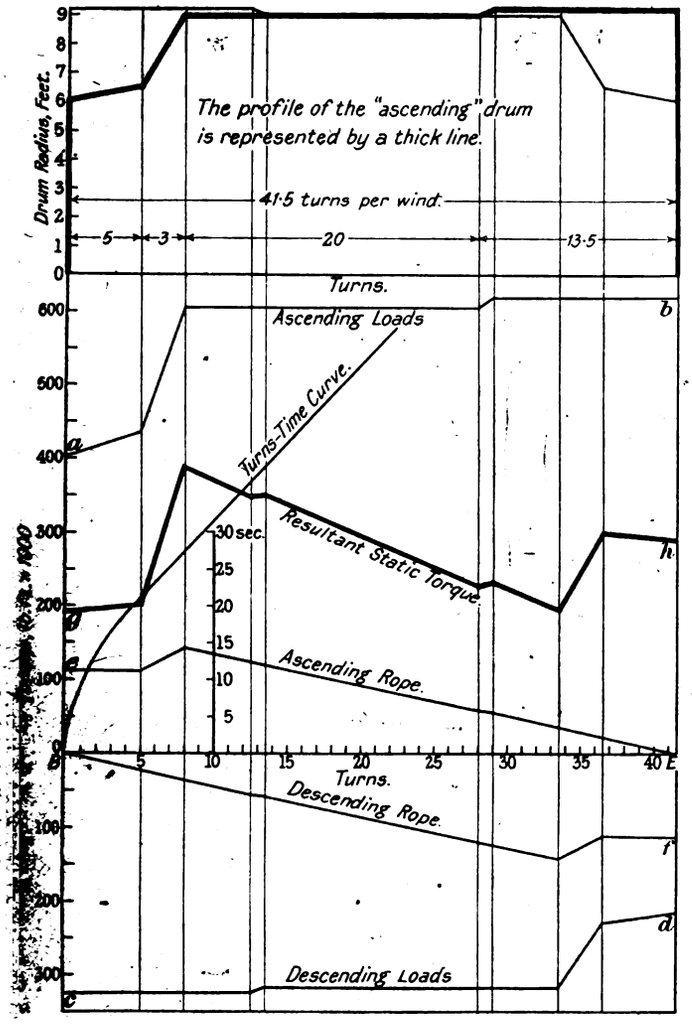

FIG. 58.—RESULTANT STATIC TORQUE OF A SPIRO-CYLINDRICAL DRUM WINDER.

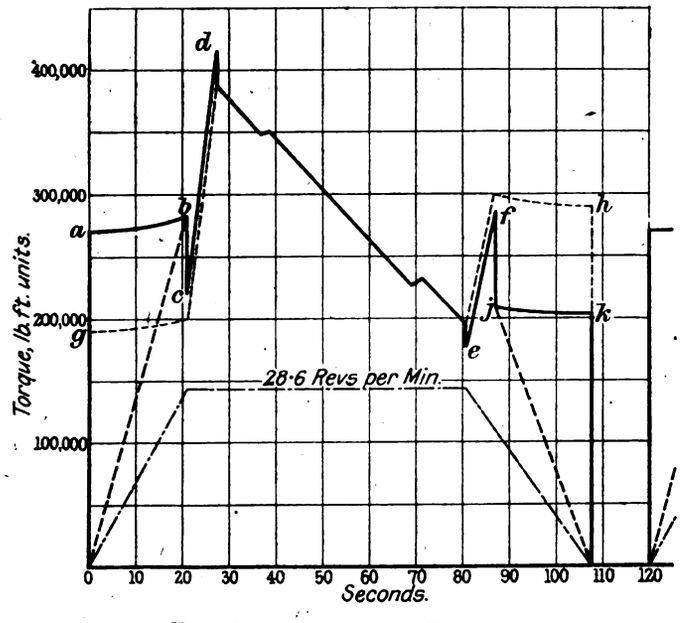

FIG. 59.—TOTAL TORQUE DIAGRAM.

This curve is transferred to a time base, Fig. 59, by the method described in the section on conical drums.*

(To be continued.)

* THE ELECTRICIAN, p. 453.

The Production of Electricity by Steam Power.*

By ALEX. DOW.
(President Detroit Edison Co., U S.A.)

Let me make first the point again, that delivered power and generated power are two different factors. The net power output is what the great majority of central-station men are concerned with. Then they have a third expression, "cost of power delivered" to consumer and presumably paid for. The confusion between these three is sometimes, I am sorry to say, intentional.

Load factor had become a rule, a guiding law, to me, when in 1394 I found myself called upon to design a plant for a street-lighting load, a matter of 2,000 H.P., in four or five engine-units, with, at night, a street-light load of 4,000 hours a year, shut down at the coming of daylight; and only a trifling load all day. I deliberately selected a marine type steam engine for 160 lb. to 170 lb. steam, at practically a fixed cut-off, although there was a governor of a sort; and I met the occasion of a day load, which ran from 150 H.P. down to 75 H.P. by the expedient of letting steam pressure run from 160 lb. or 170 lb. down to 80 lb. on the boilers—down as low as it would go before I did any new firing. The result was it reduced the use of coal to 4 lb. per kilovatt-hour, which would be equivalent to 2½ per indicated horse-power.

In 1908, I believe it was, I made my first personal, real contribution to the reduction of steam-power cost. Up to that time I was merely developing the ideas of other men. Then I came to the conclusion that a large boiler would be perfectly safe and feasible; that a very large furnace was desirable for burning bituminous coal; that stokers should have certain characteristics; and I was able to get the financial support to build a power-house designed for 56,000 kw., in which the boilers and furnaces were of that type.

In 1912 two of these boilers were tested very liberally by Dr. Jacobus, and the results of those tests are in the text-books now. They established the very great importance of the correct adjustment of the furnace, and the stoker as a part of the furnace, to the proposed fuel and the proposed work. They also decided that the efficiency curve, of the boiler and furnace together, is a very flat curve; that a range (in this instance) from 40 per cent. of the nominal rating to 200 per cent. of the nominal rating of the boiler, was entirely practicable. That upper limit has now been much exceeded. A design for long range is essentially a compromise design. Please do not overlook that.

Lastly, in 1914 and 1915, came the Connors Creek power-house, which represented the best I knew, and which is the occasion why I speak to you to-night. The figures of the operating cost of that power-house have been given to the public. They have been published at six months' periods, and by years, and as far as I am advised they have not been, for long periods and for a complete power-house, thus far improved upon. I know of three power-houses in operation and some others coming through, which should beat them 8 or 9 per cent.; but their figures have not been given out, and we are from time to time assured that the beating to which we are entitled has not yet been given to us.

The two Tables, I. and II., are tabulations of the Connors Creek plant costs for two periods of 12 months. It is necessary to use figures for one year in such presentations, because of the difference between summer and winter costs and because of occasional temporary aberrations of service, or of fuel, which would give exceptionally good or exceptionally poor showings for shorter periods. It will be noticed that the increased cost is almost entirely in the increased price of fuel. To a small extent it is due to uneven quality of fuel, because for the last nine months we had to burn any kind of coal we could get, and a change from one fuel to another is always temporarily accompanied by poorer combustion. The other causes affecting costs are very decided increases in hourly rates of pay, the effect of which is cancelled to a good extent by increased output; and the fact that, during the Table II. period, No. 2 turbine was running without its last row of nozzles and buckets, and its steam consumption was thereby increased some 4 per cent.

Note that the stated output is kilowatt-hours metered to outgoing 23,000-volt trunk lines, also that the stated load factor is a customary central station load factor based upon the maximum half-hourly reading of output during the period.

Let me say this: Fuel cost is the one figure on which comparisons can be made, and fuel cost must be expressed in heat units to make the comparison. These Connors Creek figures show year in and year out an approximation of 20,000 heat units per kilowatt-hour with periods below and periods above it. In cases where they exceed the 20,000 figure, the excess is of the order of 1½ or 2 per cent.,

* Abstract of an Address to the American Electrochemical Society.

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Table I.—*Connors Creek Plant.*

Costs per Kilowatt hour of Net Output. Twelve months ending June 30, 1916.

Production account.	Total expense.	Costs per kw.-hour. Cents.	Pence.
Operation:			
Superintendence	$16,841.40	0·013	0·0065
Wages	54,308.36	0·043	0·0021
Fuel	197,554.76	0·158	0·0790
Water	10.99	—	—
Lubricants	1,416.60	0·001	0·0005
Station supplies and expense	5,562.85	0·005	0·0025
Maintenance:			
Station buildings	7,786.96	0·006	0·0030
Steam equipment	23,826.70	0·019	0·0095
Electrical equipment	3,299.80	0·003	0·0015
Total	$310,607.43	0·248	0·1240

Kilowatt-hour output	125,158,800 kwh.
Maximum demand (30 minute)	35,000 kw.
Average load	14,300 kw.
Load factor	40·9
Coal per kw.-hour—lbs.	1·44
B.T.U. per kw.-hour	19,700

Table II.—*Connors Creek Plant.*

Costs per Kilowatt-hour of Net Output. Twelve months ending June 30, 1917.

Production account.	Total expense.	Costs per kw.-hour. Cents.	Pence.
Operation:			
Superintendence	$21,756.67	0·010	0·0050
Wages	98,710.84	0·047	0·0235
Fuel	503,447.63	0·240	0·1200
Water	0.51	—	—
Lubricants	1,193.73	0·001	0·0005
Station supplies and expense	11,096.28	0·005	0·0025
Maintenance:			
Station buildings	22,174.19	0·011	0·0055
Steam equipment	40,353.83	0·019	0·0095
Electrical equipment	2,939.75	0·001	0·0005
Total	$701,573.43	0·334	0·1670

Kw.-hour output	210,039,700 kwh.
Maximum demand (30 minute)	50,000 kw.
Average load	23,900 kw.
Load factor	47·8
Coal per kw.-hour—lbs.	1·52
B.T.U. per kw.-hour	20,040

and when they get below it, it is at very favourable seasons of the year. They are the best which can be done with the present limitations of that power-house.

The house is of a design, and a selection of machinery, of the years 1913 and 1914. It is not completed. When completed it will do a little better. The reduction of losses by radiation from the boilers proper is so extreme that the boiler room must be heated in winter for the firemen. The turbines are essentially 12 lb. per kilowatt-hour machines, and are habitually operated at their best points, say 11½ on test conditions; but we do not rate them at that.

The particularly interesting feature is the arrangement made for getting the most out of the steam used by auxiliaries; and here begins what I might call Chapter 1 of Instruction, as follows:—

Heat Balance.—You shall not throw heat overboard beyond what you cannot save, and you shall get as much power out of all the steam you make as is possible.

In electrical heating units you use electricity because of electricity's other merits—not for its thermal efficiency from fuel to work. And its large use proves that wise men are willing to pay for those other merits, and that fuel economy is not the only thing to consider in industry. Put me down as saying that where electric heating, electric steel making, electric reduction of ores—that where these things are used and the origin of the electricity is in fuel, you are absolutely applying that heat wastefully considered as an application of heat, and the wastefulness is hopeless. The loss overboard in the condensing water is the big loss. All other losses, such as stack losses and radiant losses from boilers and engines, are minor in comparison.

The losses in auxiliaries have been very great. Originally they were driven from the main engine. The next style of auxiliaries was in the use of separate direct-acting steam pumps, which were popular improvements in pumping devices; and we had the theory propounded that inasmuch as these were always operated with a closed heat cycle, the steam used in those auxiliaries was not a loss, but the heat therein was wholly returned to the system. That was true, but the heat was returned without removing anything like the amount of power which should have been removed.

The Connors Creek auxiliary plan, which as far as I am aware was not preceded by and certainly not taken from any earlier design, but was one of my own sketches, made in 1912, is to operate the auxiliaries by electric drive from a separate turbo-generator, exhausting into a condenser whose temperature is controlled according to the requirements of the feed-water; that is to say, you run a separate electric generator of comparatively small size, and from that you drive your auxiliaries (except a steam turbine feed pump) and the exhaust from the turbine of that generator goes to heat your feed-water to the economical temperature. That economical temperature being settled by other considerations, you get from the steam which goes to supply your auxiliaries all of the possible power and likewise all of the heat; and your auxiliaries have the great convenience of the electric drive.

At Connors Creek we have a method which is capable of various and numerous changes. In our last sketch the feed-pump is also made electrical, with a standby steam feed-pump to meet occasional conditions. The combinations possible are legion. I could talk to a mechanically interested audience at least three hours on this subject. Right there let me say that *all-steam* drive of auxiliaries must be wrong; and *all-electric* drive usually is wrong. The correct choice lies between the two.

Let me say about Connors Creek, there is no economiser there; that is a commercial proposition. The use of the economiser would unquestionably save 4 per cent. of the heat units; and commercially, under the conditions of coal cost as they were two or three years ago, it would not pay. If put in, the economiser would better the economy 4 per cent.; then the turbines could be replaced by similar machines 4 to 5 per cent. more efficient; and with the heat balance betterments we can see, we would pick up 1 or 1½ per cent. more; that is to say, we could reduce the present 20,000 heat units per kilowatt-hour to 18,000. That is an entirely practicable figure at present without going into new designs. There are certain ways whereby a still lower annual heat cost could be obtained in practice, and they are commercial, such as improved load factor.

Let me say also there is a difference between summer and winter efficiency, as in winter you have a much better vacuum. On the other hand, if you over-cool your condensate you are losing too much heat overboard.

Now the total cost is the fixed cost plus operating. Now, as to the capital cost, a fixed or first element—the capital cost of the Connors Creek plant, for the first units, is between $50 and $60 per kilowatt. If you buy land for 300,000 kw. you must pro-rate that over the proposed investment.

Let me say a word here about depreciation. Now, the depreciation conditions are really affected by an electrochemical load. Depreciation, save and except "obsolescence," is higher with higher load factor. Depreciation will be some function of use, and a high load factor will obviously mean a higher rate of depreciation. That should be remembered in figuring costs of any purely electrochemical plant.

Now, assume we have the problem put to us by some of your members, that you want a power plant, the object being low total cost of power, and you have some choice of location. The first thing to consider is how the location may affect the power plant, and that leads to discussion of those non-engineering problems I spoke of earlier.

With electrochemical industries, of course, you must consider your raw material and your markets. You must have good shipping points; you must have fairly good labour conditions, &c. These conditions would have a large influence in determining the location; and if you leave us free to transmit the power over from a satisfactory location to the power plant—if that condition be in the premises of this discussion, we can forget these considerations for the present and consider one location against another as reflected in design.

Take item No. 1—the fuel cost. If the load factor is of the order of 90 per cent., fuel cost will be the most important thing to consider. In connection with fuel cost you must consider the certainty of the supply—that it will not be interrupted.

Then you must have plenty of water. The quantity of water used by a big steam turbine plant is something you do not conceive. A plant of 100,000 kw., operating at 50 per cent. load factor, will require to pass through its condensers approximately the same amount of water as will be used by a mixed residential, industrial and commercial community having a population of 750,000 people. Therefore, the water supply is the next thing to consider after a good supply of fuel. You must locate on navigable rivers or streams

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or on the Great Lakes. Cooling towers are devices you must forswear if you are working for maximum efficiency. One of the appropriate places for a cooling tower is in the dry South-west, where the rapid evaporation in an exceedingly dry atmosphere cools the water sufficiently, and the night chill gives you a fair start the next morning. To locate a big plant on a country duck pond is foolishness.

The next consideration of importance is the labour conditions. Power-house labour is changing its character very much. There was a time when the power-house got all the incipient geniuses; that was a mistake. But the day has come for brains, and they are being secured. To-day the power-house employees expect good pay and good environment.

These things balance up. Low fuel cost can be offset by poor water supply. It is better to go a little further away from the coal to get better car service and so on. The next thing is whether you will locate close to your load, or will transmit.

Now, transmission is expensive. It has a very definite measure as to its capacity and a high figure as to its unit cost. The right-of-way of your transmission lines is an item of high cost. The line loss may be a high cost. Some interesting figures were obtained when I was asked to furnish the comparative American costs of electric transmission of energy from coal mines against railroad movement of coal, for comparison with possible English costs, with an assumed line loss of 15 per cent. The preliminary result of the comparison is that England cannot move energy by freight train as cheaply as by electric transmission lines, while American freight trains hauling short tons of coal at something like one-third of a cent per mile can move it more cheaply than the transmission lines. There you see how you must balance one thing against the other.

Again transmissions are not utterly reliable. You must balance permissible unreliability against costs.

The distribution loss is of the order of 20 per cent. total.

As to generating costs with present practice, 19,000 heat units are entirely practicable. The other operating costs are of the order of one-tenth of a cent per kilowatt-hour. You can figure the cost of your 19,000 heat units, plus one-tenth cent.—and you might note that 17,000 heat units is possible, without any radial departure from present methods or materials.

What is the possibility of higher steam pressures? I speak of pressure above our present 250 to 300 lb. If you get to consideration of the fact that you are working with high tangential velocities in the turbines, and talking of pressures of 300 to 400 lb. per square inch, and temperatures of 700 Fahrenheit and upward; if you consider that these pressures and velocities and superheats and temperatures are all present—you will realise that the selection and production of suitable materials of construction is a problem. I am told no steel manufacturer will guarantee analysis or qualities of steel at the present time. If that is true the ideal turbine will have for the present to be a thing to be dreamed of and not built. The technical difficulties are solely those of materials. The commercial reasons are likely to keep us under 300 lb. steam pressure and under 700 Fahrenheit, for total steam temperature, for some time to come.

Pulverised coal must be considered in any new design. It is first class now in big locomotives because of the impossibility of firing by hand the present big machines. There is a better control of the air mixture; and you cut off your fuel, and that is the end of it. It may permit the use in power plants of coals which now work very badly in stokers. Please remember that coal is not always coal; it is sometimes an invention of the devil, which should be called by another name. Coal that works into a kind of molasses candy is an exasperation, and not a fuel. Coal that fluxes down your furnace walls, and coal that must have acid furnace brick or basic furnace brick—the coal for one kind of fire brick may be the worst kind of coal for another kind—these may be dealt with by pulverisation.

Now, the whole question of pulverised coal turns upon the point that it may make coals useful, which with stokers of the present time are not useful, and thereby may reduce total power cost. The big point is to adapt the plant design to the fuel you are going to use.

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"Applications of Electrolysis in Chemical Industry," by A. J. Hale, B.Sc. (London: Longmans, Green & Co.) Pp. ix.+148. 7s. 6d. net.

"On the Nature of Things," by Hugh Woods, M.D. (London: Simpkin, Marshall, Hamilton, Kent & Company.) Pp. v.+248. 10s. 6d. net.

"The Ideal Servant-Saving House," by an Engineer and his Wife. (London: W. & R. Chambers, Ltd.) Pp. vi.+122. 1s. 6d. net.

The Labour Outlook.*

(BY OUR LABOUR CORRESPONDENT.)

WORKS SCHOOLS.

The Education Act has introduced the possibility of another bone of contention in industry. The way of industrial peace is hard enough as it is without any further complications.

It came to pass for some reason or another—perhaps the shortage of school accommodation or perhaps with a view to winning the support of certain groups of employers—that Mr. Fisher agreed to recognise "works schools" as continuation schools.

Under the new Act, boys and girls between the ages of 14 and 16 (and after seven years between the ages of 14 and 18) are compelled to attend classes in the daytime for a total of 320 (or it may be 280) hours per year. It will be possible for employers to open schools in their own works for youths and girls of continuation school age. Pioneer employers have in the past voluntarily provided educational facilities for their juvenile workers, and little exception has been taken to it. But the new development is a different matter; and, though protests have as yet only been made here and there, it certainly appears that the question is likely to cause trouble in the future.

There is a strong and growing opposition amongst organised labour against employers *qua* employers stepping outside their economic functions and becoming general providers of social amenities and amusements. In general, though there may be exceptions, the firms which have done most in the way of providing cricket fields and so forth are to be found in the lesser organised trades. At the bottom, the workman feels that houses and social amenities ought to be supplied by other agencies than the firm for which he works. His argument is that the motive is either philanthrophy or profits; he dislikes the former, and regards the latter motive as another means of "exploitation." There are many employers, too, who feel that workpeople ought to provide their own sports grounds or use public grounds, and some who are not disposed to fall in with the housing policy which employers are taking up.

The workman's objection to a "tied" house provided by the employer may be applied to works schools. There are local authorities whose business it is to provide education. They are under public control. Why, then, should the employer go to the trouble and expense of providing it? The answer is either because he is a philanthropist or because it will pay. Organised labour will decline what they will call "charity," partly because they dislike it, and partly because there are publicly provided schools which their children are entitled to attend. On the other hand, the trade unionists will not be anxious to assist the employer to profit out of their own children by means of education which is not directly under public control. They will in time, moreover, begin to suspect the education which is provided by the "works school" as they already in so many quarters suspect technical education. They may be wrong, but they will take a good deal of convincing that the education of juvenile workers is not to be carried out more in the interests of the employer than in the interests of the young people themselves.

Further, though it is true that a boy or girl cannot be compelled to attend school at the works in which he or she is employed, it would seem that, as the employer could dismiss on some ground or another a young worker who refused to do so, attendance at the works school would in practice become a condition of employment. In other words, the employer, and not the parent, would determine the school of the juvenile worker and the kind of education received. Not only so, but serious complications would arise in the case of an industrial dispute resulting in a stoppage of work. If a strike or lock out occurred the juvenile employees attending a "works school" would be placed in an uncomfortable predicament. It is unlikely that the trade unions involved in the dispute would tolerate the attendance of the younger workers at the works. On the other hand, if the latter failed to attend according to requirements of the scheme under which they came, they would be infringing the law. In the event of a dispute on a national scale in an industry where the employer had adopted a policy of supporting "works schools," the number of juveniles temporarily deprived of educational facilities might be considerable. If the position is going to be that continuation education depends on industrial peace, one can only say that that is not what Parliament intended.

It would have been better had the right not been given to regard "works schools" as continuation schools within the meaning of the Education Act. But, the situation being what it is, employers will be well advised to consider the pros and cons carefully before committing themselves to a policy of school provision. If they decide in favour of it, then they should discuss the matter frankly with the trade unions concerned.

* We do not necessarily endorse the views expressed by our Correspondent.—ED. *E.*

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The Electrician.

FRIDAY, NOVEMBER 1st, 1918.

Editorial and Publishing Offices:—

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Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

The Ultimate Economy of the Power Station.

During the last few years there has been more than one discussion on the consumption of coal that may be expected in stations equipped with reasonably large turbo-generator sets, by which we mean sets of 10,000 kw. and upwards. Of course, in such estimates it is no longer sufficient to deal in terms of coal, which may vary very considerably from one locality to another. We have reached a stage where greater accuracy in our terms is necessary, and where it is only possible to make true comparisons on the basis of thermal units. Such figures have been given from time to time, but they are sometimes confused as to the basis of comparison and more often than not they depend upon test results or upon guarantees given by manufacturers. There is, however, a very great difference between test results and actual running results from one year's end to another. It is the latter which are important, and unfortunately those who are responsible for the most efficient stations in this country are inclined to keep the actual results obtained to themselves.

It is, therefore, with more than usual interest that we have read an Address given by Mr. ALEXANDER DOW, President of the Detroit Edison Co., to the American Electrochemical Society, in which he deals with the production of electricity by steam power, giving in support of his views the results obtained at the Connors Creek power station. From these results, which are given on another page, it will be seen that year in and year out an approximation to 20,000 B.Th.U. per kilowatt-hour into the feeders at the switchboard is obtained. The load factor in the first record was 40·9 per cent., which, although good, is by no means very unusual in these days, and in the second record this has risen to 48·7 per cent. Still higher load factors will, no doubt, cause some improvement. The total capacity of the plant, according to recently published information, is 60,000 kw. The turbines are described by Mr. Dow as essentially 12 lb. per kilowatt-hour machines and are habitually operated at their best points, which would correspond, say, with 11½ lb. on test conditions. The plant was erected in 1914-1915 and, therefore, it must be admitted that these results have been obtained under perfectly commercial conditions without utilising any special devices that may have been developed in the meantime. Moreover it is an interesting fact that the equipment includes no economisers. If these were used, Mr. Dow expresses the view that the figure of 20,000 B.Th.U. might be brought down to 18,000. At the time, however, when this plant was laid down the inclusion of the economiser was not a commercial proposition; in other words, we presume that the price of fuel was very low.

Mr. Dow lays emphasis upon the great losses which may occur through auxiliaries. In his opinion, an all-steam drive of auxiliaries must be wrong and the all-electric drive is usually wrong. The correct choice must lie between the two, and we think this view will be generally admitted. At Connors Creek the plan adopted is to operate most of the auxiliaries from a separate turbo-generator exhausting into a condenser whose temperature is controlled by the requirements of the feed water. In this country the custom has developed of driving the condenser plant by means of small steam turbines. The object in view in any case is to reduce, as far as possible, the enormous quantity of heat which unfortunately passes to waste in the cooling water, and with this end in view the system must be considered as a whole.

In Mr. WILSON'S address to the Association of Engineers-in-Charge, which we published last week, an efficiency of 16 per cent. is mentioned as the higher of two limits. We believe there are some stations in the country which are doing somewhat better. On the basis of 20,000 B.Th.U. per kilowatt-hour the efficiency is over 17 per cent., and if this can be brought down to 18,000 B.Th.U. the average thermal efficiency becomes over 19 per cent. Mr. Dow expresses the view that the latter figure is an entirely practicable one at the present time without going into new designs. If further developments are borne in mind still lower figures can be obtained. Meanwhile it would be well for our engineers to assure themselves that they are approaching even the lower figure given by Mr. Dow, and that they are not running at seriously lower efficiencies which are by no means justifiable.

Review.

Telegraphy, Aeronautics and War. By CHARLES BRIGHT, F.R.S.E. (Constable & Co.) Pp. xi.+407. 16s. net.

The author of this volume occupies a prominent position as an authority on telegraph questions; previous to the outbreak of the war, he had read a number of Papers, before important bodies, advocating a reduction of the telegraph tariff between the various parts of the British Empire, and on cognate matters. Mr. Bright has, at various times, also contributed many articles to the leading periodicals on questions affecting, *inter alia*, cable communications, the administration of Imperial Telegraphs and the cable censorship. He has during the war prepared a number of memoranda on cable and wireless communications and other telegraph subjects for the information of the Dominions Royal Commission, the War Office, the Foreign Office, &c.

Mr. Bright's name has, in more recent times, come before the public in connection with aeronautics; he served on the Committee appointed in 1916, under Mr. Justice Bailhache's chairmanship, to enquire into the Administration and Command of the Royal Flying Corps. As a member of that Committee, he prepared "Additional Recommendations," and certain supplementary memoranda relating to aeroplanes, aero-engines, &c., which form part of the Final Report of the Committee in question.

The volume under notice contains reprints of the Papers read by Mr. Bright, prior to the war, before the London Chamber of Commerce, the Royal Society of Arts, &c.; reprints of the articles contributed by him recently to the "Empire Review," the "Quarterly Review," the "Nineteenth Century," the "Saturday Review," &c.; the "Additional Recommendations" and the memoranda prepared by him in connection with the Final Report of the Royal Flying Corps Committee, 1916. The foregoing Papers, articles and memoranda are preceded by an "Introduction," in three sections, devoted to War, Aeronautics and Telegraphy respectively. In the volume are also included addresses, entitled "A Nation's Awakening" and "Nothing as Usual," delivered during the war, by Mr. Bright to his own village (Leigh, Kent), as well as in other parts of the country on behalf of the Victoria League. A useful table giving approximate cable distances from London to various important centres, and the ordinary rate for cablegrams thereto, and a Telegraph Map* of the World complete the volume.

* The publishers will shortly be in a position to supply copies of a map showing not only the world's cable system but also (1) both past and present wireless stations, and (2) suggested air stations.

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In the War Section of the "Introduction" Mr. Bright makes a rapid survey of a wide field beginning with "Our Aims," and ending with the "Lessons of the War." In the Telegraphy Section of the "Introduction," many questions of commercial, political and military importance in relation to cable and "wireless" are touched upon, and at p. 72 of the volume, Mr. Bright sums up, under the heading "Recommendations," his articles of faith, so to speak, on telegraphic matters. Many of these matters are fully discussed in the Papers and articles, which appear in this volume.

Chambers of Commerce of practically every important town in the United Kingdom have strongly supported Mr. Bright's proposals for the provision of a system of All-British cables, their object being to improve and strengthen the Inter-Imperial telegraphic network of the Empire strategically and commercially. There are many other questions dealt with in this volume, however, in relation to which there is not likely to be the same unanimity of opinion in business and other circles; many people will probably demur, for instance, to effect being given to the reiterated proposal that a part of the cable system at present owned by British companies should be nationalised. A similar proposal met with little support when Mr. Bright read his Paper on "The Administration of Imperial Telegraphs" before the Royal Society of Arts in the summer of 1914 (*vide* discussion at pp. 189 *et seq.*, of the volume). Since the outbreak of the war the public has been brought into close contact with Government Departments at many more points than was previously the case; the result, judging by the attitude of the commercial community, seems to have been to strengthen, rather than to weaken, its opposition to governmental control of matters of vital interest to the industries and commerce of the country—in this category cable communications naturally fall.

Mr. Bright is inclined to be somewhat impatient with those who cannot see eye to eye with him on this point. Whilst admitting the desirability of the introduction of ordinary business methods into the public services, his view is that "The arguments for State control are not, however, affected in principle by the need in Government Departments for men with business training and methods." He considers the two questions as quite distinct; this may be so. It is under these circumstances, however, that it has proved so difficult to persuade the public that undertakings, which are now being efficiently conducted by private enterprise, should be transferred to the State in order to satisfy some theoretical requirement, sound or unsound, in relation to their control and management by Government officials. It is by practical results, affecting its pocket, that the public has ever been wont to judge a situation; therefore when its attention is being repeatedly drawn to the conspicuous failures in the handling of important matters by the State, as, for example, that of the Imperial Wireless Chain (a subject which recently came to notice again, this time in the Law Courts), a Chain concerning which Mr. Bright makes more than one reference in his book, it should be no matter for surprise should the public evince a decided preference for the management and control of public utility services by private companies instead of by Government officials.

The questions discussed by Mr. Bright in this volume are of equal interest to the technician as to the commercial man, the politician and the soldier; many of them contain problems awaiting solution in the immediate future. The volume will prove a useful source of information to those interested in Inter-Imperial Telegraph problems and those allied thereto.

W. A. J. O'MEARA.

Industrial Coal Economy.*

BY D. WILSON.

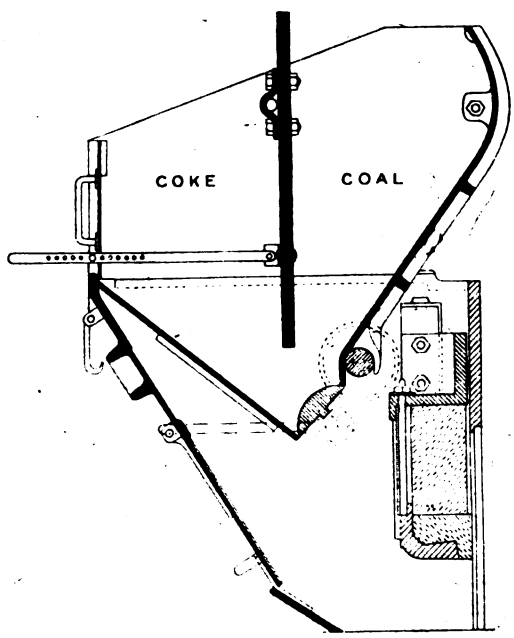
(*Concluded from page* 540.)

7. *Coke Fuel.*—There has been far too much prejudice in the past in connection with the burning of coke fuel. On a hand-fired boiler a distinct thermal advantage is obtained by using coke, since the hydro-carbon loss which immediately follows the firing of bituminous coal is absent. With many types of mechanically-fired boilers this advantage does not occur, but in both cases the use of coke fuel is limited by the quantity which can be consumed per hour on a given grate area and with a given draught. On many boilers where the draught is insufficient, steam jets have been applied with fairly satisfactory results, but in such cases it is very necessary to ascertain accurately the amount of steam used in producing this extra draught.

Mechanical stokers have been designed for burning coke fuel alone, and firms are now assisting the coal situation by burning a percentage (from 5-50 per cent.) of coke fuel mixed with coal. The London County Council are now consuming considerable quantities of crushed coke on chain grate mechanical stokers. In one section of the plant they are burning coke fuel alone; in another case coke fuel mixed with coal on the "Sandwich" system. I believe that the London County Council engineer has succeeded in burning a half-and-half mixture of coal and coke in this way, without suffering any appreciable decrease in output. There is still a considerable surplus of coke breeze available, and every engineer should try to burn some quantity of this fuel even if this means some inconvenience.

8. *Calorific Values.*—Every engineer should attempt to ascertain the calorific value of the coal which he is using, otherwise it is quite impossible to intelligently consider efficiency results. In America it is common practice to buy coal on the B.Th.U. basis, and I hope that eventually all coal in this country will be purchased in this way. Every power house should possess a calorimeter, and the necessary apparatus for obtaining the proximate analyses of coal, or establish a B.Th.U. record of the coal used by sending samples regularly to some recognised testing laboratory. If this cannot be done the approximate "Litharge" method may be applied.

9. *Efficiency.*—It is practically impossible to obtain even a fair approximate estimate of the efficiency of industrial firms due, firstly, to the absence of the necessary data in many cases, and secondly,



ADJUSTABLE PARTITION PLATE FIXED IN HOPPER OF CHAIN-GRATE STOKER TO FEED COAL AND COKE INTO FURNACE IN DISTINCT LAYERS.

to the difficulty in equating the numerous factors involved. A rough guess of 50 per cent. boiler efficiency would certainly not be too low, and as a modern boiler unit complete with stoker, super-heater and

* Abstract of an address to the Association of Engineers-in-Charge.

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economiser will give a combined efficiency of at least 80 per cent. on test, the margin of difference between test conditions and actual working conditions should be explored. Firstly, there is the question of incomplete design. There are many boilers installed without stokers, super-heaters or economisers. Secondly, there is insufficient supervision, and it should be possible to bring up the average efficiency of the boiler house to a figure more closely approaching that of the test conditions.

10. *Feed-water Temperatures.*—Speaking generally, 1 per cent. of fuel is saved for every 11 deg. rise in the feed-water temperature, provided the heat producing this rise in temperature would otherwise be wasted; yet in many works heat is being thrown away which could easily be recovered for heating the water. The exhaust from at least a portion of small auxiliary plant, should be directed through an oil separator, to the feed-water tank, rather than to a condenser, until a maximum temperature of, say, 200° F. is obtained. In the case of reciprocating engines, it is often more economical to give the feed-water temperature first consideration, in preference to high vacuum.

In conclusion I wish to say a very few words about my mission with the Coal Controller. In a free country such as ours, we all detest the necessity of Government control, and I am sure that no one detests this necessity more than Sir Guy Calthrop. One of his many functions is to see that as far as possible the available supplies are distributed to the best advantage. The Controller has always been most anxious to reduce inconvenience to a minimum. Every technical complaint received by the Controller has received most careful consideration. The coal economy campaign has only been in operation for a short time, but the prospects are hopeful. It will be necessary to investigate 36,000 cases. Out of 364 works visited during the first few weeks a saving of 106,000 tons per annum is estimated. We do not look upon the scheme of procedure as ideal, but we have been guided by the fact that whatever is done, must be done quickly. Four hundred engineers have very kindly given their part services voluntary. Each will visit a group of firms within their local radius, reporting to headquarters any evidence of inefficiency and answering a detailed questionnaire which has been specially drafted for the purpose. We would naturally like to see experts or economy committees appointed for each separate industry, but the war would be over before we could establish such an organisation. We have therefore endeavoured to cast over the whole country an economy net, having a large mesh in order that it may be operated quickly. I expect from this step a saving of several million tons.

APPENDIX I.—*Litharge Method of Coal Testing.*

Weigh out 1 gramme of finely powdered dry coal, thoroughly mix with 60 grammes of pure litharge and about 10 grammes of ground glass. Place in a Battersea clay crucible, and cover it with a layer of common salt. Fire to a bright red heat in a boiler furnace, or similar source of heat, for 15 to 20 minutes. After the crucible is cold, break and extract the lead button that remains. The weight in grammes, of the lead button, when all slag has been removed, multiplied by 483 gives the calorific value of the coal in B.Th.U.'s per lb. The constant 483 is obtained from the equation $C+2H+3Pbo=CO_2+H_2O+3Pb$, whence we see that one part of C and H reduces 44·3 parts of Pb. The calorific value of H is about 62,000 B.Th.U. per lb., and carbon is about 14,560 B.Th.U. per lb. The calorific value of a mixture of C and H in the proportions given by the equation is 21,350 B.Th.U. per lb., that is—

44·3 grammes of lead represent 21,350 B.Th.U. per lb.,
i.e., One gramme of lead gives 483 B.Th.U. per lb.

The various assumptions made and calculated are not strictly true, but the errors cancel out to a great extent.

APPENDIX II.—*Method of Determining Approximate Efficiency and Evaporation of a Boiler without Measuring or Weighing Water or Steam.*

FORMULA.

$$\left(0{\cdot}35\times\frac{T_1-T_2}{CO_2}\right)+R=\%\text{ loss}$$

Where—

T_1 = Temperature of gases leaving boiler.
T_2 = Temperature of air in boiler house.
CO_2 = Percentage of CO_2 in gases (at point T_1) as determined by Orsat set or CO_2 recorder.
R = Radiation and other losses taken at 5 per cent.

Deterioration in German Iron.—According to information given in German metallurgical journals, the quality of iron has suffered much deterioration since the war. This is attributed to the shortage of pig-iron, necessitating the use of large quantities of scrap. One common fault is a high sulphur content, giving rise to cold-shortness. This defect is said to be due to the use of inferior varieties of coke.

Correspondence.

EMPIRE WATER POWER DEVELOPMENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Whatever the object of the writer of the article under the above heading in the "Times" Engineering Supplement for October was, the fact is a complete condemnation of the capabilities of British engineers to at present deal with hydro-electric propositions.

Untold injury is done to the British engineering profession, and to the manufacturing industries of this country, by articles of the character mentioned. The effect would be bad enough if the reading were confined within the shores of this country, but such articles are widely read in the British Overseas Dominions, the Indian Empire and the Crown Colonies. It is a stultification of British engineers, and an advertisement of the assumed capabilities of engineers of other nationalities without the slightest justification in fact.

Within the British engineering profession there are engineers capable of dealing satisfactorily with all the hydro-electric propositions ever likely to come forward, either in Great Britain, Ireland, the Overseas Dominions, or any other country. If a *bona fide* application were made to me to provide engineers capable of carrying out the five projects suggested by the writer of the article, I could at once name five British engineers, each of whom would be thoroughly competent to satisfactorily carry out any hydro-electric propositions, whatever its dimensions might be.

A great deal is heard of the "Hidden Hand" working in the interests of Germany. British engineers would do well to discover and amputate the "Hidden Hand" which upon every conceivable occasion seizes the opportunity of discrediting their profession.

In my judgment the writer of the article displays lack of knowledge when he ignores the fact that the water powers of this country have largely remained undeveloped owing to

1. The strangulating effect of the Board of Trade and other regulations,

and

2. The impracticability until quite recently of transmitting energy long distances due to the backward development of the high-tension side of the proposition.

My personal experience in carrying out hydro-electric schemes has not been exceeded by any engineer of other nationality.

I enclose my card, and subscribe myself

London, Oct. 28. "BRITISH ENGINEER."

INDUSTRIAL COMBINATIONS: THEIR USES AND ABUSES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A considerable amount of approbium has in the past been levelled against all forms of combines, syndicates and trusts, and although such feeling may have been justified in many instances, it is well to remember that it has been mainly because of such doubtful business methods as attempting to defeat competition and to corner markets by selling below cost, and then subsequently raising prices to an exhorbitant degree.

While this is much to be deprecated, one cannot resist from the observation that these sordid questionable methods are by no means the monopoly of the large combinations, for they are being followed, or at least attempted every day by individual manufacturers and traders in the ordinary course of their business. Usually, however, it is winked at by an indulgent public, but when practised by a more powerfu organisation, probably comprised of, say, half a dozen individual manufacturers linked up together, it is forthwith labelled unjust, autocratic and oppressive.

I mention this, not as justification of the principle, but merely to show both the fickleness and shallowness of much of the public opinion that exists.

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The policy undoubtedly represents nothing more than oppression and extinction of the small man by the mere weight of capital, which is not only unfair to a degree, but is immoral and a prostitution of all the best ideals of business.

Combines and syndicates based on economic principles and organised so that all the firms taking part are linked up as one huge producing and distributing machine, with every department administered by a specialist, who brings to bear on his particular sphere of activity the highest form of scientific business training coupled with true initiative—are surely of more value to the community than dozens of small firms acting independently of each other, with departments administered and managed in "any old way" by people who are square pegs in round holes, and do not possess any useful knowledge and ability of a specialised character whatever.

Such a state of affairs undoubtedly exists to-day in many of our industries. It creates overlapping of effort in every direction, resulting in an enormous waste of energy and labour which, with but little administrative ability and co-operation on the part of the leading representative firms in each industry, might be directed into channels of greater usefulness—thus removing a great source of weakness to the economic life of the nation and considerably adding to the material wealth of the country, which would quickly enable us to unload the burden of our huge national debt.

Most misconceptions that cling around combines and similar forms of commercial enterprise are undoubtedly due to narrowness of view and blindness to many of their different forms; therefore, no one should condemn syndicates of manufacturers unless they have good and sound reasons for so doing. They should first examine the principles on which a combine has been or is about to be formed, and also the policy of its general administration. If its formation is considered to be mainly for price maintenance and the elimination of competition by unfair oppression of capital, it will result in nothing more than enrichment of the few at the expense of many, and then, I say, public opinion should be strongly opposed to it and fight against it tooth and nail; but if, on the other hand, examination clearly shows that a syndicate is based on economic principles, and is designed to eliminate outside competition, purely by methods of efficiency and superior organisation, then it should meet with the support of every right-minded individual as an acquisition of tremendous value to the State.—I am, &c.,

Birmingham, Oct. 16. HOWARD F. SMITH.

Coal Economy Campaign.

EFFECT OF OFFICIAL INSPECTION.

The results of the industrial coal economy campaign are becoming apparent. From all parts of the country and from all classes of steam users the Coal Controller daily receives letters announcing improvements of plant, consequent decrease in coal consumption and appreciation of the advisory work of his Department.

For the purposes of this effort, which is under the charge of the Technical Department of the Coal Control, the country is divided into areas and districts each with its engineer, whose function is to visit works, to consult with and advise the management how to secure efficient working, so as to cut down the coal consumption. There are 400 engineers engaged in this work. In the United Kingdom there are between 40,000 and 50,000 steam users. Of these 6,800 cases have been reported for attention, and the process goes on at the rate of 1,400 a week.

The principal directions in which fuel economy is being effected are by the improved lagging of boilers and steam pipes, repair of defective brickwork in boiler flues, attention to leaky pistons and glands and the utilisation of exhaust steam for heating purposes, and of the hot flue gases for heating boiler feed water. The use of unnecessarily high grade coal for steam purposes is a prolific source of waste. This, to an extent which represents a large aggregate saving, is being remedied by the employment of lower grade coal, thus releasing the better qualities for other purposes.

The small steam users who are using an excessive amount of steam, and consuming an excessive amount of coal, are receiving special attention. In many cases, where it has been possible to secure the plant, substantial economies have been made by the substitution of electric motors or gas engines for small steam engines. One large establishment estimates a saving of 40 tons of coal per week by means of electrification.

The estimate and aim of the Technical Department is that, without any general scrapping of old, and installation of new, plant, a saving of 5,000,000 tons of coal per annum is practicable, provided that the economy movement has the active support and co-operation of all who work steam engines, from the managing director to the fireman who feeds the boilers.

Electricity Supply on the North-East Coast.

As announced in our last issue, the Parliamentary Committee of Newcastle-on-Tyne Corporation has issued a report on the proposals embodied in the interim report upon electric power supply in Great Britain of the Coal Conservation Sub-Committee of the Reconstruction Committee and in the report of the Board of Trade Electric Power Supply Committee.

In this report, which came before the Corporation on Thursday last, the committee state "they are apprehensive that, if the proposals of these reports receive legislative sanction, the monopolies of the private electricity companies in this district will be maintained and consolidated, and that the publicly owned undertakings which generate and supply electricity in bulk in Newcastle-upon-Tyne and in other parts of the North-east area of England, may pass from the ownership and control of the municipalities who at present own them, and be wholly dominated by a company or aggregation of companies conducted for private profit, enjoying (possibly with financial assistance from the Government) a monopoly of electrical enterprise in this area; while, at best, municipal electricity undertakers will be reduced to the position of distributors in their own areas of electricity supplied to them in bulk by the companies. The committee are of opinion that it would be contrary to public policy that a public utility service of this character which is a monopoly should be under the control of private companies, the tendency during recent years having increasingly been to place such services under the management or direction of local representative bodies; and, in view of the circumstances that the Corporation have a right of acquisition within six months of July 3, 1922, of the electric lighting undertakings in the City of the Newcastle-upon-Tyne Electric Supply Company and of the Newcastle and District Electric Lighting Company, and are themselves already generators and suppliers of electricity for traction and power, the matter is regarded as one of extreme importance in the interests of the city." The committee also submitted a statement prepared by the Town Clerk, and settled in consultation with representatives of other local authorities in the North-east area who are owners of electricity undertakings. This statement, when approved by the other authorities, will at an early date be formally presented on behalf of the municipalities to the President of the Board of Trade and to the Minister of Reconstruction, and the Council were asked to confirm the action of the committee and to authorise the sealing of the statement.

The Lord Mayor (Sir GEO. LUNN) moved the adoption of the report, and said the Coal Conservation Sub-Committee's proposals in regard to electricity supply were considered dangerous to the public interest. If the proposals were put in operation a trust would be able to take over all municipal plant and undertakings. A series of conferences had been held with other North-east Coast municipalities owning electricity undertakings, and a statement had been drawn up asking that the Government should only act after an exhaustive inquiry, at which the municipalities should be represented.

The motion was duly seconded and then agreed to.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 SPECIFICATIONS.

111,110 CHASE. Electric cables. (2/11/17.)
114,414 PIRELLI & CO. Electric cables. (26/3/17.)
111,463 BERGES. Electrical driving of machines. (6/11/16.)
114,841 AKTIESELSKAB ARENDAL SMELTEVERK. Electrode holders for electric furnaces. (13/4/17.)
116,290 ETABLISSEMENTS DE DION-BOUTON SOC. ANON. Magnetos. (31/5/17.)
116,889 JOUBERT. Supporting means for electrical conductors. (4/6/17.)
116,892 BRITISH WESTINGHOUSE ELECTRIC & MFG. COMPANY. Electrical insulating bushings. (8/6/17.)
119,073 TURNBULL. Electric ignition apparatus for internal combustion engines. (17/9/17.)
119,076 WILLNER & APEX ELECTRIC ACCUMULATOR SYNDICATE. Accumulator electrode grids. (18/9/17.)
119,081 POLLOCK. Rectification of alternating currents of electricity. (19/9/17.)
119,099 BROWN. Electrical system for indicating an alarm of fire or such like simultaneously at any required number of points or stations. (26/9/17.)
119,100 LA ROCHE. Electric accumulators or secondary batteries. (26/9/17.)
119,105 RAILING & TAYLOR. Electric hand lamps (2/10/17.)
119,110 BROWN & SONS & CHILD. Magnetic separation of metals or magnetic bodies from oil flowing through oil circuits. (4/10/17.)
119,119 MCLEAN. Electric adapters and the like. (17/10/17.)
119,141 RAILING & HILL. Electric cigar lighters, pipe lighters and like apparatus. (14/11/17.)

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119,143 RAE. Incandescent electric lights and signals. (15/11/17.)
119,166 SOC. CERAMICA RICHARD-GINORI. Electric insulators. (27/12/17; addition to 24,631/14.)
119,178 FULLERS' WIRE & CABLE COMPANY & FULLER. Electric conductors (4/2/18.)
119,192 EDISON ACCUMULATORS & MONNOT. Electrically propelled road vehicles. (12/3/18.)
119,200 SHEPHERD & BRAZIL, STRAKER & COMPANY. Electro-deposition of iron. (26/4/18.)
119,220 AJAX METAL COMPANY. Electric heating by high-frequency currents. (19/9/17.)
119,228 KEENE. Electric furnaces. (5/9/17.)
119,236 BRADLEY. Method of electrical treatment of gases. (21/6/16.)
119,237 BRADLEY. Apparatus for the electrical treatment of gases. (21/6/16.)
119,238 BRADLEY. Method of and apparatus for the electrical treatment of gases. (21/6/16.)
119,254 LE PONTOIS. Combined ignition and lighting and like current generators. (26/7/17.)
119,270 BENJAMIN ELECTRIC, LTD., & FOWLER. Security or locking devices for electric incandescent lamps. (21/9/17.)
119,279 JONES. Metal electrodes used in depositing and soldering by the electric arc. (26/9/17.) (Addition to 14,468/15.)
119,302 KIEVITS & KYNOCH, LTD. Method of construction of electric furnaces of the heated-coil type. (13/10/17.)
119,341 GOMEZ. Electric telephony. (27/11/17.)
119,345 B. T.-H. CO. (G. E. Co.) Protective means for systems of electric distribution. (7/12/17.)
119,354 B. T.-H. Co. (G. E. Co.) Electric cut-outs. (18/12/17.)

1918.

119,365 B. T.-H. Co. (G. E. Co.) Systems for amplification of small currents. (2/1/18.)
119,388 FAWSSETT. Measurement or indication of alternating electric current quantities and apparatus therefor. (16/2/18.)
119,405 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Electric motor controllers. (22/3/18.)
119,435 MASON & BOWERS. Magnetic tray control for use in connection with biscuit-making machinery. (15/7/18.)
119,449 AUTOMATIC TELEPHONE MFG. CO. Automatic telephone systems. (19/9/17.)
119,454 REMY ELECTRIC CO. Electromagnetic speed-controlling device. (1/-/17.)
119,491 SCISM. Junction box coupling for electric conduits. (27/8/17.)
119,511 MIDGLEY & VANDERVELL & CO. Electric gyroscopes. (29/9/17.)
119,514 MILLAR & STRACHAN. Mine signalling apparatus. (1/10/17.)
119,520 WOODBURN. Electric welding apparatus. (2/10/17.)
119,524 DIXON. Telegraph or like signalling systems. (2/10/17.)
119,530 FULLER ACCUMULATOR CO. & WOOD. Electric storage batteries or electric accumulators. (3/10/17.)
119,539 GOLDSTONE. Incandescent electric lamp holders. (5/10/17.)
119,560 HELLYAR. Electric battery lamps. (19/10/17.)
119,585 BLADES. Cradle for use in supporting electric cables and their fittings. (19/12/17.)
119,592 DONOVAN & DONOVAN. Electric switches. (10/1/18.)
119,604 WRAY. Gas fires, electric radiators and the like. (14/2/18.)
119,627 DONOVAN & DONOVAN. Electric switches. (18/10/17.) (Divided application on 15,111/17).
119,628 DONOVAN & DONOVAN. Electric switches. (18/10/17.) (Divided application on 15,111/17).
119,651 MENCO-ELMA SYNDICATE. Electro-magnetic speed changing gear. (22/9/17.)
119,657 FABRIQUE DES LONGINES FRANCILLON & CO. SOC. ANON. Energy meters for alternating electric current. (17/9/17.)

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

September 25, 1918.

15,548 WATSON & CO., ETCHELLS & GREAVES. Electric furnaces.
15,586 SYNDER. Electric furnace.
15,587 STEWART. Electrodes or plates for accumulators of the alkaline type.
15,600 CROSBY. Electric furnaces.
15,603 SEIMBILLE. Instantaneous electrical heating of water. (28/9/17, France.)
15,614 SEIMBILLE. Instantaneous electrical heating of water. (28/1/18, France.)

September 26, 1918.

15,652 AUTOMATIC TELEPHONE MFG. CO. & SMITH. Diaphragms.
15,672 BENJAMIN ELECTRIC, LTD. Incandescent lamp holders, &c. (16/10/17, U.S.)
15,700 AKTIESELSKABET ELECTRISK BUREAU. Telephone apparatus for one common line. (15/11/17, Norway.)
15,701 MASON. Ignition dynamos.
15,709 SOC. ANON. DES ETAB. L. BLERIOT. Electromagnetic switches or contact makers. (7/11/17, France.)

September 27, 1918.

15,728 FAIRCLOUGH. Portable electric cable controller.
15,762 CASOLINI. Electricity meters.
15,769 RODRIGUEZ. X-ray apparatus.

September 28, 1918.

15,794 CLIFTON, COWELL & COX. Electric bells.
15,795 BATH & FLACKETOITE. Polishing iron for electric or gas iron.
15,812 LAWTON. Electric furnaces.
15,831 COLLINS. Synchronizers for internal combustion steam or electric motors.

September 30, 1918.

15,836 ELECTRICAL IMPROVEMENTS, LTD., & BEARD. Reactance coils.
15,853 MATHER. Selective devices for wireless receiving apparatus.
15,868 B. T.-H. Co. (G. E. Co.) Incandescent lamps.
15,869 B. T.-H. Co. (G. E. Co.) Electric welding apparatus.

October 1, 1918.

15,945 B. T.-H. Co. (G. E. Co.) Manufacture of incandescent lamps.
15,953 PRICE. Dynamo electric machines.

October 2, 1918.

16,035 YOULTEN. Electric clocks, &c.
16,044 COX. Receiving and repeating systems for telegraphy.
16,046 BRAGG & YOUNG. Detection of variable electric currents in the sea.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain of the Week.—Capt. W. Darley Bentley.
Next for Duty.—Capt. E. G. Fleming.
Sunday, Nov. 3.—Annual Musketry Course at Pirbright. Parade Waterloo Station 9.0 a.m. Drill Order, with rifles, greatcoats. Mid-day and tea rations to be carried.
Monday, Nov. 4, to Saturday, Nov. 9.—Drills as usual.
Sunday, Nov. 10.—Commandant's Parade at Waterloo Station for work at Esher, 9.0 a.m. Drill Order, greatcoats. Mid-day and tea rations to be carried.

Legal Intelligence.

Walsall Corporation and Motor Omnibuses.

Last week a Divisional Court (Justices Darling, Avory and Salter) granted the application of Walsall Corporation for the discharge of the rule nisi granted by the Court on June 4 last calling upon the Corporation to show cause why a writ of mandamus should not issue to them to determine the application of the Birmingham & Midland Motor Omnibus Company for licences to run omnibuses within the Corporation's jurisdiction. The Corporation based their refusal to grant licences mainly on the ground of congestion of traffic on the Birmingham-road, and the need for saving petrol and labour at present.

Mr. TOMLIN, K.C. (for the company), contended that the Corporation had been influenced by the fact that the 'buses competed with their trams, and that they were not entitled to take cognisance of that.

Mr. Justice DARLING, in saying the rule should be discharged, stated that the Corporation were entitled to consider whether it was extravagant or injurious to run these 'buses, and whether there should be only trams running along the streets. His difficulty was to see what consideration they could act upon except such a consideration as that there was a tramway already running along the streets, and that it was necessary in these times to economise petrol and labour.

Mr. Justice Avory and Mr. Justice Salter concurred, and the rule was discharged.

Birmingham Corporation v. S. Allsopp & Sons.

On Friday a Divisional Court (Justices Rowlatt and McCardie) heard this appeal by defendants from a decision of Judge Ruegg, K.C., in Birmingham County Court. It appeared that on March 5, 1917, defendants' motor-lorry collided with a section box attached to an electric standard belonging to the corporation. Damage was done to the extent of £29. 11s. On Sept. 5, 1917, the Corporation summoned defendants under sec. 20 of the Gasworks Clauses Act, 1847, which provides that ". . . every person who shall carelessly or accidentally break or damage any pipe, pillar or lamp belonging to the undertakers, or under their control, shall pay such sum of money by way of satisfaction to the undertakers for the damage done, not exceeding £5, as any two justices . . . shall think reasonable." The summons was heard on Oct. 5, and the justices awarded the Corporation £5. An action was afterwards brought by the Corporation in the County Court to recover from defendants the balance of £24. 11s., and Judge Ruegg gave judgment for the Corporation for that amount.

Defendants appealed, and after legal argument the appeal was allowed.

Mr Justice ROWLATT said that it was clear the common law remedy of damages for negligence was not ousted by sec. 20 of the Act of 1847, but when a person had been awarded a sum of money, as in that case, it was by way of compensation and satisfaction.

Mr. Justice MCCARDIE agreed, and said it was essential to give full effect to the words of the section "by way of satisfaction." When a person spoke of satisfaction he meant full sarisfaction. Moreover, it would be very inconvenient to hold that a second set of costs might be incurred in order that plaintiffs might recover damages in the County Court.

Dispute About Trade Name.

A case came before Mr. Justice Sargant last week, which Mr. Jenkins, K.C., said was a motion by Cosmos Lamp Works, Ltd., to restrain Cosmore, Ltd., from using their present name in connection with their business. Defendants had shown that they took the name bona fide, but they recognised that confusion might arise between their company and the plaintiffs' name, and they were prepared to give an undertaking to take another name with the consent of the Registrar.

By consent, his Lordship made an order staying further proceedings on that undertaking, no order being made as to costs.

Parliamentary Intelligence.

LIFE OF PATENTS.

In reply to a question in the House of Commons last week, Sir A. Stanley stated that the Controller-General of Patents, Designs and Trade Marks was empowered (inter alia) by the temporary rules of 1914 to extend the time of any patent for doing any act or filing any document, when it was shown that the patentee (or proprietor) was prevented from doing the act or filing the document by reason of active service or enforced absence from this country. Every consideration was given by the Controller to cases where the patentees were on active service.

ELECTRICITY SUPPLY CHARGES.

In the House of Commons on the 23rd ult., Sir G. Greenwood asked the President of the Board of Trade whether his attention had been called to the prices now charged for electricity by certain electric lighting companies in the Metropolis, and whether there was any statutory limit upon such prices.

In reply, Sir A. Stanley said that the statutes under which the undertakings of electric lighting companies in the metropolis were authorised fixed a maximum price, and the position of the companies was analagous to that of gas companies having a maximum price.

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WATER POWER IN INDIA.

In the House of Commons on Monday Col. Yate asked the Secretary of State for India whether he had received the report of the Committee appointed by the Government of India to inquire into the possible resources of water power in India.

In reply, Mr. Montagu stated that the Government of India had since decided, before constituting a Committee, to appoint an experienced engineer to report on the possibilities of promising sites as regards storage and power development. They had associated with him an electrical expert. At the same time, information would be collected regarding industrial possibilities within reach of promising sites, and the terms for the grant of concessions would be considered in consultation with local Governments.

Commercial Topics.

Currency and Foreign Exchanges.

The Committee appointed to investigate the question of currency and foreign exchanges after the war has issued its first interim report, and its main recommendations are: Restoration of the gold standard as soon as possible after the war, together with the substitution of Bank of England notes of low denomination for the present issue of Treasury notes. The report states: "In our opinion, it is imperative that after the war the conditions necessary to the maintenance of an effective gold standard should be restored without delay. Unless the machinery which long experience has shown to be the only effective remedy for an adverse balance of trade and an undue growth of credit is once more brought into play there will be grave danger of a progressive credit expansion, which will result in a foreign drain of gold menacing the convertibility of our note issue, and so jeopardising the international trade position of the country."

Other recommendations of the Committee are:—

Cessation of Government borrowing as soon as possible after the war, with the establishment of an adequate sinking fund provided out of revenue, for the reduction more especially of the floating debt.

While the obligation to pay Bank of England and currency notes in gold on demand should be maintained, it is not necessary or desirable that there should be any early resumption of the internal circulation of gold coin.

In view of the withdrawal of gold from circulation, the gold reserves of the country should be held by one central institution, and all banks should transfer any gold now held by them to the Bank of England.

A central gold reserve with a minimum of £150,000,000 should be created.

* * * *

The Greek Commercial Mission.

A luncheon was given on the 23rd ult. by the Federation of British Industries to welcome back the Greek commercial delegates from their provincial tour, in the course of which they visited many industrial centres, with the ultimate object of improving the commercial relations between Great Britain and Greece. Sir R. Vassar-Smith presided, and suggested the formation of a small united committee, representing the British and Greek nations, to foster and encourage trade between the two countries. He emphasised the importance of establishing better banking facilities.

M. Michalacoupoulos, Greek Minister of Agriculture, acknowledged the kindness with which the mission had been received during their visit, and said that they had seen for themselves in their tour what wonderful efforts had been put forward by the manhood and womanhood of Great Britain, and especially in the industrial world, to help not only their own Armies and Navy, but the whole of the Allies, in the supply of coal, food and munitions of war.

Sir Arthur Steel-Maitland, head of the Department of Overseas Trade, said his department would be only too pleased to do anything that they could to promote the objects of such an association or committee as had been suggested by the chairman.

It was then agreed to form a committee, the first names to be Sir Francis Barker, Mr. Philip Lockhart and Mr. Edmund Hill (secretary of the Federation), and MM. Embiricos, B. Lemanos and J. Damala.

* * * *

Women in Industry.

The position of women workers after the war was recently discussed at a conference between leading trade union women and employers of labour arranged by the National Alliance of Employers and Employed. The first question discussed was whether the 1¾ million women who, in addition to the three million in industry before the war, now compose the women's industrial army could be retained in industry after the war. It was pointed out that there was to be first considered the pledge of the Government to the trades unions that the men should all go back to their old jobs, and that pre-war conditions should be reinstituted in industry. There was also the great difficulty of converting the factories from the production of raw materials to the needs of peace, and there was the further problem of obtaining the necessary raw materials. The rate of demobilisation would be an important factor. Demobilisation, proceeding at the rate of 50,000 a week (a very high figure), would take 2½ years at least. It was realised that the Government must be compelled to fulfil its pledges to the trades unions, but this would not apply to new industries, such as the dyeing industry, which had been created during the war, or to the extension of old industries that had led to the employment of an increased number of workers. The general opinion was expressed that while there would be a temporary period of dislocation, during which the whole community would have to be patient and work on a give-and-take basis, there was little doubt that there would ultimately be work for all, and the whole of the women at present in industry could be retained. The meeting was unanimously in favour of a minimum wage, based on a reasonable standard of life, but varying in different areas. It was also agreed that during the period of demobilisation it would be better to institute a system of part time work, so that the whole of the workpeople should be employed for part of the day or part of the week. It was anticipated that this period would be only temporary. Dissatisfaction was expressed at the delay in the production of definite and co-ordinated plans by the Government.

* * * *

British Trade With the Dominions.

Complaint is made of the lack of support and sympathy shown by Government departments to British manufacturers in their efforts to retain their old and form new trade connections in the Dominions, and particularly in regard to schemes for the erection of jointly owned plants to protect their trade. It is stated that when manufacturers have applied to the Treasury for permission to invest the necessary funds, the officials have made it plain, even when limited assent has been given, that requests of the kind receive a very cold reception. The Priority Department at the Ministry of Munitions has also not shown much appreciation of the importance of the movement, for the Dominions have not obtained any preferential, if indeed equal, treatment over foreign buyers of plant and machinery. It is rightly urged that neither the Treasury not the Priority Department realise that they are handicapping British manufacturers in their competition with foreign firms. It is pointed out that in Japan important manufacturing interests have arisen which will compete with European goods. In metal manufactures, particularly of copper, zinc and brass, Japan is doing a most active trade in the Orient and introducing her wares into Australia, and in the chemical and textile trades she is exhibiting exceptional enterprise.

* * * *

Canadian Trade in 1917.

In the report of H.M. Trade Commissioner for 1917 it is stated that when the war ceases United Kingdom manufacturers should have no fear that they will not be able to regain the businesses which they have been compelled to relinquish during the war, provided they maintain their system of supplying goods above reproach at reasonable prices. So far as the Canadian market is concerned, there will probably be large purchasing power available to absorb United Kingdom productions of a kind suitable for Canada.

During the year ended March 31, 1917, the total value of the imports of merchandise for home consumption was $845,356,306 against $507,817,159 in 1916, and the domestic exports were valued at $1,151,375,368 compared with $741,610,638 in 1916. Of the imports $107,096,584 worth came from the United Kingdom against $77,404,361 in 1916, the corresponding figures of imports from the United States being $664,219,653 compared with $370,496,574 in 1916.

When United Kingdom firms are again in a position to manufacture and to ship for overseas requirements, it is necessary that those firms who wish to regain their Canadian trade and those firms wishing to enter the market in competition with the manufacturers of the United States and Japan, should be in a position to resume or to commence operations with a clear understanding of the task which lies before them. The United Kingdom manufacturer who is not already represented in the Dominion will not find it worth his while, as a general rule, to send catalogues even to a well-chosen list of prospective buyers of his goods, or to advertise even in a series of trade papers suggested by competent advertising agents. The personal touch is the distinguishing feature of the Canadian market. When catalogues are judiciously mailed for distribution and use by representatives in Canada, who are in close touch with the right kind of buyers, they should be prepared by a person intimately conversant with the Canadian trade in the specific goods to be sold. The great fault of the catalogues which reach Canada from the United Kingdom is that they contain so many goods not suitable for this market. Advertising matter of this kind should be well got up and artistically illustrated, where illustration is needful. Prices should always be stated in Canadian currency (dollars and cents); weights should be given in centals (100 lb., not 1 cwt.) and short tons (2,000 lb., not 2,240 lb.). One ruling rate of discount should prevail throughout the list. Bulky catalogues are objected to.

If it is decided after careful investigation to deal directly with Canadian buyers, the general methods followed may be summed up as: (*a*) To send the firm's travellers from the United Kingdom at regular intervals to call upon buyers in Canada; (*b*) to sell only to jobbing or wholesale houses in Canada, under direct orders from them by mail or cable (based on samples, &c.); (*c*) to appoint a reliable Canadian commission agent for the whole of the Dominion, or agents for different provinces or districts, as circumstances may dictate. (The tendency in Canada is for commission agents to attempt to combine too many agencies. It is advisable to make it a condition, when appointing an agent, that he shall not handle the agency of a competing firm, either American or British. Liberal salaries or commissions are necessary. Local agents are most favourably situated to deal with Provincial Governments, Municipalities, Government-owned railways, &c.) (*d*) To open a branch office or offices in Canada.

In the event of a decision to combine with other manufacturers, after the market has been thoroughly investigated, the obvious courses are: (*a*) to appoint a reliable selling agent to handle the goods of the combination, or (*b*) to open a branch office (a central selling agency), the expenses of which shall be borne by the affiliated firms in such proportion as they may decide.

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Electricity Supply.

It is proposed to erect a sub-station on land adjoining BLACKBURN Technical School.

The FERMANAGH county surveyor has been asked to report upon a proposed electric supply scheme for Pettigo.

BARNSLEY CORPORATION has applied to the L.G. Board for sanction to a loan of £12,500 for electric supply extensions.

Messrs. Caird & Company, of GREENOCK, have been authorised to erect an electric power station in their shipbuilding yard.

CARLISLE Electricity Committee is increasing its charges for current by 25 per cent., making 50 per cent. over pre-war charges.

KING'S LYNN Corporation is increasing its charge for electrical energy for power by 10 per cent. and for other purposes by ½d. per unit.

SKELMANTHORPE (Yorks) Urban Council has consented to the proposed application of the Electrical Distribution of Yorkshire for a provisional order.

STRATFORD-ON-AVON Council has agreed to an increase of the local electric lighting company's charge for current for lighting to 7½d. per unit.

NEWBRIDGE (KILDARE) Town Council is considering a scheme of electricity supply. It is thought that water power of the Liffey may be used.

Two boilers at the DOVER CORPORATION electricity works are to be fitted with induced draught apparatus, at a cost of £1,470, so that Kent coal may be used.

Sanction to borrow £1,500 for additional mains between Duncan-street sub-station and the Back-o'-th'-Bank generating station is being sought by BOLTON Corporation.

The Committe on Production have awarded the semi-skilled and unskilled men employed at the NEWPORT (MON.) CORPORATION electricity works an advance of 3s. 6d. per week, as from Aug. 16.

WOLVERHAMPTON Corporation has entered into an agreement with the Midland Electric Corporation for Power Distribution for the supply of electricity to Small Heath and Heath Town pumping-stations for the period of the war and 12 months after.

In the House of Commons on Monday the Financial Secretary to the War Office stated, in reply to a question, that the relative advantages of obtaining a supply of electric power from the SLOUGH & DATCHET ELECTRIC SUPPLY COMPANY and the installation of independent generating plant at a Chippenham depot had been "most exhaustively considered," and it had been decided for reasons of economy to adopt the latter proposal.

A North-Western section, comprising Shropshire and Staffordshire, and a Birmingham section have now been formed in the Midland Division of the Electrical Power Engineers' Association. The hon. sec. of the North-Western section is Mr. T. Mason, 94, Gospel Oak-road, Ocker Hill, Tipton, Staffs., and of the Birmingham section, Mr. W. A. Kitchin, "Soho House," Soho-avenue, Handsworth, Birmingham. The next smoking concert in connection with the Midland Division will be held at the White Horse Hotel, Congreve-street, Birmingham, on the 6th inst., the chair to be taken at 6.30 p.m.

The accounts of the OLDHAM electricity supply department for the year ended March 25 show, total capital expenditure £406,429 (increase £4,009), of which £224,176 is outstanding. Revenue was £79,405 (compared with £73,555 in the previous year), working and general expenses were £47,479 (£41,715), and gross profit was £31,926 (£31,840). Sinking fund required £11,942 (£11,361), and interest £12,292 (£11,229), and the net profit was £7,572 (£9,032). Average price obtained was 1·240d. (1·201d.) per unit, and total revenue costs were 0·75d. (0·69d.). Maximum load was 7,751 kw. (6,810 kw.) and load factor was 22·36 (24·31) per cent. Units generated were 18,896,189 (18,222,900) and sold 15,183,088 (14,506,010).

Last week the STIRLING Council had under consideration a recommendation of the Coal Controller that condensing plant should be installed in order to effect a saving of coal. Mr. J. W. Papworth, burgh electrical engineer, who has since resigned, estimated the capital cost at £3,670, and stated that if the capital were borrowed for 15 years the net annual gain would be £336. He recommended that two thirds of the profit of each year's working of the undertaking should be carried to sinking fund, so that the loan would be paid off in a shorter number of years than it had been borrowed for, the remaining third of profit being carried to reserve fund.

It was agreed to obtain a report from Mr. James A. Robertson, of Salford, on the question, and also to make a provisional application to the Secretary for Scotland for sanction to borrow £4,000.

Electric Traction.

It is proposed to extend the tramways from the Brunston-road terminus to Leicester-lane railway bridge.

The salary of the BURTON-ON-TRENT tramways manager, Mr. A. B. Slater, has been increased by £50 a year.

GILLINGHAM CORPORATION has instructed the Borough Surveyor to report upon the question of purchasing an electric refuse van.

OLDHAM Tramways Committee has decided to construct a new tramway track along Oxford-street, Block-lane and Thompson-lane.

SHEFFIELD HEALTH COMMITTEE has asked the Finance Committee to re-vote a sum of £2,200 (already voted but not spent) for the purchase of two electric vehicles for refuse collection, &c.

HASLINGDEN Tramways and Electricity Committee is considering the question of an increase of salary to all technical engineers on the staff of their electricity and tramways undertaking.

A London United tramcar got out of control while descending a hill near the Royal Cambridge Asylum, KINGSTON, on Thursday last, and dashed into another car at the foot of the hill. Twelve passengers were injured, and both cars were wrecked.

A meeting of the members of the Metropolitan Association of Electric Tramways Managers was held at the Municipal and County Club, Whitehall court, S.W., on the 25th ult., when there were present: Messrs Ullmann (East Ham), Hammond (Met. Electric), Harvey (Ilford), Murray (Walthamstow), Williams (Erith), Bruce (L.C.C.), Mason (South Met.) Mackinnon (London United), and Goodyer (Croydon). Messrs. Ullmann, Hammond and Goodyer were respectively re-elected chairman, vice-chairman and hon. secretary.

The accounts of the WALLASEY tramways department for the year ended March 31 show gross capital expenditure £237,197, of which £5,9201 has been repaid or provided for repayment. Income was £82,562 (compared with £70,756 in previous year), working expenses and war allowances, &c., amounted to £54,397 (£45,861), and, after providing for interest, sinking fund and instalments of loans, there remained £20,320, of which £4,000 (against £3,000 in previous year) has been placed to reserve for depreciation and renewals, £11,000 (£8,500) devoted to relief of rates and £5,320 (£3,858) carried forward. Receipts per car-mile were 15·42d. (13·58d.), and working expenses 10·16d. (8·8d.), including war bonuses, &c. Passengers carried were 17,111,453 (increase 1,985,812) and car-miles run 1,284,647 (increase 34,840.)

Imperial and Foreign Notes.

It is reported that Mr. Justice Bruneau, of Montreal, has dismissed the petition of the Marconi Wireless Telegraph Company of Canada for an injunction to restrain the Canadian Car & Foundry Company from installing certain apparatus for wireless telegraphing in ships under construction for the French Government at Port Arthur and elsewhere in Canada.

In the "Government Review" on the Administrative Report of the MYSORE STATE (India) for 1916–17, it is stated amongst the principal items of work sanctioned during the year were the improvement of the Mysore transmission lines and the provision of new windings for transformers at Sivasamudram. The number of power installations in Bangalore and Mysore cities rose from 70 to 89, and there has been a satisfactory increase in the demand for power for minor industries. In the plant at the Kolar section a higher voltage was substituted in the latter part of 1915–16, resulting in a large saving of power in 1917. The work has been carried out by Mr. S. G. Forbes, chief electrical engineer.

The Thermo Electric Ore Reduction Co. has acquired large interests in NORTH QUEENSLAND mines, and has purchased the important wolfram and molybdenite mines at Koorboora, owned by the Irvinebank Tin Co., as well as some tin properties. The company is erecting extensive works at Wolfram for the recovery of wolfram, molybdenite and bismuth. It is stated that anxiety is being expressed in the centres of molybdenum production in North Queensland concerning the action of the Government in taking the buying agency away from Dalgety's and handing over control to the Thermo-Electric Co. If the Thermo Company reduce the concentrates to metals locally, and produce the wolfram pure, Australia will certainly acquire an important industry, and become self-contained in the matter of smelting and refining these minerals. Scepticism however, is widely felt as to the ability of the company to carry out its contract in view of the difficulties in the way of securing the requisite machinery. Many of the producers regard with alarm the idea of being absolutely dependent on what is now the biggest producer in Queensland. They allege that they can only get their stone milled when the Thermo Company has none of it own ore available, and they have to sell to a rival producer who is also a consumer. A movement is on foot to send a protest to the Federal Government, asking that Dalgety's should either be reinstated or should be appointed as alternative agents.

AN "ALL-RED" CABLE SERVICE.

In the abstract of the minutes of the "Proceedings" of the IMPERIAL WAR CONFERENCE of 1918, it is stated that the Imperial Authorities have acquiesced in the proposal to co-operate in the acquisition of a State-owned cable across the Atlantic as part of an "All-Red" cable service between the United Kingdom and Canada, Australia and New Zealand. The resolution is as follows: "That it is in the highest interests of the Empire that the rates for telegraphic communications between the United Kingdom, Canada, Australia, South Africa and India should be further materially reduced as soon as practicable. That in order to ensure generally the cheapest and most secure telegraphic communication between the United Kingdom, Canada, Australia and New Zealand, it is desirable that they should co-operate in the provision of a State-owned cable across the Atlantic."

In the course of the discussion on the resolution, the representative of the Imperial Post Office (Mr. Pike Pease) said that as far as the British Post Office was concerned he was not in a position to say whether it would be possible to obtain facilities for taking over the various cables as had been suggested, but in view of the fact that 13 were controlled by the United States the amount of capital required to take over so many lines would be very great.

The resolution, which was supported by the representatives of India, Canada, Australia and New Zealand, was accepted without dissent.

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It is reported that preliminary surveys have been ordered in connection with a scheme for the electrification of the ROME-CASTELLAMARE-ADRIATICO RAILWAY. The water power of the Pescara river falls will be utilised for generating the necessary electrical energy.

During the year hydro-electric schemes of 15,000 H.P. and 12,000 H.P. were commenced at the falls in Asturias and in Valencia, respectively. There were under construction the Electra de Viesgo (Asturias) of 18,000 H.P. and Dos Aguas (Valencia), with a potential capacity of 60,000 H.P., of which it is intended only to use 20,000 H.P. Electric railways and tramways were constructed or extended in the provinces of Barcelona, Granada and Pontevedra. Plans were submitted for the electrification of the railway over the pass of Pajares (on the main line from the Asturian coalfields to Central Spain), and for a direct electric railway from Madrid to Valencia.

Miscellaneous.

Sir Arthur Fell, chairman of the House of Commons Channel Tunnel Committee, has given notice of intention to move at an early date a resolution in favour of the construction of the CHANNEL TUNNEL at the earliest possible moment after peace.

A training centre for the instruction of disabled soldiers in the art of diamond-cutting is to be established in Fort William, where workshops capable of accommodating 200 men are to be erected. The necessary power will be supplied by the Fort William Electric Lighting Company.

It is notified that all consumers of more than 22,500 cubic feet of gas or 120 B.T. units of electricity a year, whether in flats or dwelling houses, must have to apply to the local fuel overseer for an assessment, and forms can be obtained from the gas or electricity undertakings if the consumer does not buy coal.

If the flat or office is part of a block where the heating is supplied by the landlord or main occupier, or if the gas or electricity is supplied by a sub-meter from the general supply to the building the premises may be decided by the local fuel overseer to be a case for one joint assessment, and occupiers should inquire from their landlords in the first instance.

The members of the Greek Commercial Mission paid a visit on Oct. 24 to the New British and Key Industries Exhibition organised by the Industrial Section of the Tariff Reform League. They evinced great interest in what they saw and expressed their high appreciation of the development of new industries in this country.

The COAL CONTROLLER has issued figures which show a further serious falling off in the estimated output of coal during the first 36 weeks of this year, compared with the output during the corresponding period of last year. The net shortage is nearly 15¼ million tons, or about 8·8 per cent. The stocks of coal at mines and in trucks on Sept. 14 of this year, were about 750,000 tons less than at the corresponding date of last year. The output has steadily improved during the last three months, partly owing to the return of miners from the Army and to the stoppage of the holiday season, yet the demand for coal is greater than ever. It is gratifying to report that the miners in many counties are responding to the appeal for increased output.

The third report of the DEFENCE OF THE REALM LOSSES ROYAL COMMISSION has been issued, and in a schedule gives a list of the applications determined during the year ended August 31, 1918. For a 400 kw. dynamo and a shunt regulator requisitioned by the Ministry of Munitions, the Electric Construction Company, Ltd., claimed £816, the market value of the requisitioned machinery, and the price which the Ministry agreed to pay for a similar machine. The Ministry contended that the real loss was the price at which applicants had originally agreed to make and sell the machine to their customers, namely, £567. The commissioners, however, rejected this contention, and awarded £816 Messrs. Crompton & Company were also successful in their claim for £641 for the requisitioning of a generator and shunt regulator. The Scarborough Tramway Company claimed £385 for interference with the running of their tramways, and were awarded £150.

The President of the L.G. Board has appointed a committee to consider whether it is desirable to introduce a SCHEME OF SUPERANNUATION applicable to the persons in the employment of local authorities in England and Wales, and, if so, to make recommendations on the subject, with special reference to (*a*) the finance and general working of any such scheme, (*b*) classes of officials or employees which it should embrace, (*c*) its relation to any existing superannuation scheme. The members of the committee are: Mr. R. C. Norman (chairman), Mr. J. Boggan, Sir A. W. Chapman, Mr. A. Collins, Mr. W. R. Davies, C.B., Mr. Mr. W. P. Elderton, Rev. R. V. O. Graves, Sir H. Haward, Mr. C. Knight, Mr. H. List, Mr. E. R. Pickmore and Sir A. W. Watson. Mr. G. W. B. McLeod will act as secretary, and communications should be addressed to him at the Local Government Board, Whitehall, London, S.W. 1.

At a mass meeting of LONDON telephonists on the 23rd inst, two resolutions were adopted. The first demanded an immediate increase of not less than the amounts stated in the claim recently submitted to the Arbitration Board, both for women and men telephonists: the second declared that the time had come to "end the unnatural system of regarding telephonists as part of the machinery, and ignoring every human aspiration," and called for the "immediate abolition of the reformatory-like discipline, the secret observation tables, the use of stop-watches, and for a reduction in the amount of work per individual." Mr. A. Lynes (acting general secretary, Postal and Telegraph Clerks' Association) said that they must wait for the award on the immediate claim and accept it, whatever it might be. Then they must await the report of the Board on equal work for equal pay. If that was not satisfactory then would be the time to take action

Educational.

The scheme drawn up for post-war developments, under Prof. W. A. Bone, of the Chemical Technology Department of the IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, South Kensington, will involve an outlay of about £100,000 for buildings and equipment and £10,000 a year for maintenance. There will be four principal sections. The first will be concerned with the general technology of fuels, carbonisation of coal, chemistry of coal tar and its derived products, chemistry of gases and technical gas catalysis, refractory materials, &c It is proposed to make provision for the scientific side of wood distillation and for the extension of the important investigations on lignites. In the chemical engineering section, facilities will be afforded for the advanced study of the operations required in chemical manufacture. The third section will cover the principal applications of electricity in the chemical industry and the fourth will be concerned with celluloses, sugars, starches, gums and resins, animal and vegetable oils and fats, rubber, &c.

The second reading of the SCHOOL TEACHERS (SUPERANNUATION) BILL took place last week in the House of Commons, and in moving the second reading the President of the Board of Education (Mr. Fisher) said the Government had come to the conclusion that it was essential at the earliest possible moment to bring under one State pension scheme all qualified teachers of aided schools of all kinds below those of University rank. The superannuation scheme would be non-contributory, and the terms upon which benefits had been calculated resembled those of the Civil Service system. A teacher with an average salary of £400 a year during the last five years of his teaching service would, upon retirement, at the age of 60, receive an allowance of £200 a year, and in addition a lump sum of £533. No pension scheme could be regarded as satisfactory unless it provided for the free passage of teachers from one type of grant-aided school to another. Under the Bill, no service in future would be pensionable except that which was rendered in grant-aided schools, with an exception in favour of schools which come upon the grant list within the next five years. In future the benefits to both men and women teachers would be proportionate to their salaries. He believed that the Bill would promote the unity of the teaching profession, improve the quality of the instruction given, and secure an army of men and women teachers who would be attracted to the calling by the fact that for the first time the State had given adequate recognition to the teaching profession. It is estimated that the cost, additional to that of the present pension scheme, will be in 10 years' time £2,000,000 per annum, but the ultimate total cost will be about £2,428,000.

Tenders Invited and Accepted.

BEDFORD Corporation require tenders by noon Nov. 13 for the supply and erection of two water-tube boilers, mechanical stokers and induced draught plant. Specifications, &c., from the Electrical Engineer.

The GREAT NORTHERN RAILWAY COMPANY (IRELAND) require tenders by 10 a.m. Nov. 7 for six or 12 months' supply of stores and materials, including electrical fittings and lamps, electric cable and wire, carbons, rubber goods, signalling materials, oils, &c. Forms of tender from the Secretary, Amiens-street Terminus, Dublin.

ST. PANCRAS (LONDON) BOROUGH COUNCIL has accepted the following tenders: Rees Roturbo Manufacturing Company, two circulating pumps, £2,886; Underfeed Stoker Company, mechanical stoker, £1,906; Strachan & Henshaw, completion of steel work for coal handling plant at King's-road station, £2,777.

STIRLING COUNCIL has renewed the contract with the Tudor Accumulator Company for the maintenance of the battery for 10 years, from April 1, 1918, for an annual payment of £60, plus a small addition depending on the price of lead.

Appointments Vacant and Filled.

Stirling Town Council require an electrical engineer and manager of their electricity department. Salary £300 per annum. Applications by Nov. 4.

St Helens Corporation invite applications for the post of chief electrical engineer, at a commencing salary of £650. Applications to the Town Clerk by Friday, Nov. 8.

Wigan Corporation requires a rolling stock and works superintendent for its tramways department. Salary £250, rising by annual increments of £25 to £300 per annum. Applications to town clerk (Mr W. H. Tyrer) by Nov. 16.

The Government of India require a resident electrical engineer (salary Rs. 700 per month) and a shift engineer (Rs. 400 per month) for munition factories near Calcutta. Applications to the Chairman, Indian Ordnance Factories Extensions Committee, Armament Buildings, Whitehall, London, S.W. 1.

Mr. W. J. Papworth, burgh electrical engineer, Stirling, has resigned in order to take up an appointment at Bristol.

Mr. W. Y. Anderson, A.M.I.E.E., has been appointed commercial engineer of the City of Birmingham electric supply department.

Business Items.

Messrs. Johnson & Phillips, Charlton, London, S.E. 7, have recently issued Leaflet No. T 1/47, which gives illustrated particulars of the transformers supplied by them for colliery work.

Messrs. Rose Bros. have opened a branch in Manchester (25-27, Miller-street) under the management of Mr. Harold R. Pearson, where a general stock of electrical goods and accessories will be kept.

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Companies' Meetings and Reports, &c.

A dividend of 10 per cent. per annum has been declared on the ordinary shares of DICK, KERR & COMPANY, LTD.

The directors of BABCOCK & WILCOX, LTD., have declared a dividend of 6 per cent. (tax free) on the ordinary shares.

A dividend of 7½ per cent., together with a bonus of 5s., has been declared on the ordinary shares of CLAUD HAMILTON, LTD.

A dividend of 2½ per cent. (2s. 6d. per share), tax free, has been declared on the ordinary shares of the CALCUTTA TRAMWAYS COMPANY, LTD.

A dividend of 7 per cent. per annum (3s. 6d. per share), less tax, has been declared on the ordinary shares of the CALCUTTA ELECTRIC SUPPLY COMPANY, LTD.

The MONTREAL LIGHT, HEAT & POWER CONSOLIDATED, LTD., has declared a dividend of 1 per cent. (being at rate of 4 per cent. per annum) for quarter to 31st ult.

At an extraordinary meeting of VICKERS, LTD., last week the special resolutions, regarding the increase of capital which were passed on the 8th ult., were duly confirmed.

For the year ended Sept. 30 the profit of the CLEVELAND TRUST, LTD., was £2,086. The directors recommend a dividend at rate of 4 per cent. on the ordinary shares and to carry forward £623.

A dividend on the 5 per cent. cumulative perpetual preference stock of the BRITISH COLUMBIA ELECTRIC RAILWAY COMPANY, LTD., for the year ended June 30 will be paid on the 30th inst.

The net earnings of the VICTORIA FALLS & TRANSVAAL POWER COMPANY, LTD. (including those of the Rand Mines Power Supply Company) for the quarter ended June 30 last were £229,633, before providing for taxation in South Africa and the United Kingdom.

The directors of BRUCE, PEEBLES & COMPANY, LTD., have declared a dividend at the rate of 7½ per cent. per annum (less tax) on the cumulative participating preference shares for the half-year ended June 30, payable 8th inst.

The profit of TRAFFORD PARK ESTATES, LTD., for the year ended June 30 was £40,795. 11s. 2d., which, together with £54,766. 8s. 10d. brought forward, provides an available profit of £95,562. The directors recommend payment of a dividend of 6 per cent., and to carry forward the balance of £58,227.

The gross profits of HURST, NELSON & COMPANY, LTD., for the year to July 13 were £88,992 after providing for excess profits duty, &c., an increase of £10,221. A dividend of 10 per cent. and a bonus of 5 per cent. (both tax free), against 10 per cent. and 2½ per cent., have been declared; £20,000 has been placed to reserve and £6,000 to reserve for a payment of an interim-dividend in May next at 5 per cent. on the ordinary shares, carrying forward £20,843.

Mr. R. Mond, J.P., who presided over the recent annual meeting of the MOND NICKEL COMPANY, LTD., said the balance profit for the past year was £531,840, an increase of £195,000. An interim dividend on the ordinary capital at 1s. per share was paid in February, and a further dividend of 3s. was paid in July. The directors proposed to place £250,000 to reserve and to carry forward £18,251. The industry carried on by the company was one of those "key" industries which were of vital importance to the country, and he emphasised the advantages accruing from the possession of an important refinery of Canadian ores situated in this country. He referred to the growing dislike of Government control of industry among all classes, and said that if we were to be successful in supplanting German trade both in home and foreign markets, we should get ready to do so now.

The report of the ELECTRIC SUPPLY COMPANY OF VICTORIA, LTD., for the year ended March 31 last states that the lamps connected to the electric supply department's mains were 211,746 against 188,402 in 1917 and 166,253 in 1916. The passengers carried were 4,881,924 against 4,803,895 and 4,877,325 in 1917 and 1916 respectively. The revenue was £95,009. 6s. 4d. and the expenditure £63,566. 14s. 11d., leaving a gross profit of £31,442. 11s. 5d. The balance to credit of profit and loss account is £29,730, and with £16,426. 14s. 10d. brought forward, the total is £46,156. 18s. 8d. Deducting debenture interest (£7,026 7s. 6d.) and amount transferred to debenture stock redemption account (£7,257. 17s. 9d.) and amount written off cost of debenture issue (£450) the balance is £31,422. 13s. 5d. The directors propose to pay on account of arrears of preference dividend £10,500, and to carry forward £20,922. 13s. 5d.

New Companies, &c.

AABADA DRY BATTERIES, LTD. (151,596.)—Private company. Reg. Oct. 5, capital £3,000 in £1 shares, to enter into an agreement with George Nikolayevitch Autonoff for a licence to use a certain invention relating to improvements in dry cells in electrical batteries, &c. Reg. office: 61, St. James's-street, S.W. 1.

BRITISH FEDERATION OF IRON, STEEL, TINPLATE & METAL MERCHANTS (INCORPORATED).—(Word "Limited" omitted from title by licence of Board of Trade.) (151,654)—Reg. Oct. 12 as a company limited by guarantee, not formed for purpose of profit, with an unlimited number of members, each liable for £1 in event of winding up. Objects: To create a federation of (1) the members of all associations of persons, firms and corporations interested in or connected with the buying, selling, importing, exporting and distributing iron, steel, tinplate and metals which shall become affiliated; (2) the members of all affiliated iron, steel, tinplate or metal merchants' sections of Chambers of Commerce: and (3) all individual merchants or merchant firms or corporations, or members or representatives thereof, interested in any such businesses and not belonging to any such association or section: to promote the discussion among members of questions affecting their interests. Secretary: C. T. Everrett. Reg. office: 5, East India avenue, London, E.C.

W. G. AYRES & CO. (LTD.) (151,564)—Private company. Reg. Oct. 1, capital £1,000 in £1 shares, to carry on the business of automobile and electrical engineers, dealers in electrical fittings, &c. First directors are W. G. Ayers and W. F. Ashley. Reg. offices: 54, Gracechurch-street, E.C. 3.

FERMANS (1918) (LTD.) (151,502)—Private company. Reg. Sept. 23, capital £100,000 in £1 shares, to take over the business of engineering manufacturers of die castings in aluminium and other metals carried on as Fermans (Ltd.). First directors are H. Smith, A. Bednell and C. C. Fowler. Reg. office: Mitre House, Scrubbs ln, Willesden Junction, N.W.

GORDON MANUFACTURING COMPANY, LTD. (151,705.)—Private company. Reg. Oct. 18, capital £100 in 5s. shares, automobile, mechanical and electrical engineers, manufacturers of machinery, &c. First directors: G. Stewart (permanent) and G. H. Upjohn. Reg. office: 18-19, Woodstock-street, S.W. 1.

LEEDS FLINT GLASS CO. (LTD.)—(151,461)—Private company. Reg. Sept. 18, capital £10,000 in £1 shares, to take over the business of electric lamp bulb and tubing manufacturers carried on by the Yorkshire Incandescent Electric Lamp Co. at Leeds as the Leeds Flint Glass Co. Agreement with Yorkshire Incandescent Electric Lamp Co. First directors are H. F. McDowell and W. Plews. Reg. office: Old Mill-lane, Hunslet, Leeds.

M.P. MFG. CO. (LTD.)—(151,551)—Private company. Reg. Sept. 28 capital £1,000 in £1 shares. Electrical, gas and mechanical engineers, manufacturers of primary batteries, &c. First directors: J. W. Manley and B. W. Peteers. Reg. office: Twyford Hall, Twyford-street, N.

YORKSHIRE BATTERY MFG. CO. (LTD.) (151,470)—Private company Reg. Sept. 18, capital £10,000 in £1 shares, to take over business of electric battery manufacturers carried on by Yorkshire Battery & Mfg. Co. First directors are H. F. McDowell and W. Plews. Reg. office: Low Field Mills, East-street, Leeds.

Mortgages and Charges.

DURAM (LTD.)—Particulars of £20,000 7½ per cent. debentures created June 11, 1918, have been filed, whole amount being issued on Sept. 2. Property charged: Company's undertaking and property, including uncalled capital. No trustees.

INTERNATIONAL ELECTRIC COMPANY, LTD.—Land registry charge dated Oct. 10, 1918, securing £600 charged on freehold messuage and garden, "Meads Smithan," Downs-road, Purley. Holder: Mr. Cyril Woodham Mann, Bexley.

OMEGA LAMP WORKS (LTD.)—Particulars of £1,000 debentures created July 6, 1918, filed, amount of present issue being £400. Property charged: Company's property, present and future. No trustees.

Receivership.

WEAVERHAM ELECTRICITY SUPPLY COMPANY, LTD.—Notice of appointment of H. L. Dale, 133, Chester-road, Northwich, as receiver on Oct. 3, 1918, under powers contained in trust deed dated 1916, has been filed.

Thirty-Seven Years Ago.

[From THE ELECRICIAN, October 29, 1881.]

A GERMAN TELEGRAPH SCHOOL.—According to a notice recently issued by the Secretary of State for the German Post Office, the Telegraph School at Berlin will shortly commence another session of six months, lasting until April. Here employees of the telegraph service may undergo a course of physics, chemistry, mathematics, &c.

LITERATURE.—The current number of the "Quarterly Review," just published, contains an article on the "Development of Electric Lighting." In the July number of the same periodical is an article on earthquakes, in which the writer endeavours to trace their origin and cause to electricity. The undulatory motions are supposed to be the result of electricity endeavouring to break through cushions of soft, non-conducting materials, and the creaks and chasms opened in the soil are put down to the power of the electric jet to rip asunder the surface. We believe seismologists in general do not agree with the author of the latter article.

THE "HOOPER."—This fine vessel, specially suited for cable work, has, we understand, been purchased by the India Rubber, Gutta Percha & Telegraph Company from Messrs. Hooper, and will be employed in laying the South American Cables, now being manufactured. It is expected that the ship will leave for the Pacific Coast in March next. Her tonnage and measurements are: Length over all, 350 ft.; beam, 55 ft.; moulded depth, 36 ft.; gross tonnage, 4,935 tons; net registered, 3,724 tons. She has three cable tanks, each 30 ft. deep, with diameters respectively 41 ft., 53 ft. and 51 ft., and has the usual cable gear. The "Hooper" is the largest cable ship afloat. It is the intention of the present owners to call her the "Silvertown."

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CONTENTS.

Notes 567
Arrangements for the Week 569
Electric Traction on the Central Argentine Railway. Illustrated. —*Concluded* 570
California Railroad Commission's Rules on Inductive Interference 573
Electric Winding Engines and Mine Hoists. By H. H. Broughton. Illustrated.—*Continued* 574
Welded Ships. By William Shenstrom 575
The "Record" Internal Combustion Engine. Illustrated 576
Dover Corporation Tramways 577
Tasmanian Hydro-Electric Works 577
Minimum Charges for Electricity 577
The Government as Trader 578
Review 578
New Zealand Industrial Progress 579
The Labour Outlook. By Our Labour Correspondent 579
Correspondence 580
Patent Record 580
Volunteer Notices 580
Federation of British Industries 581
Legal Intelligence 581
Parliamentary Intelligence 581
Commercial Topics 582
Electricity Supply 582
Tenders Invited and Accepted 584
Companies' Meetings and Reports 584

Notes.

In Sight of Peace.

We have no intention of suggesting that peace will be virtually upon us during the present month; possibly another six months may be necessary to bring about this happy event. Yet it is equally possible that peace may come very quickly, and, therefore, it behoves us to ask what will be the immediate effect upon industry? First there will be undoubtedly a period of suspense in which the manufacturing of munitions may be continued but at a reduced rate, and this will be followed in due time by the order to cease manufacture. During the first period it may be desirable to retain all those who are engaged in the manufacture of munitions as a matter of precaution. Later, however, their services will not be required. What, then, is to happen when the order is given to cease manufacture? Some hundreds of thousands of munition workers are subject to a week's notice. That, of course, is a simple solution of the matter, but it is not one which any responsible person would contemplate as a desirable measure to adopt. A very large amount of unemployment would be a most serious evil, and this can only be avoided by giving time for industry and labour to adjust themselves to the new conditions. The expenditure on the war has been so enormous that a little additional expenditure in so far as munition workers are concerned is scarcely worth consideration if it is to serve a useful purpose, and in all probability the Government will take this view. We think it would be a great advantage, however, if the Government would state their intentions at the present time rather than wait for a difficult position to develop. The problem is one of great importance. We have the Ministry of Reconstruction for dealing with such matters, and, therefore, there seems to be no good reason for delay in dealing with a situation which may come very suddenly upon us.

Restriction of Output and Profits.

In his presidential address before the North-East Coast Institution of Engineers and Shipbuilders, Mr. E. L. Orde made some pregnant remarks on problems of reconstruction, referring especially to the so-called "limitation of output." This practice dates back to the days of the hungry forties, and was no part of the earlier scheme of labour in which master and man were "mates," each conscious that the withdrawal of effort meant loss to both. In the years following the war it will only be possible to meet the burdens imposed by war expenditure by eliminating all deliberate restrictions of output. Our task must be to convince masters and men that they are still mates—that the fruits of their labour are sold by the master for their joint advantage. Turning to the common argument that all income above a certain figure represents unjust withdrawals from the wages of the worker, Mr. Orde quoted some statistics to show that the distribution of all income, over £1,000 among workers could only raise wages at the rate of about 1½d. in the shilling. This statement is supported by the conclusion that in pre-war times a 10 per cent. rise in wages in the engineering and shipbuilding trades, unless borne by the consumer, was sufficient to absorb all the average earnings of capital. In the remainder of his address Mr. Orde dealt with various points of technical interest to the shipbuilding industry, especially the question of standardisation and the bulk fabrication of ships. Apart from the manufacturing side he raised the point how far such methods can be accommodated to the demands of labour. They may facilitate greater leisure and shorter hours of work. On the other hand, they tend towards monotony and the removal of the intellectual stimulus which workers experience from variety in jobs. This is a problem which many other industries will also have to consider in laying their plans for reconstruction.

Statutory Undertakings and Increased Charges.

Some little time ago an Act of Parliament came into force giving power to the Board of Trade to allow statutory undertakings to increase their charges temporarily so as to meet the heavy costs under which such undertakings are at present working. In certain cases this permission has been given, but in the case of the undertaking supplying Weybridge and Walton, the application has been refused without so much as an inquiry being held, the Board merely suggesting that a further application might be considered in six months' time. It is difficult to understand this attitude. It appears that figures have been supplied showing that the increased charges due to war conditions not only wipe out all dividends on preference share capital but also prevent the full debenture interest being earned. Under these circumstances surely there is an excellent case for an increased charge. To postpone the matter for six months, so that no increased charge can be made during the winter months when most of the revenue is earned, can only place the undertaking in an extremely difficult financial position. Whether the refusal is due to the fact that the local authority is opposed to the increase in price we do not know. Possibly the municipal council feel that

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they must oppose any such application for political reasons, quite irrespective of the merits; if so, it is an unfortunate position and a short-sighted policy, which should be terminated at once by the holding of an inquiry. We fear that this action of the Board of Trade is on a par with others to which we have referred from time to time, and which show that the Board, notwithstanding its name, have little knowledge of what trade really means.

The Dover Tramways.

WE fear that there are many tramways in the country at the present time which are in a seriously bad condition from the point of view of maintenance. At Dover the position has become most acute. According to a report by Messrs. Dick, Kerr & Company, a large part of the track requires renewal. For this purpose it will be necessary to have 240 tons of rails, a corresponding number of points and crossings and other accessories, 2,000 tons of ballast, 800 tons of sand and 500 tons of cement. If 100 men were employed the work would require three months for completion. The poles also appear to be very light for their work, and the trolley wire, which is unusually small, is badly worn. Out of 20 cars only 12 remain on the road; and the report states that even if the track were put into proper condition the improvement would probably beun noticed, as it would be nullified by the exceptionally bad state of the cars themselves. According to the tramways manager, no actual renewals can be traced other than running repairs, and this statement, it should be noted, applies to the pre-war history. Under present conditions it is, of course, difficult to carry out renewals, both on account of the scarcity of material and owing to the fact that work of this kind cannot be carried out at night in a town like Dover. The Corporation is now faced with the alternative of spending a considerable sum of money, the provision of which, owing to the present high cost of materials, would have a bad financial effect upon the undertaking, or of selling the whole equipment as scrap. The latter course would bring in an unusually large value at the moment, as tramway material and even scrap metal is at a premium. In that case the tramway service would be supplanted by a motor-'bus service. For the moment the matter is still under consideration. The moral of this unfortunate history is that adequate repairs and a fund for such a purpose are of prime importance. According to the report of Messrs. Dick, Kerr & Company, there appears to have been no regular system of maintenance and no sum set aside for repairs, all work having been done out of revenue. In this way the tramways have been literally starved as regards upkeep. The result of such a policy is inevitable, and must come sooner or later. We hope that there are few undertakings in the country which have run their tramways on such an unsatisfactory basis.

America's Energy Supply.

UNDER the above title Dr. C. P. STEINMETZ contributes an imaginative article to the "General Electric Review" (U.S.A.), and though the facts quoted refer to the available supply of energy in America, the principles are of general application. Taking the calorific value of average coal, Dr. STEINMETZ arrives at the conveniently expressed conclusion that the chemical energy of one ton of coal is equivalent to the electrical energy of 1 kw.-year (24-hour service), assuming 100 per cent. efficiency in conversion. If it be assumed that half the coal is applied to electric power at 10 per cent. efficiency and that the other half is used as fuel and for metallurgical purposes at an average efficiency of 40 per cent, then only 217 million kw.-years are made available from a production of 867 million tons per annum. Turning next to the potential energy in the form of water power, rainfall, &c., Dr. STEINMETZ arrives at a total of about 1,000 million kw.-years. This, after deductions for water required for agriculture, evaporation, &c., is reduced to 380 kw.-years, and ultimately, assuming an efficiency of conversion of 60 per cent., to 230 million kw.-years. The question is how to utilise all this energy, much of it existing in the form of small rivulets and streams, before its potential value diminishes. It is interesting to notice that the figure arrived at is approximately the same as that now produced from coal; in other words, if the coal supply failed even the most efficient utilisation of existing water-power would hardly make good, let alone appreciably surpass, the present energy-demand. The efficient utilisation of water-supply on these lines would, however, involve much simpler methods of generation than at present. According to Dr. STEINMETZ, it may best be achieved in the future by the adoption of the induction generator for smaller water-powers, such generator stations acting as adjuncts to large synchronous stations to which the functions of regulation and control would be transferred.

Batti-Wallah's Society.—The next monthly luncheon of this Society will take place on the 18th inst. at the Holborn Restaurant, London, the principal speaker being Mr. Llewellyn B. Atkinson.

Royal Institution.—At a general meeting of the members held on the 4th inst. special thanks were returned to Mr. R. Pearce for a donation of £100 to the Research Fund. It was announced by the Secretary that the Christmas Course of Juvenile Lectures would be delivered by Prof. D'Arcy Thompson, the subject being "The Fish of the Sea."

I.E.E. General Conditions of Contract.—In these Conditions as used hitherto the 20 per cent. retention money has been divided into two parts, 10 per cent. being payable at the expiration of one month after the works are taken over or put to beneficial use by the purchaser, and the remaining 10 per cent. at the expiration of nine months after the first payment becomes due. These percentages have now been changed to 15 per cent. and 5 per cent, respectively.

Industrial League.—On the 30th ult. the annual dinner of the Industrial League, was held, the chair being taken by Mr. G. H. Roberts, M.P., Minister of Labour. Mr. Roberts announced that he had consented to act as President of the League for the ensuing year as he felt that the work which the League was carrying on was of great importance. If internal strife were to follow the war, the recovery of the country would be impossible. He thought the time had now come when the efforts of the various bodies formed to solve this question should be pooled. There was special need for such work. The individual workman, while entitled to claim his rights must also admit his responsibilities. Mr. John Hodge, M.P., Minister of Pensions, spoke in favour of increased production.

Power Station Extensions.—The Council of the Incorporated Municipal Electrical Association have issued the following circular to Members of Parliament:—"The Council of the Incorporated Municipal Electrical Association, representing practically the whole of the electricity supply undertakings in Britain, view with grave concern the lack of uniformity of treatment at the hands of the Government Department concerned in granting permits for power station and plant extensions of large electricity supply undertakings, and respectfully request that impartiality be shown when deciding future applications for necessary extensions of electricity supply schemes. It is felt that the success of the scheme of the Board of Trade for the re-organisation of the electricity supply industry is being seriously prejudiced by the close connection between the principal staff of the Ministry of Munitions and large private electricity undertakings in the country."

Naval Invention.—It is announced that the Admiralty Board of Invention and Research, which was created in July, 1915, has had 53,000 inventions and proposals submitted to it

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up to July last. About 36,000 related to the submarine and mine in attack and defence, and to engineering matters; 13,000 to naval ordnance, ammunition, &c., and the rest to aircraft. In many inventions which have been examined by the Board a sense of fundamental conditions has been absent. Thus, of the inventions and suggestions placed before the Board only a small percentage possess any naval utility. Sir Eric Geddes instituted early this year the Department of Experiment and Research at the Admiralty with the object of ensuring the closest contact between the naval officer, the scientist and the engineer. There are also local committees and a committee of the Institution of Electrical Engineers. Each of these is dealing with the problems which are most nearly allied to the industries which have sprung up in the district.

Industrial Reconstruction Council.—The Industrial Reconstruction Council and the Reconstruction Society have formed a Joint Committee and planned a national campaign on the lines of the work which they have been doing for the past year and which is having such a beneficial effect upon the attitude of mind of both Capital and Labour. There is no doubt that this first effort at co-ordination will meet with public approval, and will help to dispel the confusion which must inevitably arise when Leagues and Alliances, Councils, Committees and Societies are all apparently preaching the same gospel and covering the same ground. The two societies which are now joining hands have found it almost impossible to meet the demands made upon them for speakers and literature, and at none of the numerous meetings they have held have they been able to accommodate all who have attempted to secure admission. The fourth lecture of the series arranged by the Industrial Reconstruction Council will be held in the Saddler's Hall, Cheapside, E.C. 2, on Wednesday, Nov. 13. The Chair will be taken at 4.30 by the Rt. Hon. Lord Burnham, C.H., and a lecture entitled "A Retrospect from 1970," will be delivered by Sir Arthur Steel-Maitland, Bart., M.P., Parliamentary Secretary Foreign Office and Board of Trade (Department of Overseas Trade). Applications for tickets should be made well in advance to the Secretary, I.R.C., 2 & 4, Tudor-street, E.C. 4.

Obituary.

EDWARD BENNIS.—We regret to record the death on the 29th ult. of Mr. Edward Bennis, founder and managing director of Messrs. Ed. Bennis & Company, Ltd. Mr. Bennis was born in Limerick in 1838, and educated at the Quaker College, of Newtown, Waterford. On leaving college he was apprenticed to Mr. Thos. Chandler, of Balls Mills, Waterford, subsequently entering the service of Mr. Peter Moore Fisher, of Piltor, County Cork. Afterwards he started in business on his own account, and within a few years he had acquired a competency which enabled him to retire from business. Some years after, entering once more into business, he began to take an active interest in the mechanical firing of boilers. Previous to 1873 the firing of boilers by mechanical means was almost unknown, though there were then two types of machine stokers used on a small scale. At this stage in the history of the subject Mr. Bennis joined Mr. Dillwyn Smith, of Philadelphia. Works were started in Liverpool, but Mr. Bennis soon came to the conclusion that the system which provided only for throwing the fuel on the fire was incomplete. After lengthy experiments, Mr. Bennis succeeded in inventing a self-cleaning furnace which answered the requirements he had set himself to meet. A great increase in evaporation was effected in boilers fitted with his apparatus, the smoke was lessened and a considerable economy was effected. He continued to improve his machine, and ultimately established his works in Bolton. A new principle of machine firing was later introduced, in which the coal was spread over the fire, not in a continual rain, as in the older machines, but by a striker, which distributed it intermittently. The newer principle effected a complete revolution in machine firing and it took rank as a leading engineering industry.

Machine firing had aroused such attention that a competition of mechanical stoker makers was held at the Manchester Sanitary Exhibition in 1882, and the medal for merit on the points of smoke abatement, power and efficiency was won by Mr. Bennis. At the Yorkshire Jubilee Exhibition a gold medal offered for the best system of machine firing was again won by Mr. Bennis. More recently still a newer system was introduced by Mr. Bennis, in conjunction with his son, in which all the advantages of forced draught, machine firing, induced draught and self-cleaning furnace have been concentrated in one invention. It is said that by means of this the rating of a boiler may be nearly doubled, while maintaining a very high economical efficiency and a smokeless chimney. It is evident that when a considerable number of boilers are fitted with machine-firing apparatus a great advance is made if the fuel can be fed to the hoppers of the machine-firing apparatus by mechanical means, and the ashes and clinker removed from the front of the boilers by similar means. To effect this an adaptation of apparatus already used by collieries was first tried; but improvements quickly suggested themselves, and in a short time the patents were taken out which kept the Bolton works busy producing fuel-conveying plant. The latter includes automatic weighing machinery, which weighs the fuel in transit into the works, tips it into the conveyors and registers the weight delivered in the day. As the works at Bolton were too small, a site for a new factory was obtained at Little Hulton, near Bolton, in 1904. Up-to-date buildings, which were provided with electric cranes and every appliance to get the utmost output, were erected; but since then the buildings and plant have been extended year after year to meet the continued growth of business. All types of machine stokers are now built, including chain grates for water-tube boilers, and every description of coal-handling device—coal bunkers, pneumatic ash-handling plant, conveyors for coal, cement and like products. The firm have now branch establishments or concessionaires in most of the countries of the world. Of late years Mr. Bennis and his son have devoted much attention to the mechanical firing of boilers on board ship, but developments have been held in suspense in consequence of the war.

T. C. HUTCHINSON.—The death recently took place of Mr. Thos. Chas. Hutchinson, managing director of the Skinningrove Iron Company, who installed the first electrically driven cogging mill in Great Britain.

DEATHS ON ACTIVE SERVICE.—The following deaths are reported:—

Company-Sergt.-Major J. P. Batey, D.C.M. (R.E.), who is now presumed to have been killed, was a Fellow of the Chemical Society and was formerly a student at the Manchester School of Technology, won the Schuster Research Scholarship in 1908, and took the degree of M.Sc. (Tech.). He had also been awarded the Belgian Croix de Guerre.

Lieut. J. H. Waddington (R.A.F.), who was killed on Oct 22, was formerly employed by the British Westinghouse Electric & Manufacturing Company.

We regret to learn that Sec.-Lieut. John Poynter (20th Manchester Regt.) was killed in action on Oct. 25. He was chief assistant to his father, Mr. J. F. Poynter, managing director of the Maxim Lamp Works, Ltd., until he joined the Army as a private early in 1916.

Personal.

The degree of D.Sc. (Eng.) of the University of London has been conferred on Prof. Miles Walker, M.A., of the Manchester College of Technology, for a thesis entitled "Supply of Single-Phase Power from Three-Phase Systems."

Prof. Dr. Ernst Hagen, director of the Electrotechnical Department of the Physikalisch Technische Reichsanstalt, Berlin, retired on Oct. 1 after a service of 25 years.

Arrangements for the Week.

FRIDAY, Nov. 8th (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, Imperial Institute-road, S. Kensington, London, S.W. Papers to be read: "Low Voltage Arcs in Metallic Vapours," by Prof. J. C. McLennan, F.R.S.; "Relativity and Gravitation," by Mr. W. Wilson, D.Sc.; "A Demonstration of Experiments illustrating Colour Blindness" by Mr. C. R. Gibson, F.R.S.E.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

6.15 p.m. At the Literary and Philosophical Society, Newcastle-on-Tyne. Lecture on "Electric Welding for Shipbuilding Purposes," by Mr. W. S. Abell, M.Eng.

SATURDAY, Nov. 9th.

MANCHESTER ASSOCIATION OF ENGINEERS.

6.30 p.m. At the Grand Hotel, Manchester. Paper on "Workshop Measurements with Special Reference to the Limit System," by Mr. W. F. Rhodes, M.I.Mech.E.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7.0 p.m. At the Swan Hotel, New-street, Birmingham. Paper on "Automatic Telephones," by Mr. H. W. Dipple.

MONDAY, Nov. 11th.

INSTITUTION OF ELECTRICAL ENGINEERS, WESTERN LOCAL SECTION.

7.0 p.m. At the South Wales Institute of Engineers, Park-place, Cardiff. Address by the President, Mr. C. H. Wordingham.

TUESDAY, Nov. 12th.

INSTITUTION OF ELECTRICAL ENGINEERS, NORTH-WESTERN CENTRE.

7.0 p.m. At the Engineers' Club, Albert-square, Manchester. Address by the Chairman, Mr. A. P. M. Fleming.

JUNIOR INSTITUTION OF ENGINEERS, NORTH-EASTERN SECTION.

7.15 p.m. At the Mining Institute, Neville-street, Newcastle-on-Tyne. Paper on "The Design of High Speed Steam Turbines," by Mr. M. Ward.

INSTITUTION OF ELECTRICAL ENGINEERS (SCOTTISH CENTRE).

7.30 p.m. At 207, Bath-street, Glasgow. Inaugural Address by the Chairman, Mr. J. F. Nielson.

FRIDAY, Nov. 15th.

INSTITUTION OF MECHANICAL ENGINEERS.

6.0 p.m. At the Institution of Civil Engineers. Adjourned discussion on "A Law Governing the Resistance to Penetration of Metals which are Capable of Plastic Deformation, and a New Hardness Scale in Fundamental Units," by Prof. C. A. Edwards and Mr. F. W. Willis; "The Value of the Indentation Method in the Determination of Hardness," by Mr. R. G. C. Batson; and "The Ludwik Hardness Test," by Dr. W. C. Unwin, F.R.S.; and also a Paper will be read, if time permits, on "Electric Welding," by Mr. T. T. Heaton.

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Electric Traction on the Central Argentine Railway.

(*Concluded from p. 552.*)

ELECTRICAL EQUIPMENT OF TRAINS.

The average distance between stations on the Tigre (Victoria) route is 1⅛ miles; the present timing of electric trains which stop at all intermediate stations is 47 minutes, giving a scheduled speed of 22½ miles per hour. This can be increased to 25 miles per hour when desired without overloading the equipment. As the average length if run is comparatively great, and as there are no severe gradients on the line, it was not necessary to utilise the whole of the weight of the motor coaches for adhesion by gearing a motor to each axle. Consequently a two-motor equipment was adopted, each motor dealing with a load of about 45 tons. With the width between wheels available on the broad gauge (5 ft. 6 in.) it was possible to design a motor (Figs. 15 and 16) of ample capacity without interfering with the normal proportions of its various parts. In addition to the stopping service, the trains are also required to make express or semi-express runs, stopping only at one or two intermediate stations and performing the journey at a scheduled speed of 37½ miles per hour. This condition is provided for by reducing the excitation of the main fields by 50 per cent. in one step. Details of the electrical equipment of the coaches are given in Table VII.

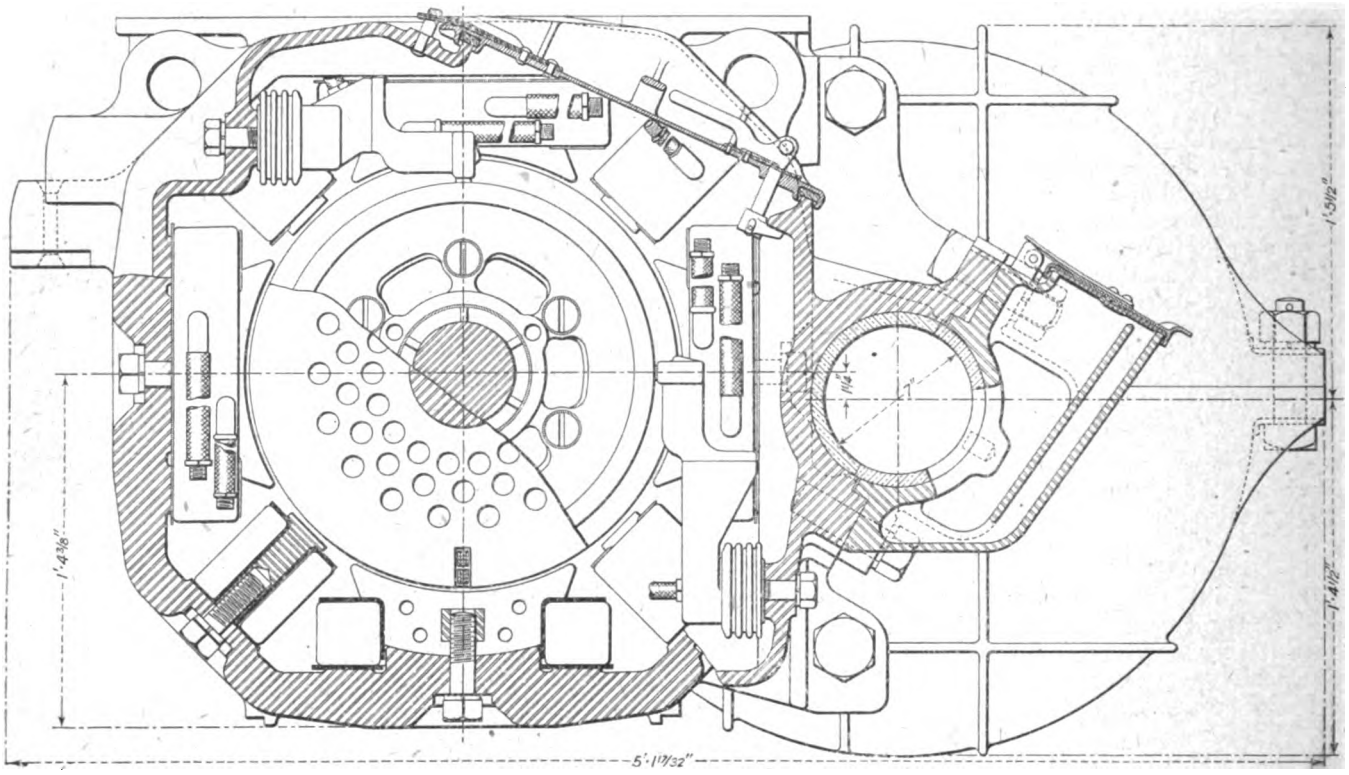

FIG. 15.—CROSS SECTION THROUGH MOTOR.

Table VII.—*Details of Electrical Equipment of Rolling Stock.*

Type of motor, G.E. 235.
Horse-power of motor, 250 H.P. on one hour rating (75°C. rise).
Voltage across motor, 800.
Overall length of motor, 5 ft. 0⅞ in.
Diameter of armature, 20 in.
Core length, 17½ in.
Diameter of commutator, 17⅞ in.
Length of commutator, 7⅝ in.
Weight of motor, including gears and gear case, 8,430 lb.
Armature-bearing (pinion end), 5 in. by 11¾ in.
Armature-bearing (commutator end), 4½ in. by 8⅞ in.
Gearing, pinion: 22 teeth; 2¼ in. diametral pitch; forged steel; oil tempered.
Gearing, gear wheel: 70 teeth; width of face 5¼ in.; cast steel hub, with oil tempered forged steel rim shrunk on.
Wheel diameter, 3 ft. 6 in.

The two motors, mounted on each motor bogie, are arranged for nose suspension from the bogie transom, the suspension nose being cushioned by springs against both upward and downward movement; they drive the axles through single pinions and gears with a gear reduction of 70:22. The clearance between the lowest point of the cast-iron gear-case and rail level is 4½ in. The suspension bearings on the axle are fitted with gun-metal linings, the length of axle between bearings being protected by a housing to exclude dust. The armature bearings are gun-metal lined with white metal. Both sets of bearings are lubricated with oil and waste.

The motor carcase is a single steel casting with machined seats for the four main and four commutating poles.

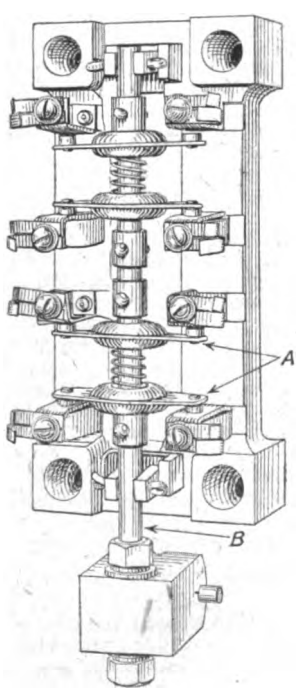

FIG. 17.—CONTACTOR INTERLOCKS.

Provision for ventilation is made in the form of a rectangular opening of 160 sq. in. at the pinion end arranged to take a flexible duct communicating with the interior of the coach, through which the air can be drawn if it is found that there is too much dust in the air taken direct from beneath the coach. The air entering this opening passes to the commutator end between the fields and over the surface of the armature; it then returns through ducts in the core and is expelled through openings in the upper part of the end shield by a fan fixed on the armature shaft. All other openings in the carcase are fitted with watertight covers.

The armature core stampings are mounted direct on the shaft and can be kept solidly together when being pressed off by bolts passed through some of the ventilation ducts. The armature coils are made up of flat strips insulated from each other with mica, bound together with tape, and insulated from the core with pressed mica. The field coils are copper strip,

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the main coils being wound on the flat and the commutating coils on edge.

The two brush holders each carry four carbon brushes, the pressure on which is adjusted to 4½ lb. Each holder is carried off two porcelain insulators, the stud insulation being mica.

The motors are built and insulated for a working pressure of 800 volts, and the control system provides for operating with two motors in series, in parallel with full field, and in parallel with tapped field. The control at starting is automatic, the rate of cutting out series resistance being determined by a "notching" relay which allows the contactors to close in the proper order as the main current falls to a pre-determined value. The main contactors are wound to operate with any line voltage from 480 to 850. They are 15 in number and are mounted in a sheet steel box with the front covers hinged to swing open for inspection. The interlocks (Fig. 17) which make the combinations required for the successive control steps are mounted on spindles at the back of and are operated by the contactor arms. In this figure the contact pieces are shown at A and are insulated from the spindle B. The main resistances are cast-iron grids insulated with mica and mounted in frames carried from the under-frame members by insulated bolts and bobbins. The main circuit-breaker, which can be set or tripped from the driver's cab, and the reversers are mounted in watertight sheet steel boxes. All cables beneath the coaches are carried in solid drawn steel conduit, screwed into the cases containing the apparatus; where breaks are required in the cable junction boxes are provided. The conduit was erected in this country and shipped in position on the underframe, the cables being pulled in during the re-erection of the coaches in Buenos Aires.

The leads which run from end to end of the train are three in number:—

(*a*) The train line, a single core cable.

(*b*) The pump line, a twin core cable, one core being the full speed and the other the half-speed lead for the pump motor.

(*c*) The control line, a bundle of seven cables coupling up controllers, circuit-breakers, &c.

These leads bifurcate at the end of each coach and terminate in sockets attached to the headstock. Connection between coaches is made by removable jumpers and plugs.

The vacuum pump and motor are mounted in a framework slung to the underframe. The pump is a single acting two-cylinder machine coupled to the motor through a helical spring coupling. It is geared down 4 : 1 by a chain inside the pump casing. The motor is of 3½ H.P. capacity, series wound. A series resistance which can be short-circuited permits it to be run at two speeds, one approximately double the other. Normally the motor is run at half-speed to maintain the vacuum against leaks and the use of the vacuum horn; when the driver's brake-handle is put into the "release" position the brake controller cuts out the resistance and the motor runs at full speed till the required vacuum is obtained, whereupon the brake-handle is put to the "running" position, thus inserting the resistance again into the circuit.

There are four positions of the driver's brake-handle:—

1. Neutral position. Motor stopped; train and pump pipes not connected together.

2. Release position. Motor running full speed; train and pump pipes connected through full gate in driver's valve.

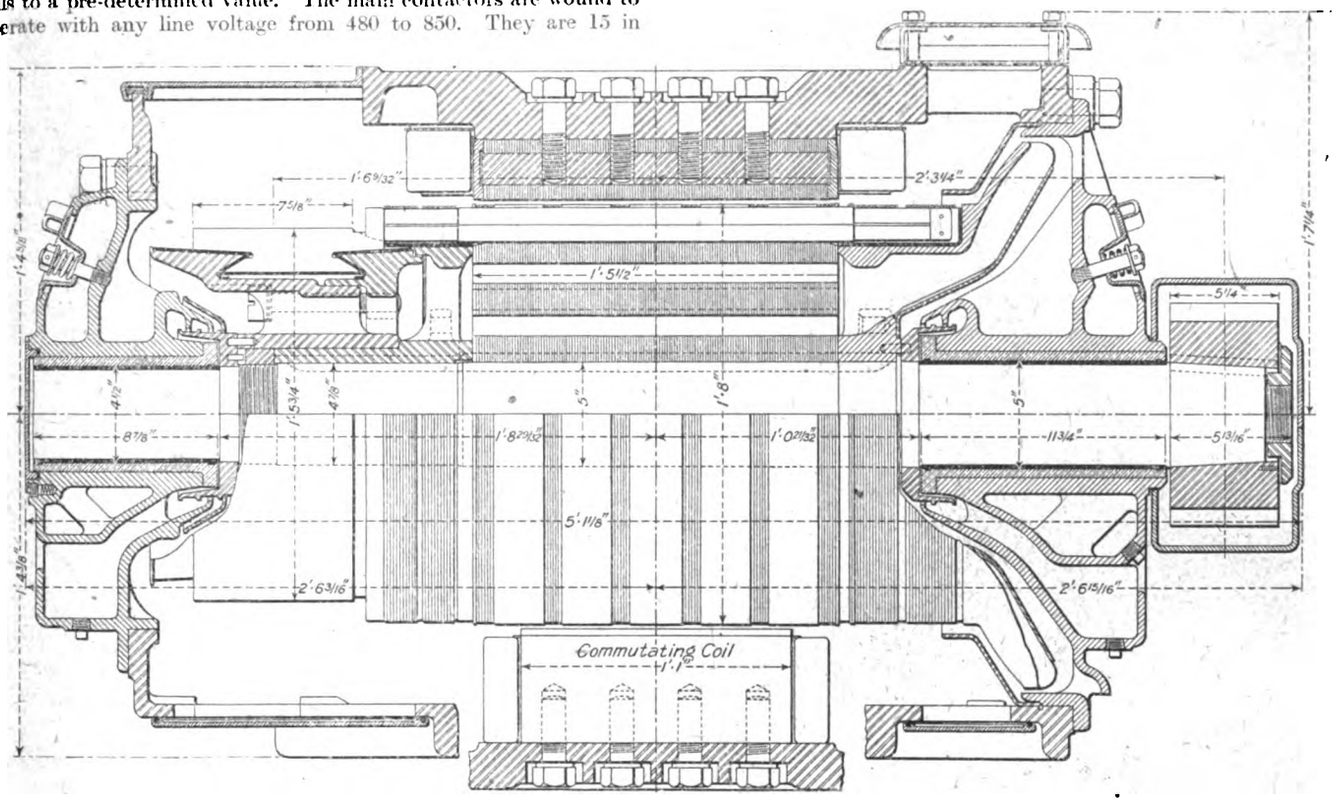

FIG. 16.—LONGITUDINAL SECTION THROUGH MOTOR.

3. Running position. Motor running half speed; train and pump pipes connected through half gate in driver's valve.

4. Application position. Motor running half speed; train pipe full open to atmosphere; pump pipe blanked off.

The "dead man" device on the controller consists of a pilot valve operated by a knob on the main handle. When the knob is released this valve admits air to the emergency valve which is thus actuated and opens the train pipe to atmosphere, blanking off the pump pipe.

CAR SHEDS.

For the reception of the electric rolling stock the Company built a new car shed at Victoria. This shed is 230 yds. long and contains 10 tracks. The rails are raised from the floor on longitudinal concrete supports so that the equipment underneath the coaches can be easily examined. Power for moving the coaches in the shed is supplied from overhead trolley wires carrying little carriages from which hang cables that can be plugged into the train line sockets on the coaches. An existing shed was adapted as a repair shop by raising the roof and installing 20-ton travelling cranes.

The routine maintenance of the stock consists of a nightly inspection and a shed day once a fortnight. It is intended to give a heavy overhaul when cars come in for wheel turning, which will be for the motor coaches after running 60,000 to 80,000 miles, and for the trailer coaches after 100,000 miles. The shed and repair shop staff consists of two shifts each of 31 men, with 7 other men employed in the shops during the day only, and three rolling stock examiners who are stationed at Retiro.

ELECTRICAL EQUIPMENT OF TRACK.

The electrical equipment of the track (Table VIII.) comprised the bonding of the track rails, the erection, bonding and protection of the conductor rails, the laying of inter-connecting cables across gaps in the conductor rail and the provision of switchgear for dividing up the track into short electrical sections.

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Table VIII.—*Details of Electrical Equipment of Track.*

Conductor Rail.—Make,	North Eastern Steel Co.'s high conductivity steel.
Weight per yard	86 lb.
Length of rail	33 ft.
Composition	Carbon (0·03 per cent.). Silicon (nil). Sulphur (0·05 per cent.). Phosphorus (0·06 per cent.). Manganese (0·36 per cent.).
Electrical resistance...	6·7 times that of copper of equal volume.
Ramps	Shaw's cast steel.
Insulators.	
Type	Doulton's single shed round porcelain.
Caps and clips	Malleable cast iron.
Bonds.	
Type	British Insulated & Helsby Cables Co.'s solid head and pin types.
Track bonds	Ribbon type, 13½ in. long, 0·166 sq. in. area.
Conductor rail bonds.	Ribbon type, 6⅞ in. long, 0·166 sq. in. area.
Cross bonds	19/0·106 in. stranded, 24 in., 82 in. and 123 in. long, 0·166 sq. in. area.
Cable terminal bonds	169/0·0435 in. stranded, 18 in. long, 0·25 sq. in. area.
Bond tester	Evershed & Vignoles type.
Anchorages.	
"A" type.....	British Insulated & Helsby Cables Co.'s composition insulators with shackles, plates and clamps.
Sectioning gear	B. T.-H. Co.'s 800 volt remote operated type.

Sundry Works.—There are 75 level crossings on the route, and in order to prevent people and animals from straying on the line at

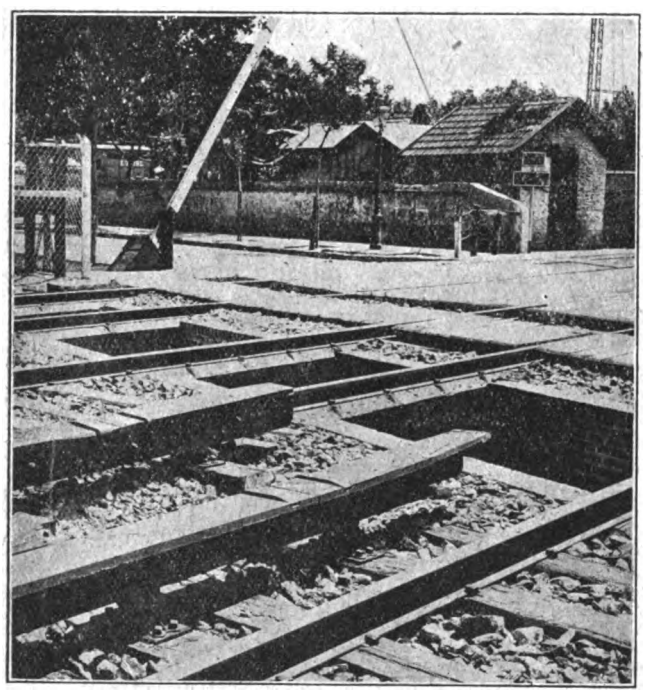

FIG. 18.—VIEW OF LEVEL CROSSING, WITH CATTLE GUARD.

these places special "cattle guards" were installed. A cattle guard (Fig. 18) consists of a trench dug across the tracks parallel to the road with brick retaining walls and concrete invert. The depth varies, the standard being about 7 ft.; the width is 6 ft. 6 in. The track rails are carried across on wooden beams having the upper corners chamfered off to reduce the foothold. The fences are carried up to the trench and a footway with a locked gate is provided for the use of the maintenance gangs.

Other incidental improvements were the provision under every rail of four sleepers of extra length to carry the insulators, and the installation of new track fishplates.

Track Bonding.—The track rails are used throughout for the return circuit of the traction current; they weigh 85 lb. per yard and are part 40 ft. and part 33 ft. long. The joints were bonded with two copper bonds of the ribbon type with solid heads giving a total cross-section of ½ sq. in. of copper and making the ratio of conductivities of 6 ft. of rail including and excluding a bonded joint about 3 to 5. To reduce the risk of loss by theft the bonds are fixed under the fishplates. This involved the provision of new fishplates with sufficient clearance for the bond between the plate and the web of the rail. The bond holes were drilled with ratchet drills without interfering with traffic and the bonds were fixed by hand-operated screw compressors. A few pin-type stranded bonds were used at special work of manganese steel, the bond holes being drilled at the maker's works and painted with spirit varnish to prevent rusting. The two rails of each track are cross-connected every 100 yards with stranded copper bonds carried in wooden troughs fixed to the sleepers. Adjacent tracks are cross-bonded every 100 yards.

In the Retiro terminus the rails are used for track circuiting with alternating current. To permit of using the same rails as a path for the traction current impedance bonds are placed at the ends of the track-circuiting sections, these bonds consisting of heavy choke coils contained in oil-filled cast-iron cases which are placed between the sleepers. Where crossings occur only one rail of each track is used for the traction current.

The routine maintenance of the bonding consists of the removal of the fishplates, and an examination for broken strands. This work is organised to extend over 12 months. In addition resistance measurements of the joints are taken every six months by means of an Evershed and Vignoles bond tester.

The Conductor Rail.—Trespassing on the railway tracks is much more prevalent in the Argentine than in this country, so any form of conductor rail adopted must be particularly well protected from the risk of people touching it. It was felt that the common form of flat-bottomed rail with side boards attached to it was too exposed on the top to be safely used, and it was not possible to provide top cover or adopt the American type of under-running rail on account of the limited space available between the structure and load gauges. The form of rail shown in Fig. 13 was ultimately selected as occupying the minimum space consistent with proper clearance, and as permitting of a very complete insulating covering. The rail was rolled without difficulty in high-conducting steel, and can be handled without any tendency to distortion. To save space in shipping, two rails were nested together, oak distance pieces being put between them, and bolts being passed through the fishbolt holes. Before leaving the works the rails were dipped hot in bitumastic solution to prevent rusting; when the service started up, a special skate with scraping edges was fixed to the collector shoe gear on a coach which was hauled up and down by a steam locomotive till the contact surface of the rail was clean; hand scrapers were also used.

The fishplates are single and applied to the back of the rail, the bolt-heads being countersunk in the head to leave a free passage for the toe of the skate. Two bonds with solid plug heads are fixed under the fishplate, giving a cross-section of 0·33 sq. in. of copper at each joint.

Where gaps occur, the rails finish off with cast-steel ramps 5 ft. long, shaped to guide the skate into position without jarring.

The rails and ramps are covered with a protection of creosoted wood boards built up in the shops, and fixed in position on the ground by hammering over the ends of steel strips to embrace the edges of the top table and foot of the rail. The protection has proved very efficient, no case of fatal injury from shock having occurred up to date, though barefooted boys have been seen to run about over the rail and men have used it as a barrow plank.

The rail is carried on malleable iron castings cemented into porcelain insulators, which stand on the ends of specially long sleepers, and are fixed to them by malleable iron clips. The sleepers are of Argentine hardwoods, which are very difficult to drill and cut. They are not finished very square, and in order to provide a flat soft bearing, and to allow for the running rail sinking into the sleepers, packing pieces are placed below the insulators consisting of creosoted pine boards ½ in. and ¼ in. thick. The insulation of the rail is very good, the usual weekly figure for leakage from the 50 miles erected being between 1·0 and 1·5 amperes.

To prevent creepage, every length of conductor rail is anchored, and no length exceeds ½ mile. The anchors are of three types:—

(*a*) Insulated links attached to a plate either fixed in a block of concrete or fastened down to a sleeper. These are used on long lengths of rail.

(*b*) Clips on the foot of the rail which bear against the cap of a special insulator; these are used on lengths of rail up to 700 yds.

(*c*) Clips on the rail which engage the lug on a standard insulator; these are used for anchoring one or two rail lengths.

Where the rail is cut to leave room for expansion (say ¼ mile from an anchor), a short length of rail is mounted behind the gap and bonded to the main rails with stranded bonds.

Track Cables.—When a conductor rail continuity cable crosses under the track it is carried in a cast-iron trough bolted to an old sleeper. At cattle guards the cables are carried in iron troughs supported by old rails.

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All positive cables finish in terminal pillars, consisting of cast-iron bends into which a fibre sleeve is slipped, the cable being threaded through and the core being sweated into a gunmetal cap resting on a porcelain insulator fitted into the top of the bend. The cap has bolted to it a terminal plate with sockets for stranded bonds, which make connection with the conductor rail. The cap and terminal are surrounded by a potware cover, which prevents a person walking past from coming accidentally in contact with live metal.

Track Sectioning.—The conductor rail is so divided into sections by switches mounted in signal cabins that the signalman can quickly isolate any faulty section, leaving the rest of the system unaffected. The sections are also so arranged that in case of, say, a derailment the platform lines at Retiro are controlled by switches mounted in cast-iron boxes, with a danger signal showing when the switch is closed.

Track Maintenance.—A complete outfit of insulated tools is provided to permit the maintenance gangs to change insulators and pack sleepers without having to make the conductor rail dead. The electrical equipment of the track is maintained by seven gangs of five men each; one of these men is charge hand, and another is an examiner, who goes over his section every day and reports matters requiring attention.

Operation.—In the first 12 months the mileages run were: Motor coach, 1,782,000 miles; trailer coach, 1,353,000 miles.

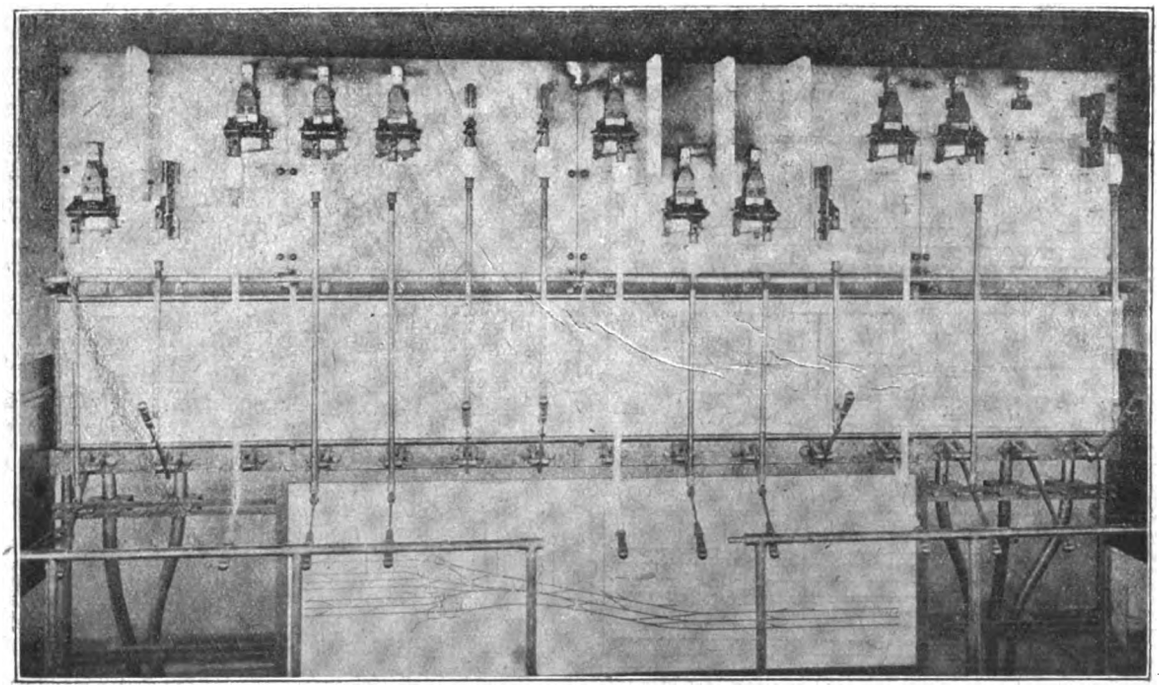

FIG. 19.—SECTIONING BOARD IN SIGNAL CABIN.

at one place, any route which would be available for self-propelled trains is also available for the electric trains. Provision is made for paralleling the "up" and "down" conductor rails in order to make full use of their combined conductivity. A view of a cabin sectioning board is shown in Fig. 19. The sectioning switches are normally of the 1,000-ampere quick-break knife type; inter-connecting switches and those feeding the tracks in Retiro terminus are automatic circuit-breakers. Emergency switches are provided at the cross-overs at wayside stations to allow of trains discharging passengers and setting back to the other line when a fault occurs beyond the platform in a section containing several stations. Sidings and

The total number of times the supply to the conductor rail was interrupted was: Under one minute, 66; over one minute, 42.

The total number of trains run was 41,706 and the total amount by which all trains were late arriving at the termini was 817 minutes. The percentage of trains arriving late was 0·213 per cent., of which 0·129 per cent. were over five minutes late. These figures include delays to trains caused by late running of other trains.

As may be judged from these figures, the initial difficulties and maintenance troubles have been few and of minor importance, and the whole system is giving results commensurate with the care devoted to the design, manufacture and erection of the plant.

California Railroad Commission's Rules on Inductive Interference.

The Railroad Commission of the State of California has recently issued a General Order, No. 52, "In the Matter of the Construction and Operation of Power and Communication Lines for the Prevention or Mitigation of Inductive Interference." This Order became effective August 1, 1918, and supersedes General Order No. 39, which was issued in 1914.

The rules contained in this Order are based on the results of five years' investigation carried on in California by the Joint Committee on Inductive Interference, and on the recommendations made by this Committee in their final report to the Railroad Commission.

The principle of co-operation between all parties involved has been strongly emphasised throughout as the means for determining the best methods for the prevention or mitigation of inductive interference.

A number of rules of a precautionary nature are given, not limited to the lines involved in parallels and apparatus connected thereto, but applying to all new installations.

The most important points covered by the rules are, in brief, as follows:—

I. *General Provisions.*—The essential points considered are the applicability of rules, principle of least cost, co-operation and the relation of existing parallels to these rules.

II. *Location of Lines.*—Distance between lines, notice of intention and avoidance and length of parallels are considered under this head.

III. *Design and Construction of Lines.*—Rules relating to transpositions and to the arrangement and spacing of power conductors are given.

IV. *Design, Construction and Arrangement of Apparatus.*—Rules under this head consider the design, construction and arrangement of transformers, switches, lightning arresters, rectifiers, fuses, special instruments and communication apparatus.

V. *Operation and Maintenance.*—Under this head balance of lines and the operation of transformers and method of switching and charging lightning arresters are the main points considered. Abnormal conditions of the power circuit are also considered.

A number of definitions are given preceding the rules defining certain technical terms employed.

The Railroad Commission has deemed it inadvisable to make the Order retroactive, and on this basis its application is limited generally to new construction, except those rules dealing with maintenance and operation of lines. The principle embodied is that all newly reconstructed plant, as it is installed or rebuilt, shall be made to conform to the Order.

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Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

(*Continued from page* 555.)

Summary.—The author deals with the spiro-cylindrical drum. After considering the influence of drum profile on performance, and noting briefly the great advantage often obtained by the use of spiro-cylindrical drums, an example is fully worked out for balanced operation.

Inertia.—The only parts of the wind to be considered are the first eight turns of the drum and the last eight. During the first five turns the angular speed of the drum is uniformly increased from 0 to 28·6 revs. per min.; the corresponding angular acceleration is, therefore, $2\pi \times 28{\cdot}6 \div (60 \times 21) = 0{\cdot}142$ radian per sec. per sec., and the whole of the masses are affected. During the last five turns of the drum the angular

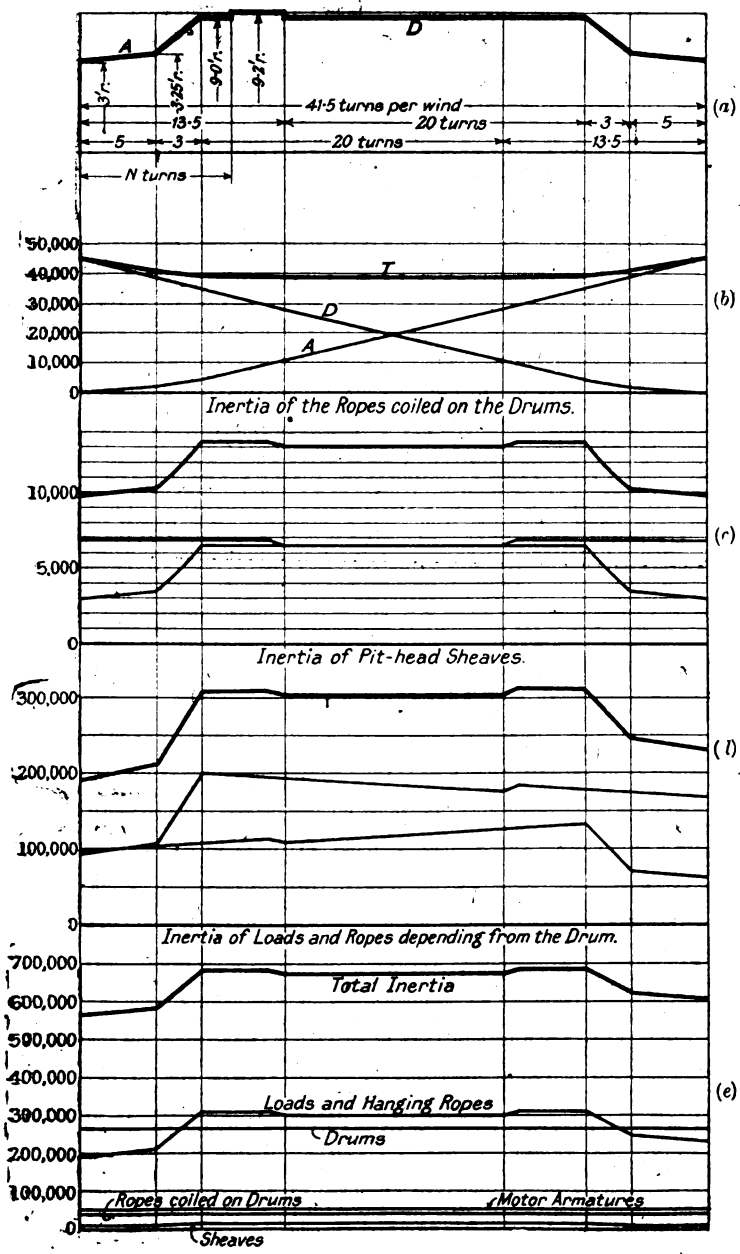

FIG. 60.—INERTIA CHARACTERISTICS AND ITS COMPONENTS.

retardation is 0·142 radian per sec. per sec., the accelerating and retarding periods being of equal duration, and the whole of the masses are, again, affected.

During the sixth, seventh and eighth turns of the drum, the ascending rope mounts the scroll and in so doing its velocity is increased from $\pi \times 13 \times 28{\cdot}6 \div 60 = 19{\cdot}45$ ft. per sec. to $\pi \times 18 \times 28{\cdot}6 \div 60 = 27$ ft. per sec. The time during which this increase of speed of $(27 - 19{\cdot}45) = 7{\cdot}55$ ft. per sec. takes place is $(3 \div 28{\cdot}6)60 = 6{\cdot}3$ sec., and the linear acceleration is, therefore, $7{\cdot}55 \div 6{\cdot}3 = 1{\cdot}2$ ft. per sec. per sec. The masses subjected to this acceleration are the loads, namely, cage, tubs, coal and the length of rope depending from the drum on the ascending side, as well as the sheave over which the rope passes. The loads on the descending side are not affected, since the rope on this side is at a constant radius during the whole of this time.

Towards the end of the wind, actually eight turns before the end or 33·5 turns since the beginning, the descending rope begins to uncoil from the scroll and the speed is decreased from 27 to 19·45 ft. per sec. during the next three turns of the drum in 6·3 sec. The linear retardation is thus 1·2 ft. per sec. per sec. The masses subjected to this retardation are the empty cage and tubs, a certain length of rope and the pit-head sheave over which the rope passes. The loads on the ascending side are not affected, because some turns previously, 5·5 to be precise, the rope on this side commenced to coil on the second layer of the drum at the maximum radius.

The inertia curves, depicted in Fig. 60, have been drawn by the method previously described. Although not absolutely necessary for the purpose of solving this example, it is thought that these curves may enable the reader to follow the argument more readily. In practice, however, it is unlikely that the curves would be drawn.

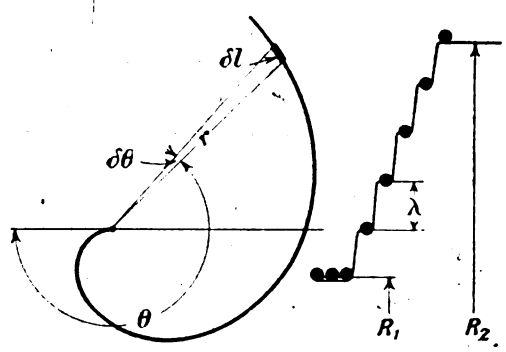

FIG. 61.

Referring to Fig. 60 (*e*) it will be noticed that there is a slight increase of the total inertia during the (angular) accelerating period, and that there is a slight decrease during the retarding period. The values are determined in the following manner:—

Beginning of Wind.

(*a*) *Drums and coupled rotating parts.*

$$\text{Inertia} = 265{,}000 + 53{,}000 = 318{,}000$$

(*b*) *Ropes on Drums.*—With the exception of a few dead turns there is no rope on the drum on the ascending side. The whole of the rope on the descending side is coiled on the drum. In the accompanying table is set out a summary of the calculations. This table is thought to be self-explanatory.

Inertia of Rope Coiled on Drums.

Section.	Weight of rope, W lb.	Drum radius, R ft.	Inertia, $WR^2 \div g$
Cylinder, Second layer	6,510	9·2	17,100
,, First layer...	9,460	9·0	23,700
*Scroll	1,229	8·0	2,380
Starting cone	1,640	6·3	2,020
		Total =	45,200

* The length of rope in a scroll is $l = \pi(R_2^2 - R_1^2) \div \lambda$, where R_1 and R_2 are the initial and final radii in feet, and λ is the pitch in feet measured at right angles to the axis of the scroll, Fig. 61.

The inertia (Wr^2/g) of the rope on the scroll is

$$I = \pi w(R_2^4 - R_1^4) \div 2\lambda g,$$

where w is the weight of the rope in lbs. per foot.

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(c) *Loads and Ropes in Shaft.*—On the ascending side the loads consist of cage, tubs, 12 tons of coal and a 2,250-ft. length of rope weighing 18,830 lb. On the descending side the loads consist of a cage and 12 empty tubs.

Ascending.		*Descending.*	
Cage	27,500 lb.	Cage	27,500 lb.
Tubs	9,600 lb.	Tubs	9,600 lb.
Coal	26,880 lb.		
Rope	18,830 lb.		
	82,810 lb.		37,100 lb.
Radius = 6·0 ft.		Radius = 9·2 ft.	
Inertia = $82,810 \times 6^2 \div 32·2$		Inertia = $37,100 \times 9·2^2 \div 32·2$	
= 92,600		= 97,300	

Total = 92,600 + 97,300 = 189,900.

(d) *Sheaves.*—In the case of the sheave on the ascending side the rope from the sheave coils on to the drum at 6·0 ft. radius, whereas on the descending side the rope coils off the drum at 9·2 ft. radius. The equivalent inertia is, therefore, $6,500 \times 6^2 \div 9^2 = 2,880$ in the one case and $6,500 \times 9·2^2 \div 9^2 = 6,800$ in the other, giving a total of 2,880 + 6,800 = 9,680 for the sheaves.

Hence the total inertia of the masses to be set in motion at the beginning of the wind is :—

$$I = 318,000 + 45,240 + 189,900 + 9,680 = 562,820,$$

and the accelerating moment $= I \times \omega = 562,820 \times 0·142 = 80,000$ lb.ft. This torque is added to the static torque as shown in Fig. 59, point *a*.

Just before the end of Angular Acceleration.

(a) *Drums and coupled Rotating Parts.*—Inertia = 318,000.

(b) *Rope on Drums.*—During the accelerating period the rope on the ascending side has completely filled the starting cone on the drum, and the inertia—obtained from the last line of the table in the corresponding section for the beginning of the wind—is 2,020.

On the descending side five turns, each of 9·2 ft. radius, have been uncoiled. From the table, the inertia of 13·5 such turns is seen to be 17,100, hence on this side the inertia has been reduced by $17,100 \times 5 \div 13·5 = 6,340$, and the inertia is, therefore, equal to 45,240 − 6,340 = 38,900, making a total, for both sides, of 38,900 + 2,020 = 40,920.

(c) *Loads and Ropes in Shaft.*—In the one case the loads consist of a cage, full tubs and a length of rope weighing 17,610 lb. at a radius of 6·5 ft., and in the other of a cage, empty tubs and 2,420 lb. weight of rope at a radius of 9·2 ft. Therefore, on the ascending side the inertia is $81,590 \times 6·5^2 \div 32·2 = 107,000$; and on the descending side the inertia is $39,520 \times 9·2^2 \div 32·2 = 104,000$, making the total 211,000.

(d) *Sheaves.*—On the ascending side the inertia is $6,500 \times 6·5^2 \div 9^2 = 3,400$; on the descending side the inertia is 6,800 as before, and the equivalent inertia of the two sheaves is 3,400 + 6,800 = 10,200.

Just before the drum attains constant angular speed, the total inertia of the masses is, therefore,

$$I = 318,000 + 40,920 + 211,000 + 10,200 = 580,120,$$

and the corresponding accelerating moment is $580,120 \times 0·142 = 82,600$ lb. ft. This is combined with the corresponding static torque giving the point *b* on the total torque diagram, Fig. 59.

Linear Acceleration. — When the drum has made five revolutions, the rope, on the ascending side, begins to mount the scroll and during the next three revolutions is transferred from the starting cone to the first layer of the cylindrical portion of the drum. The linear acceleration, determined in one of the introductory paragraphs, is 1·2 ft. per sec. per sec., and the principal loads concerned, when linear acceleration begins, are :—

Cage	27,500 lb.
Tubs	9,600 lb.
Coal	26,880 lb.
Rope	17,610 lb
	81,590 lb.

The corresponding mass is $81,590 \div 32·2 = 2,530$; and, remembering that force is equal to the product of mass and acceleration, the accelerating moment is $2,530 \times 1·2 \times 6·5 = 19,800$ lb. ft. In comparison the moment required to accelerate the sheave is small and may be neglected.

Just before the ascending rope reaches constant linear speed the mass undergoing acceleration is $80,370 \div 32·2 = 2,500$, and the accelerating moment $= 2,500 \times 1·2 \times 9 = 27,000$ lb. ft.

These two moments, namely, 19,800 and 27,000 lb. ft., are added to the static torque at the corresponding instants, giving the points *c* and *d* respectively on the diagram, Fig. 59.

In like manner the points *e*, *f*, *j* and *k* are determined for the retarding period, *e* and *f* being due to the linear retardation of the loads and rope on the descending side ; and *j* and *k* to the angular retardation of the whole of the moving masses.

But enough of spoon-feeding. The determination of the points referred to can well be left for the interested reader to tackle at his leisure. Other important problems connected with the winder await attention.

(To be continued.)

Welded Ships.*

By WILLIAM SHENSTROM.

The basic improvements in the art of electric arc welding were made in Sweden about 15 years ago. Several organisations in various parts of the United States started to utilise this process mainly in the repairs of ships' boilers and ships' hulls about 10 years ago. The railroads, through their ferry-boats and tugboats having repairs made, next applied electric welding to locomotive boilers and locomotive frames. However, most electric welding done in railroad shops is of the roughest kind.

In the manufacture and repair of high-pressure vessels, such as boilers, chemical digesters, automobile parts, internal combustion engines built of steel, &c., it became desirable to develop highly specialised electric welding machines. The aim was to build machines which furnish constant current and have a voltage limiting device, so that the skill required by the operator is considerably reduced ; the current furnished and the voltage limit can be set by a welding foreman, thus eliminating the chance of the welder holding a long arc and burning his metal. With machines of this type, labour has been put on commercial work of rather delicate character after a few days' practice only.

The tendency, during the last four years, in designing such machines has been towards close regulation and low voltage, around 25 to 35 volts. The potential of the arc for the ordinary run of work should be around 18 to 20 volts to give the best results. The advantage of the low voltage is that a short arc has to be drawn, insuring an even welding temperature and making the welding machine more or less foolproof. The welding of ships has been feasible for many years. It is a question of engineering methods.

The design of the joint for welding is of greater importance than either the machine used or the electrode. Successful welding can be done with any ordinary direct-current source of power supply (provided it is of sufficient capacity), and the ordinary grid or water barrel resistance, using ordinary soft steel wire. The art has reached a state of development where many things, which a few years ago seemed impossible, are perfectly feasible. Such important work as the lining of the Catskill Aqueduct with welded steel rings in order to withstand a working pressure of 315 lb. on a 14 ft. diameter for a length of 900 ft. was, six years ago, the largest electric welding job ever undertaken, and was considered by many people as an impossible experiment. The tunnel has now been in operation for several years, giving perfect satisfaction.

The welding of cylinders on the interned German vessels last summer was considered a radical departure by the general public, but this type of work has been done extensively for the last eight or ten years by the pioneers in this industry.

The building of ships by means of the electric arc welding process has been the dream of the electric welder for many years. However, the present emergency has made it imperative to discard prejudices, and it may not be many months before 10,000 ton hulls will be built complete in 60 days by means of electric arc welding. In fact, there seems to be no reason why the time should not be cut down considerably after the first few ships have been built by this method. A gang of five men drive an average of about 500 rivets per day. This means on the side of a ship approximately 90 ft. An electric welder can join together approximately 30 ft. in the same length of time.

* Abstract of an article in the "Steamship."

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The "Record" Internal Combustion Engine.

The internal combustion engines made by the Record Engineering Company, Ltd., of Eccles, Manchester, have been on the market for some years; but only recently have they come into prominent notice. They are the result of long experience and careful study of the inherent defects of the internal combustion engine.

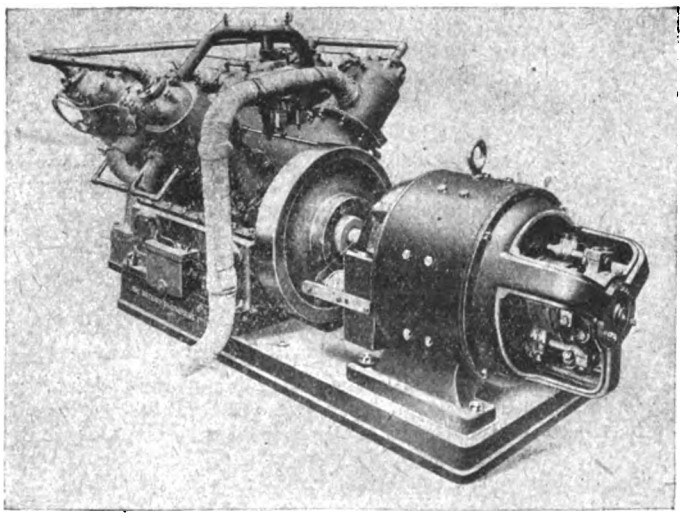

Fig. 1.—"Record" Generating Set, 50 h.p.

The main objects in the design have been reliability and simplicity, and from the particulars given below it may be concluded that these objects have been attained.

The engines are designed on similar lines, and may be very well compared with the well-known high-speed self-lubricating steam engine. All the usual two to one gears, with their cam shafts, cams, tappets and poppet valves—as used in connection with the ordinary four stroke cycle engine—have been eliminated. Consequently, this engine simply consists of the usual pistons with rings, and, generally speaking, one simple piston valve for every two cylinders, this piston valve being driven by means of an eccentric formed with, or fixed directly on to, the crank-shaft. This constitutes the whole of the valve mechanism, and as this valve only controls the distribution of the gaseous fuel to the pump cylinders, it is only subject to a few pounds pressure per square inch, and never to the heat of fire, and consequent carbonisation, &c., of the working cylinders.

It will readily be seen that these engines, being of such simple construction, are capable of maintaining their efficiency over very long periods. They are easy to overhaul and repair, and can be placed in the hands of unskilled labour for supervision. Attendants that have had experience in the running of steam engines will find they closely approach the plant they have been accustomed to. It is, therefore, the type of engine which will appeal particularly to marine engineers.

Two-cycle engines have, in the past, been generally looked upon with considerable disfavour owing to their great inefficiency and other defects; for instance, the crank case has generally been used for handling the fuel mixture resulting in carbon and soot being deposited on the bearings and fuel oil being mixed with the lubricating oil. This in many cases made the engine very liable to give trouble due to hot bearings, leakages, excessive oil consumption and general inefficiency. In the "Record" engine this cause of trouble is entirely removed, the crank case only being used as a reservoir for lubricating oil as in the ordinary 4-cycle engine; in reality it works under more favourable conditions owing to the fact that the lubricating oil is not splashed directly on to the inside of the working pistons.

The Record Engineering Company, Ltd., have now set up a new "record" in endurance and efficiency, as they have recently completed a six days' endurance test of one of their 50 b.h.p. engines running on paraffin.

This engine was an order for a Government Department, and one of the conditions under which the engine was placed was that it would run continuously night and day, at full load, on paraffin, without any attention or adjustment whatsoever. These conditions were accepted, and the trial carried out under the direct supervision of five Government Departments who were interested in the result.

During the whole of the trial, the engine received no attention except the usual filling up of fuel tanks and the addition of lubricating oil. No plugs were changed, and when afterwards dismantled, the engine showed no appreciable wear and the cylinders were practically free from deposit. From this test it may be concluded that a two-stroke engine can be designed and built to give equal results in economy, efficiency and endurance, to a four-stroke engine, with the added advantage of great simplicity and consequent increased reliability.

As is well known, the two-stroke engine fires every revolution; consequently a two-cylinder engine will give equal turning moment to that of the four-cylinder four-stroke. The engine recently tested was of the "V" type, four-cylinder design, with two cranks giving four impulses per revolution, making the turning very even, and owing to the absence of valves and valve gear, the engine runs silently under all conditions of load and absolutely free from vibration.

Fig. 1 illustrates the side elevation of the 50 b.h.p. engine referred to, whilst Fig. 2 illustrates the standard 5 kw. petrol generating set with radiator system of cooling. Generally speaking, the engines are substantially designed as regards the working parts and ample provision is made for wear, while large doors are provided in the crank case to enable adjustments to be made without dismantling. It will also be seen from the illustrations that the cylinder heads

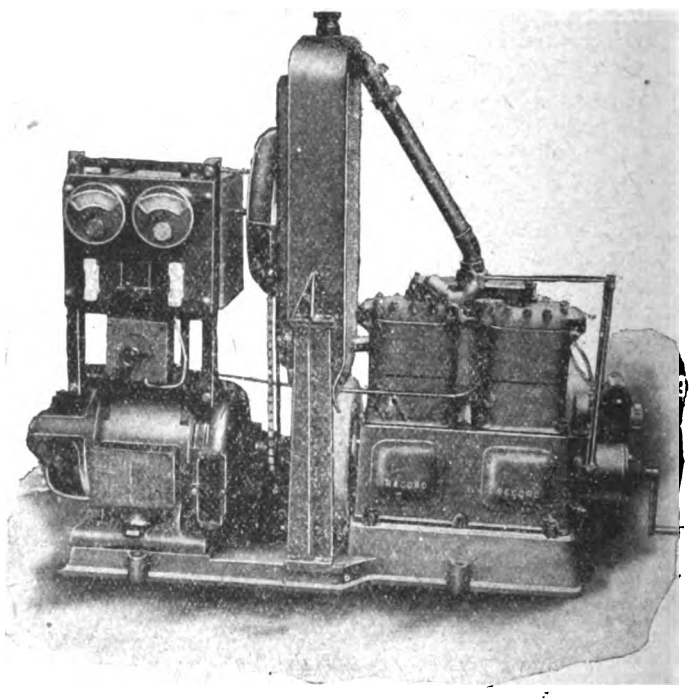

Fig. 2.—5-Kw. Generating Set

are made loose; consequently both piston tops and combustion chambers can be cleaned without dismantling the parts.

The London office of the Record Engineering Company, Ltd., is Donnington House, Norfolk-street, Strand, W.C. 2, and Mr. J. Martin Blair, resident director, will be prepared to supply any prices or information regarding the engines.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"I Fenomini Elettro-Atomici Sotto L'Azione del Magoetismo," by A. Righi. (Bologna: Nicola Zanichelli.) Pp. xvi.+434. Lire 17.50.

"Handbook of Mechanical and Electrical Cost Data," by H. P. Gillette and R. T. Dana. (London: Hill Publishing Company.) Pp. xvii.+1734. 30s. net.

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Dover Corporation Tramways.

At the meeting of the Dover Tramways Committee last week two reports on the present condition of the Corporation tramways were considered

The first report was by a representative of Messrs. Dick, Kerr & Co., and stated that the track generally was in a bad state. The foundation in certain places and for short lengths had evidently gone. In two roads the whole permanent way would have to be reconstructed. In other places it would be necessary only to take out certain lengths of rail, cut off the bad ends and re-lay on the old foundations making up the shortage of rail with second-hand rail or rails from other parts of the track. The points and crossings were most of them loose, and would have to be repacked. Some of them were in such a state that it would be necessary to replace them with others. It was evident that the tramways had been literally starved as regards upkeep. There appeared to have been no regular system of maintenance and no sum set aside for repairs, all work having been done out of revenue. About 3,000 yds. measured as single track would have to be reconstructed. New rails, if procurable, should be laid on anchors fitted with removable clips and wooden packing pieces to facilitate subsequent repairs. There were some 80 tons of rails with fittings in stock, and there was a length of track on the River route beyond the County Ground which could be lifted in order to make good the reconstructed portion. Roughly speaking, they would require at least 500 tons of cement, 240 tons of rails (at 90 lb. per yard), about 10 sets of points and crossings, 11 tons of fish-plates, 2 tons of fish-plate bolts and 3 tons of clips and bolts for anchors. The anchors could be made from the scrapped old rails. They might want 2,000 tons of ballast and 800 tons of sand, but both were local products. They would require 100 men, and the work would take about three months to complete. The overhead equipment was in a very shaky state. The poles were very light, as was the trolley wire, which was 1/0 in section, and very badly worn. The rolling stock was "on its last legs." Out of about 20 cars there were only some 12 on the road, the others having been dismantled piecemeal to keep the rest running. No matter into how good a state the permanent way might be put, the rolling stock was in such a condition that it was doubtful whether the improvement would be noticed, as it would be nullified by the cars themselves. The badly "flatted" tramcar wheels would tend to damage the newly-constructed permanent way. The report gave details of the condition of the variou routes, &c.

The SURVEYOR said that the question of the cost of the work had not been gone into. He did not think the work could be finished in three months. The cost would be double what it was when the track was originally laid, and as it was suggested that half the track should be relaid, it would cost as much as the original contract if they could get the material. The cost of the system was £60,000 with the River route.

The CHAIRMAN said that three points might be considered. First whether they should carry out general repairs; then, whether they should do away with the River system and use the materials on the main system; and the other point was whether they should do away with them altogether and sell the materials for what they could. The cost of the work would run to £36,000 or £40,000.

Councillor LIVINGS did not think that they could possibly consider spending that amount. The town could not stand it. Now was the most favourable time to scrap the system. There was £30,000 outstanding on the tramways. The amount they would receive from the sale of the materials would go a long way towards meeting that amount. They had £30,000 in the sinking fund, invested in Local Loans Stock, but that would now only realise £20,000. If, however, they could get a royalty from a motor omnibus company, and with the sale of the materials, there would be practically nothing to pay off.

Ald. LEWIS said if they were to run motor 'buses from Buckland to the Pier they would have to re-construct the whole of the roads, and it would be a very expensive job.

The report of the tramways manager (Mr. E. H. Bond) was then read, and stated that they had about 8¼ miles of trolley wire and upwards of 700 insulating points, or, excluding the River light railway, 6 miles of trolley wire. So far as could be traced no actual renewals, other than running repairs, had been attempted in the past, and even previous to the war the trolley wire had run its allotted span. The up trolley wire from pier to Buckland, and from Worthington-street to Maxton, was thoroughly worn out and needed to be at once replaced. The down wire was not so badly worn, except in sections, but its useful lifetime had also expired. It had not been possible to run up new wire on any considerable scale under existing conditions as such work could only be carried out when the service was shut down, and the authorities would not allow lights to be used to do the work at night. They could get on Sunday mornings six hours available working time, and under favourable conditions 160 to 200 yards of trolley wire could be erected at one stretch. When night work was again possible for a full night's work from 320 to 400 yards might be erected at a stretch. With the present staff it would take at least 12 months to renew the up trolley wire alone. The wire originally put up was of a very light section, only 0·324 sq. in. For renewal, wire of 00/S.W.G. (0·348 sq. in.) should be adopted. Their tower wagon was 20 years old, top heavy and unsafe, while it afforded no facility for wiremen to work as they should. A telescopic tower wagon (Trenton pattern), with swing table, as used on all other tramways, was a necessity on which men could work safely. Either an electric-propelled or a horse-drawn wagon might be obtained. A carrier for the new wire was also necessary. By means of specially prepared split clamps and wrought-iron straps and bolts, he found it possible to strengthen some poles at their weakest place. In most cases he found the upper portion of the poles in a bad condition due to exposure, salt atmosphere, and to the fact that when painting had last been done the collars were not removed. Upwards of 40 poles had been re-inforced either in the manner stated or by the insertion of an inner liner tube to support the top section of the pole. He was promised 12 poles from Sheerness as soon as they could be removed from the ground, but at least another 20 poles should be procured for present requirements. The main feeder cable from the Town Hall to Worthington-street was very old, and showed signs of weakening. It was important to install an auxiliary cable to supplement it at an early date. The underground pilot and return current cables were also much the worse for wear. The cars would require in the immediate future renovations and renewals of parts on a much larger scale than formerly.

Councillor LIVINGS said that the cars were falling to pieces. On the Folkestone-road the other day several pieces fell off from underneath, and they had to be gathered up and put on the car. In another case whilst a lady was stepping on to a car the step broke off.

Ultimately the surveyor was asked to prepare a report as to the approximate cost of carrying out the works as recommended by Messrs. Dick, Kerr & Co., also to make up an approximate estimate of the making up of the centre of the road so as to satisfy the County Council before they would take it over; and, further, an approximate estimate of what the whole of the tramways stock would be likely to realise.

Tasmanian Hydro-Electric Works.

In opening the fourth session of the Parliament of Tasmania last week the Governor (Sir Francis Newdegate) stated that it was proposed to introduce legislation to establish a board upon matters connected with the Hydro-Electric Department and to define its scope and functions. In view of the difficulty in obtaining machinery, equipment and labour the Government had deemed it advisable, before undertaking new industries, to place the State in a position to carry out new contracts. Priority, therefore, would be given to the fuller development of the works at the Great Lake and to the initial work in connection with the Lake Arthur scheme. Negotiations were proceeding for the early development of the King River scheme in co-operation with the Mount Lyell Co. In common with all other industries that were affected through lack of shipping, the Hydro-Electric Department had suffered to a certain degree, but the general manager (Mr. J. H. Butters) stated that the outlook was considerably brighter than it was a short time ago, as advice had been received from London and New York that machinery for which the department was waiting had been despatched and its early arrival was expected. Great attention was being paid to the development of hydro-electric power on the West Coast of Tasmania, and for some time past the Hydro-Electric Department had been carrying out investigations. The power scheme at present being considered was on the King River, and its possibilities were most promising. The Mount Lyell Co., which had a power scheme at Lake Margaret, was also prepared to take additional power from the State Department when available, whilst the Mount Read-Rosebery Mines, Ltd., were also prepared to take a limited quantity of electric power for the treatment of zinc, lead, sulphate ores and for other purposes. The position, therefore, generally speaking, might be considered most satisfactory.

After referring to the progress of the mining and metallurgical industries the Governor stated that arrangements were in hand for the erection of large boiler-making and engineering works at Burnie for Messrs. J. & E. Hall. A large number of men would be employed when the works were completed. The Premier and the Treasurer (the Hon. Sir N. E. Lewis) had signed the contract with the Mersey Shipbuilding Company for the construction of two 5,500 ton steel vessels at Devonport.

Minimum Charges for Electricity.

An arrangement has been made between the Coal Controller and the principal electric supply undertakings on the question of minimum charges for domestic electric lighting. It has been agreed that the minimum charge shall be extended over the year, and not be a fixed charge for each quarter as formerly. The charge shall not exceed £1 in respect of a year, unless the practice has been to charge a less amount, in which case the less amount shall be the maximum. Adjustments are to be made each quarter.

In cases where the price of electricity to the consumer is based upon the rateable value of the premises supplied, or otherwise, and the charge per unit consumed is almost nominal as an addition to the fixed amount, the consumer shall not be called upon to pay more than if the ordinary or flat rate per unit in operation in the supply area had been charged, subject to the regulations as to a minimum charge.

Though the new arrangement, which will take effect as from Oct. 1, is to be voluntary, it is expected that all supply undertakings will adopt it.

In reply to a question on this subject in the House of Commons on Thursday last, Sir ALBERT STANLEY said the right of electric supply bodies to make a minimum charge was a statutory one and was commonly conferred on electric supply undertakings, whether companies or local authorities, who were under the obligation to maintain a general supply sufficient for the use of all consumers. The object of the provision was to ensure a reasonable return on the expenditure incurred. He was taking steps to suspend the charge as far as possible when application was made for a revision of prices under the Statutory Undertakings (Temporary Increase of Charges) Act of this Session, but to do it generally would require further legislation which he was not prepared to recommend,

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The Electrician.
FRIDAY, NOVEMBER 8th, 1918.
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The Government as Trader.

Last week, in an admirable Address before the Industrial Reconstruction Council, Mr. W. L. HICHENS (Managing Director of Cammell, Laird & Company) dealt with the important subject of the Government in relation to industry. During the last four years the Government of this country has necessarily interfered so very much with industry, and has in a sense become responsible for so much of the industrial effort of the country, that many people are inclined to forget that industry in war differs very materially from industry in peace. Looking at only one aspect of the question, and impressed with a fictitious prosperity, some sections of the community are apt to clamour for the Government to retain their control of industry after peace returns. There is agitation, for example, in favour of the nationalisation of railways, the nationalisation of the coal mines, the control of shipping, and the handling by the State of all the more essential foods. Before we indulge in any such programme it is well to bear in mind the serious objections there are to any Government engaging in industry. These objections were set out by Mr. HICHENS under six main headings.

The first objection is that the Government already has far too much to do without taking on the responsibilities of industrial undertakings. There are such questions as poor law, public health and many others, and the much larger questions affecting the Empire as a whole, that are already neglected. In fact, to many of us the House of Commons appears as an extremely unbusiness-like body, and we have come to regard efficient working as hopeless so long as the vote is the basis of power. In other words, the politician does not take the affairs of the country seriously, and, if this is the case at present, the position certainly will not be improved by adding further responsibilities.

The second objection is that State trading would tend to increase international complications and the tendency to war. As an example, mention may be made of shipping rates. If shipping were a State monopoly, a "rate war" on the Atlantic would be much more serious than when it is carried on by private enterprise.

Another objection is that trading by the State would create an enormous number of Civil Service voters, who would have great political influence. This difficulty could, of course, be overcome; but this is not the case with what must be regarded as the inherent defects of Government departments. As Mr. HICHENS remarked, such departments necessarily differ very largely from private enterprise, and they cannot be run on ordinary business lines. Directors of companies and others who are responsible in private firms take risks and act promptly. Generally speaking, the result is satisfactory, but if mistakes are made, as they inevitably must be made at times, very little is said about them. In the case of a department which is responsible to Parliament and to the public the case is very different. The key note is caution; risks cannot be taken with public money, and if mistakes are made the full light of publicity is thrown upon them. In other words, a business Government is impossible of realisation. On the other hand, we are glad to note that, in the opinion of Mr. HICHENS, there is much unjust criticism of the public services. Be this as it may, and we think it will be agreed that a great deal of excellent public work is carried on, the fact remains that there are essential differences between private enterprise and public service, and it is useless to suppose that if private enterprise is taken over by the Government the elasticity of such enterprises can remain and the handicap of Government control eliminated. Red tape will undoubtedly continue, and to a large extent it is inevitable.

A fifth objection is that, under Government working, competition becomes eliminated, and consequently there is stagnation. Competition is undoubtedly the life-blood of industry. Take, for example, the electrical industry alone. Had there been no competition with gas there is little doubt that we should never have reached the perfection that has been attained. There would not have been the same inducement to produce the more efficient types of lamp; and, similarly, there is no question that the gas industry would not have reached the same position as regards lighting that it has to-day if it had not been for the competition of electric light.

The last point, and we think it is the most important, is that if the Government indulges in private enterprise it loses the great advantage of being in an independent and detached position. It would be impossible, for example, for the Government to deal with Labour disputes in an independent manner if it were at the same time a large employer of labour. We agree with Mr. HICHENS that the primary function of the Government in all such cases should be to decide conditions of industry, and to see that there is justice between one section and another. It is not for Government to forget the minority because it is returned by the majority; there should be even-handed justice. The Government may lay down certain lines according to which Capital shall not be unduly rewarded as compared with Labour, and that there shall be certain conditions of employment; but, on the other hand, it must deal with such subjects as claims to excessive wages, restriction of output and strikes. So long as a Government is not in a detached position it cannot possibly intervene successfully and hold the balance between Capital and Labour.

Review.

Theory and Operation of Direct-Current Machinery. By CYRIL M. JANSKY, B.S., B.A. (London: Hill Publishing Co., Ltd.) Pp. x.+285. 10s. 6d.

This book was prepared in the Extension Division of the University of Wisconsin, and is intended to meet the needs of students of limited mathematical training, probably switchboard attendants and the like. We venture to doubt, however, how it is possible for a student to get a really good grounding in electrical engineering, or, indeed, in any scientific subject, without having a knowledge of at least the rudiments of mathematics. It is greatly to be deplored that books should be written with the avowed intention of bringing electrical science down to the level of minds with no scientific training. It is to be hoped and perhaps, that state of affairs is now being developed, that in the near future it will not be possible for a man to hold a post of any responsibility without being able to show that he has a thorough groundwork in general scientific knowledge. When that condition of things exists, all these books which are intended to give only a smattering of the subject without any proper foundation will automatically disappear, because they will not be sufficient to give the reader the necessary qualifications.

These remarks are suggested by the preface, which tells us the author's intention to omit mathematics as much as pos-

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sible. On reading the text, however, we see that he has found it necessary to use ordinary algebra and trigonometry just as much as the authors of most other elementary books on electrical engineering. The result is that, since there is nothing new in the treatment, this book takes its place, as far as the theoretical part of it is concerned, on the same level as these other works, except that the matter is somewhat more condensed than usual. The second half of the book is devoted to descriptions of apparatus and machines and to their operation, but the treatment is very superficial. The following paragraph, headed "Interpole or Commutating Pole Motor," needs no comment: "To meet the demand for an adjustable-speed motor, there has been developed a type of motor akin to the compound-motor, but having a wider range of speed variation. As has been shown, the field winding of the compound-motor consists of series and shunt windings both placed upon the same field cores. The inter-pole motor, as its name indicates, differs from the compound motor in having the series coils upon cores midway between the regular poles."

Perhaps, if the first 100 pages or so, which deal with the theory of the subject, were to be omitted altogether and the remainder amplified considerably, the book would be very useful to men having the care of direct-current machinery, who had already obtained a good grounding elsewhere.

R. G. J.

New Zealand's Industrial Progress.

In the report of H.M. Trade Commissioner in New Zealand (Mr. R. W. Dalton) for 1917, it is stated that the buying power within the country is being maintained at a high level. If prices of produce remain high, New Zealand after the war should witness a further era of great prosperity, attended by heavy buying and an important campaign of development.

The chief part of the public works programme of the Government will be the utilisation of water power for the generation of electrical energy. The hydro-electric works at Lake Coleridge have been so successful that not only is the Government convinced by their success of the practicability of developing other schemes, but the general public is already pressing the authorities to proceed with the large programme which has been drawn up. This programme provides for a series of schemes designed to supply the whole of the North Island with hydro-electric power from three sources, eventually to be linked together. The chief electrical engineer to the Government suggested the utilisation of waters of the Mangahao River, the Waikato River and Lake Waikaremoana; the first to supply the south-east and south-west, the second the centre and north-west, and the third the north-east of the North Island. It was suggested that the first two should be proceeded with at the earliest possible moment, and that the third should be deferred until railway communication in the Hawkes Bay and Poverty Bay districts had been improved. Considerable pressure is being put on the Government to proceed with all these schemes at once, but it seems certain that the two first will be undertaken as soon as possible. It is believed locally that foreign firms have practically a monopoly of experience in high-tension water power schemes. Foreign firms, too, are well represented and have been able to consolidate their position in the market during the war. Consequently, if British firms are to obtain a reasonable share of the business which will undoubtedly offer, it will be necessary to show considerable activity. So far as the Lake Coleridge scheme is concerned, it may safely be said that the development of the use of energy in the district covered is only limited by the inadequacy of the available supply. The capacity of the Lake Coleridge works is now 8,000 H.P., but an additional 4,000 H.P. unit is on order.

Apart from the schemes definitely proposed, other districts in New Zealand are pressing for works to meet their needs. Amongst these the Southland district, largely through the activities of the Southland League, hopes to proceed with its own scheme to meet urgent needs pending the inauguration of a Government scheme. Powers are being sought for this purpose, and if these are obtained, a steam plant will be installed to serve the greater part of the southern district of the South Island.

The total imports into New Zealand in 1917 were valued at £20,919,265 compared with £26,339,283 in 1916, a decrease of £5,420,018. Of the total decrease in competitive imports of £4,757,849, about £935,000 was in the class covering metal manufactures other than machinery. The share of the United Kingdom in the total trade in competitive imports has gradually declined from 67·1 per cent. in 1914 to 53·3 per cent. in 1917. In the same period the share of the United States, the leading competing country, has increased from 11·2 per cent. to 21·3 per cent., and the share of Japan from 1·0 per cent. to 4·0 per cent. Australia's share has increased from 4·6 per cent. to 9·0 per cent., and Canada's from 2·6 per cent. to 4·7 per cent. British manufacturers may anticipate the immediate recovery of some of the trade which has been lost as soon as they are again in a position to supply. A good deal of this recovery will probably come without any particular effort on the part of manufacturers. What may happen if the war lasts very much longer must be a matter for conjecture; the quality of some of the goods supplied has much improved, and may improve still further, with the result that foreign trade may get a more secure hold than it now has. "It would be unwise for our manufacturers to imagine that the whole of the trade will revert to them as soon as the war is over, or to think that because this Dominion forms part of the British Empire less strenuous attempts than those made in foreign countries will be effective. The sentiment of purchasers is undoubtedly strongly in favour of British trade, other things being equal, and for this reason alone an effort here equal to that made in non-British countries will probably produce a greater result." Since the war New Zealand has been extraordinarily prosperous. The potential position of the Dominion as a trading country is, therefore, much stronger than it has been. Development of important industries during the war has been rapid, and the whole Dominion is looking forward to a vast development when the war is over.

The report states that the main fault in our trading with New Zealand is lack of proper organisation and of careful investigation preceding the establishment of trading relations. The number of direct importers is out of all proportion to the size of the population. The trading interests of the Dominion are undoubtedly complex for so small a market, and, to get the best out of the market, firms at home should examine these interests and understand exactly what they are doing; otherwise they run the risk of irritating important customers and losing business in consequence. To defer negotiations until after the war, when negotiations with good firms are possible now, is a mistake. The market is a long way from home and mails now take anything from six to ten weeks to reach New Zealand. Owing to the long time necessary for correspondence the completion of simple negotiations for agencies in New Zealand often take 12 months, and it is better to take that time now than after the war. There are many good firms here now who are anxious to complete their agencies with one or two new lines, and they realise that they must be ready with these lines when war is over. Lack of a selling organisation characterises some branches of British trade in normal times. Trades in which investigation and organisation by British firms is most necessary include motor cars, electrical machinery, agricultural and dairy machinery.

The Labour Outlook.*

(BY OUR LABOUR CORRESPONDENT.)

There is every indication that hostilities will probably come to an abrupt close within a very short period of time, and it is important that the position in which labour will be placed should be fully realised. No sane person desires the production of war materials to continue a minute longer than is necessary, and, with the enormous output we have achieved, its continuance, once fighting ceases, would put the Ministry of Munitions into a quandary as to where to store the products from the factories.

The cessation of hostilities, therefore, means the cessation of a great part of war production. It is true that many commodities will be needed as urgently in peace as in war time. Ships and coal are cases in point. The services of railway workers and the agricultural labourers will be needed as much whilst an armistice is in progress as they were before it. But hundreds of thousands of munition workers will be placed in a less fortunate situation. All they are entitled to under the Munitions Act is a week's notice or a week's wages in lieu of notice.

Now, what will the position of these workers be? Perhaps the evil day may be postponed for a short time by spreading the available but diminishing volume of employment over the whole body of workers. But this is not practicable as a general rule. Some will be needed to overhaul the factories, undertake repairs and make ready for peace production. The turnover will be a serious problem in a considerable proportion of the factories and workshops, and will take weeks, or even months, according to circumstances. What of the majority of the dilutees and women—and especially the latter?

The munition workers have been gathered together from every corner of the British Isles and from every trade in the country. They have been brought under the operation of the contributory unemployment insurance scheme. The benefits, however, amount only to 7s. per week, which is a miserably small sum in view of the present level of prices. Moreover, it is to be remembered that the national unemployment insurance scheme was inaugurated to meet the unemployment arising in normal circumstances, and not the catastrophic events resulting from war.

But the real difficulty is that no one can forecast what the effect of a stoppage of munitions production will be on employment generally. Unemployment in one form or another, for a longer or shorter period, may occur in trades or branches of trade where it was not expected. Economic prophecy is unreliable. The country must be prepared for sudden, even though temporary, unemployment

* We do not necessarily endorse the views expressed by our Correspondent.—ED. *E*

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outside insured trades. To take an example: If munition workers drift back to their old trades, and succeed in getting jobs, they may do so at the expense of other workers, who will be thrown out of employment without even an allowance of 7s. per week.

The alleged fabulous earnings of munitions workers will not help us. It is true that money wages have risen very considerably in munitions trades; but so have prices. And high prices have swallowed up at least a large proportion of the higher wages. Much of the rest has probably been spent. It may be said that it should have been saved. This statement is, however, irrelevant. The fact of importance is that the workers in general will not have the means to support themselves for a few weeks of enforced idleness. The Government is, therefore, faced with permitting starvation or providing assistance.

Every possible step must, of course, be taken to provide employment. The situation may be relieved by the withdrawal of a proportion of the women workers from wage earning work; but, making every possible calculation, the Government cannot be certain that there will not be a sudden outbreak of unemployment which will continue until industry can be at least partially restored to a peace basis.

The existing unemployment provision is inadequate, and it is not universal in its scope. Prices are high, and will continue so. There is little time in which to prepare an elaborate scheme of unemployment insurance, and no time to get contributions from workpeople to such a scheme. The Government is therefore driven to one of two courses: Either it must say that the unemployed workers must make the best of the situation, and struggle along until employment is available, or it must adopt a non-contributory scheme for the emergency period. The former course is unthinkable unless the Government is to play with fire. A bold and generous scheme of maintenance grants is the only way to carry the country over a very difficult period. Many people will not relish this solution, but a Peterloo in 1918 would be a disastrous beginning to the new era of international peace.

Correspondence.

"TELEGRAPHY, AERONAUTICS AND WAR."

TO THE EDITOR OF THE ELECTRICIAN."

Sir: I do not think there is really any wide difference of opinion between my reviewer (Colonel O'Meara) and myself. Moreover, my views, in their entirety, have received weighty support from Chambers of Commerce, as can be seen from resolutions that have been carried, more or less unanimously, whenever I have delivered addresses on the subject of developed and cheapened inter-Imperial communication. It is not the custom with the Royal Society of Arts to introduce resolutions of this character in connection with Papers; but if the Colonel will refresh his memory of the discussion in which he took so prominent and valuable a part I think he will find that my proposals were, in the main, very favourably received, including that which he actually specifies.

Whilst opposed in principle to State trading, I consider that the nationalisation of our inter-Imperial communicating links is justified, in that it is a matter which directly concerns the nation as a whole—and for highly important reasons. But whilst to my mind *justified* in this instance, that is not to say that the plan is the best one to pursue. As usual, there are, of course, many *cons* as well as *pros*. I have always been fully alive to the objections more or less inseparable from any business run by the State. Thus, it is only in later years that, though all along advocating fuller Government control, I have also, as a means to an end, favoured State absorption of some, or all, of the inter-Imperial communicating links.

In my opinion, greatly developed and cheapened inter-Imperial communication is of the greatest, and now eminently increasing, importance to Britain, as well as to her oversea dominions, strategically, politically, but also for the purpose of enormously developing our inter-Imperial trade. I had long hoped that something adequate might, one way or another, be done in the desired direction independently of State absorption. This hope having to be abandoned, State absorption was the only certain solution as a means to an end—short of really effective Government control. It has to be remembered, of course, that without some revolutionary invention, what is required for the purpose in view is not, on its own basis, a sound commercial proposition from the shareholders' standpoint, though, like our Navy, Army and Air Force, an excellent return to the country as a whole. Existing cable and wireless organisations command our sympathy, both as pioneers and having regard to the excellent work they have done, thanks to administration of the highest order. But the same should be conceded to the "All British" Pacific cable, especially in the light of the war. This link has repayed its cost to the country times out of number, despite all that was said against the scheme by interested parties.

The whole trouble arises from the fact that public interests and private interests can never closely coincide in such a case. If really effective State guidance and control can, in the national interests, still be achieved without State absorption, so much the better. To be satisfactory, organisation of a high order is essential. Let it be admitted that such organisation has hitherto been mainly associated with the realms of business rather than with Government Departments. Now, however, that practically everything is in the reconstructing melting pot, so to speak, surely this position can be altered, if business and scientific training is made the former part of the curriculum for those entering the Civil Service and public life generally. Meanwhile, if those working for dividends were to continue to pursue their avocations in public interests, all would be well. Surely most business people, putting aside vested interests, would say that above all, in this matter, comes the increasing importance of enormously developing our inter-Imperial communications (by whatever means) on the grounds I have above suggested.—I am, &c.,

London, Nov. 5. Charles Bright.

Patent Record.

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

October 3, 1918.

16,054 Tucker & Crabtree. Electric switches.
16,055 Tucker. Electric switches.

October 4, 1918.

16,136 Erskine Murray. Electric vacuous bulb thermonic devices.
16,137 Ionides, Jevons & Young. Detection of conducting bodies submerged in electrolyte.
16,138 B. T.-H. Co. (G. E. Co.) Wireless signalling systems.
16,142 Ness. Electro-planing and cleaning.

October 5, 1918.

16,179 Buck. Electric heat regulating switches. (11/3/18, Switzerland.)
16,217 Williams. Electrical operation of recording &c. instruments.
16,203 McColl. Protective devices for alternating-current electric systems.

October 7, 1918.

16,231 Holder. Electro-magnets.
16,248 Hudson. Mounting for wireless keyboard on aircraft.
16,250 Hacking. Replacing electric fuses.
16,251 Cowper-Coles. Electrical conductors.
16,261 Cracknell. Attaching shades to electric lamp-holders.
16,268 Madagan. Locating device for overhead electric supply wires for tramway-cars or locomotives.
16,269 Tornblom. Electric regulating resistances. (8/10/17, Sweden.)
16,278 Gill (Woods). Electrically heated water services and systems.
16,297 Western Electric Co. High frequency electrical signalling.

October 8, 1918.

16,337 Automatic Telephone Mfg. Co. & Remington. Electric signalling systems for mines, &c.
16,339 Brotherton. Recurrent water power.
16,368 Wood. Vibrating contacts.
16,374 Coolidge. X-ray tubes. (4/12/17, U.S.)
16,388 Vanderveell & Co. Ignition systems.

October 9, 1918.

16,408 Windibank. Apparatus for attachment of electric wires to terminals.
16,409 Dunkley. Name and number index for telephone apparatus.
16,417 Blake. Means for utilising flow-over and head of water from canal lock gates for generating power.
16,420 Anderson. Device for utilising flow of rivers for generating electric current, &c.
16,429 Finch. Ball-pivot bearing for contact breakers
16,444 B. T.-H. Co. (G. E. Co.) Electric welding.
16,458 Bett. Telephone apparatus.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.

Orders for the Week.

Captain for the Week.—Capt. E. G. Fleming.

Next for Duty.—Capt. W. Hynam.

Sunday, Nov. 10.—Commandant's Parade, Waterloo Station, for work at Esher, 9.0 a.m. Drill Order. Greatcoats, Mid-day and Tea rations to be carried. "Demolitions."

Monday, Nov. 11, to Saturday, Nov. 16.—Drills as usual.

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Federation of British Industries.

The annual general meeting was held last week when the retiring president (Sir R. Vesser Smith), in his presidential address, said that the Federation had now commenced the third year of its existence, and continued to grow. A year ago it represented 581 members and 78 trade associations: to day the membership was 951, in which number 164 trade associations were included. He wished to congratulate the Committee which had drawn up their new constitution. If an organisation of that size was to avoid stagnation it was essential to provide it with an elastic constitution, so that each section might make its voice duly heard in the governing body. Such a constitution they now had. A distinctive feature of the past year had been the organisation of the Parliamentary side of their work. He went on to refer to various questions which were to be discussed, pointing out that the most urgent and difficult was the tariff question. They were now within sight of being able to present to the Government a national policy which would meet the requirements and safeguard the interests of every trade. Another vital matter of policy was taxation. Other important subjects they were to consider were labour, education, housing and the organisation of industry through trade organisations. It would add enormously to the strength of the Federation and to British industry generally if their huge membership would definitely adopt the policy of buying each others products in preference to foreign goods. Finally, it would be impossible to direct the process of reconstruction effectively without the co operation of industry.

Sir Vincent Caillard was elected president for the coming year, and the following were appointed vice-presidents: Lord Aberconway, Sir Rowland Barran, M.P., Sir A. Herbert Dixon, Bart., Sir Algernon F. Firth, Bart., Sir Robert A. Hadfield, Bart., Mr. E. Manville, Sir H. R. Rowell, K.B.E., and Mr. W. P. Rylands.

Sir A. FIRTH proposed the first resolution, impressing on the Government and country the necessity of maintaining the principle of private ownership of capital and encouraging the free flow of capital into industry, and of preserving and encouraging that spirit of individual enterprise and initiative which was the vital principle of national life. He said that if the incentive to individual effort was removed and replaced by any system of governmental or communal control the death knell of the prosperity of their industries would be sounded. The interests of the community were best served by the fullest opportunity being afforded for the free play of individual talent.

Mr. F. DUDLEY DOCKER moved a resolution emphasising the supreme importance of British industry and urging upon the Government the necessity of recognising the importance of industrial interests and of consulting the representatives of employers no less than of employed. He said it was for manufacturers to see that the industrial system did not lead to results which were not socially justifiable. In the past they had been careless of that aspect of the case, and they must recognise that many of the results of the old system were not justifiable. The Federation would not commit itself to any political party, but would examine all political questions from the points of view indicated above.

Sir VINCENT CAILLARD moved a resolution on the subject of national economic policy, remarking that they had reached the point when they could look at the subject free from old prejudices and controversies. Before the war, protectionists and free traders seemed to live in worlds of different dimensions, but now they could see that different industries had different interests. Their object was to frame a policy that should safeguard the requirements of all those interests whether by way of protective duties, maintenance of free import, subsidy, transport facilities or otherwise, and thus enable each industry to attain its maximum production. The resolution also included declarations in favour of preferential treatment for the Empire and our Allies.

A resolution was moved by Mr. T. BIGGART urging the Government so to regulate and apportion taxation as to encourage the flow of capital to industry and increased production; the provision of adequate reserves to meet the cost of renewals and extensions and the maintenance by manufacturers of adequate stocks.

Sir ROBERT HADFIELD, Bart., moved a resolution dealing with technical education, and inviting the co-operation of the Government, organised labour and educational authorities, with a view to improving technical and higher commercial education, to promoting the employment by manufacturers of students who had taken advantage of the courses provided, and to securing the introduction into industry of an adequate and regular supply of suitably trained personnel. He spoke of the great field which existed for the improvement of technical education, especially in the matter of science. It was remarkable that in the Civil Service examinations, science was not a compulsory subject. He hoped the Federation would see to it that some change was brought about. He also pointed out the crying need for a building in London to house technical societies and organisations which at present were houseless. He hoped something in the way might be done in connection with the big building for housing the Federation which they all had in mind. It would greatly help on technical education to have a proper technical centre where they could meet together.

Resolutions were also moved affirming the importance of improving education (primary, secondary and adult), and urging the importance of securing in all housing schemes the greatest amenity in regard to lay-out and design, of avoiding as far as possible the segregation of classes, of providing adequate facilities for recreation and education, &c.

A resolution by Mr. FRANK MOORE affirmed that the Federation viewed with grave concern the recurring instances of industrial unrest, recorded its approval of the general principles underlying the first report of the Whitley Committee, and invited the group and sub-group Committees to consider how far those principles could be applied to their industries.

Mr. F. C. FAIRHOLME, who seconded the resolution, remarked that the Whitley Committee had been particularly anxious not to lay down exact procedure for all industries. In some cases the ideas of the report had been carried to what would, before the war, have appeared utopian length

Mr. MAX MUSPRATT moved that, with a view to consolidating the industries of the country and reducing the speculative fluctuation in prices, members were recommended as far as possible to draw their requirements of manufactured products from members of the Federation.

A resolution impressed upon manufacturers the great advantage to be derived from co-operation and the organisation of industry through trade associations.

The last resolution was one approving the general lines of the policy of the Minister of Reconstruction in forming joint committees of employers and workpeople to advise the Government on reconstruction questions, but emphasising the necessity of adapting this policy to suit the conditions of the different trades.

All the above resolutions were carried unanimously.

Sir Vincent Caillard presided over the Federation luncheon, and the guests included Sir Auckland Geddes, M.P., Dr. Addison, M.P., Mr. Hewins, M.P., and Mr. Wardle, M.P.

Legal Intelligence.

London Electric Railway Compensation Award.

Mr. H. F. Lofts, F.S.I., as arbitrator, recently heard a claim against the London Electric Railway Company for £3,209. 16s. as purchase money and compensation in respect of the compulsory acquisition of certain land in the district of The Broadway, Westminster, under Parliamentary powers. The claimants were Mr. Henry C. Wheeler (the freeholder) and his mother, Mrs. Caroline Jessie Wheeler, tenant for life.

Mr. HERBERT JACOBS (for claimants) explained that Mr. Wheeler was carrying on a coal and wheelwright's business on the property, and the claim by him in respect of his trade had been agreed at £500. The only question in issue was the value of the land. The property was freehold, was known as 16, St. Ermin's-hill and 5 and 6, Maundy-place, and the total area was 2,052 sq. ft., of which 320 ft. were subject to certain restrictions. Having detailed these restrictions, evidence was given by Mr. Wheeler, who said he had refused offers of £5,000 and £5,500 for the freehold. Mr. W. H. Mills and Mr. H. M. Rogers, surveyors, also gave evidence in support of the claim.

Mr. LIVERSIDGE (for the railway company) said the value the arbitrator had to assess was the value it was worth to claimants at the time the notice to treat was served—namely, in January, 1916.

Mr. SAMUEL WALKER, surveyor, put the purchase money and compensation payable at £1,604. Property in Westminster had gone up in value only on account of the war, and it would go back when the war was over.

Sir ALEXANDER STENNING, surveyor and architect, put a valuation of £1,692 on the property.

The ARBITRATOR, who reserved his decision, has just awarded the sum of £2,458 on the claim for £3,209. 16s. for the land. With the £500 in respect of the trade claim, the total of the award was £2,958.

Parliamentary Intelligence.

LONDON UNITED TRAMWAYS BILL.

Last week a House of Lords Committee passed this Bill. Mr. Honoratus Lloyd, K.C. (for the promoters), said there was "no money to pay dividends on ordinary or preference shares, no money to pay debenture interest, a receiver in possession, no money to carry out renewals." The total length of the Company's tramways was 50 miles, and they served a large and important area. The Company proposed to jettison £1,500,000 of capital and to reduce its loan and share capital from £4,930,000 to £2,481,000; it was proposed to provide £40,000 for reconstruction, besides providing a reserve for renewals, and the Company was asking for a definite tenure of occupancy (postponing the dates of the earliest acquisition by local authorities to 1950), for the abolition of certain abnormal fares, and for powers to revise fares and to carry out financial reorganisation and reconstruction.

Mr. JAS. DEVONSHIRE, manager and director of the Company, said the future financial stability of the scheme depended on being authorised to charge 1d. per mile for ordinary passengers.

The SECRETARY (Mr. A. R. Lee) said the additional fares would provide a net revenue of about £100,000.

SHEFFIELD CORPORATION (CONSOLIDATION) BILL.

This Bill, which confers (*inter alia*) powers upon the Corporation to carry goods, &c., upon the tramways, came before a Select Committee of the House of Lords last week.

Mr. TALBOT, K.C., for the Midland Railway Company, opposed the clauses giving the Corporation power to carry animals, goods and minerals on the tramways. He said it would be an alarming prospect for railway companies if such powers were to be extended, for the linking up of tramway systems would constitute a very serious competition with railway companies. He asked the Committee to limit the powers to

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the city of Sheffield if they thought there was a public need, and not to permit any linking up with outside systems.

Mr. CLODE, K.C. (for the London & North-Western Railway Company), and Mr. FREEMEN, K.C. (for the Horse and Motor Owners' Association), also opposed the clauses.

The Committee struck out the words "animals, goods and minerals" of Clause 143, and Clause 157, which related to the joining up of outside tramway systems was also deleted.

ELECTRICITY SUPPLY EXTENSION PERMITS.

In the House of Commons on the 30th ult., Major TERRELL asked the Minister of Munitions whether his attention had been called to a circular letter issued by the Incorporated Municipal Electrical Association, in which it was stated that a close connection exists between the principal staff of the Ministry of Munitions and large private electricity undertakings, which had resulted in a want of impartiality on the part of the Government Department concerned in granting permits for power-stations and plant extensions of large electricity undertakings; and whether he proposed to take any and what steps to refute such charges?

In reply, Mr. KELLAWAY said the Minister had received a copy of the circular letter referred to and had asked the Association to supply him with the specific grounds on which the charge of a want of impartiality was based.

Commercial Topics.

The Cinema as an Advertising Medium.

An interesting scheme for the advertising of British goods in foreign countries is to be tried. It is announced that as soon as international affairs permit it is proposed to start a world tour of a series of films, for the purpose of advertising British industries. The films will be exhibited under the auspices of Chambers of Commerce. The Council of the Liverpool Chamber proposes to make and exhibit pictures depicting the municipal, shipping, manufacturing and merchant interests of the city, &c. Last week there was a public representation of some of the more interesting commercial pictures. Among the subjects shown were the making of a big gun at Messrs. Vickers' works, a tour through Messrs. Hadfield's works, and the making of a locomotive at the Swinton Locomotive Works.

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South American Trade.

In order to encourage the export trade to Latin America and to acquaint British manufacturers with the classes of goods in demand in those countries, the Department of Overseas Trade (Development and Intelligence) has collected between 2,000 and 3,000 samples of small manufactured articles, the products mainly of enemy countries, which are selling lines in the South and Central American markets. It is proposed to offer these samples for exhibition to the Chambers of Commerce in a select number of industrial centres. These samples, which have been supplemented by specimens from private firms and other sources, cover a range of manufactured goods which are in constant request in such widely scattered places as La Paz, Caracas, Paramaribo, Callao, Argentina, Nicaragua, Costa Rica, Valparaiso, Guatemala, Monte Video, Bogota, Bolivar, Rio de Janeiro and Sao Paulo. The collection is grouped under a number of heads, and each section contains a representative number of specimens with retail prices attached. The groups include hardware and tools, fancy goods, leather goods, cutlery, glassware and china, scientific instruments, electrical fittings, &c.

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Indian Resources Development.

In the report of the Indian Industries Commission, which has recently been issued in India, the creation of Imperial and Provincial Departments of Industries and of an Imperial Industrial Service is recommended. The Imperial Department would be in charge of a member of the Viceregal Council assisted by a Board of three members entitled the Indian Industries Board, and be responsible for the industrial policy of the Government and the inauguration and carrying out of a uniform programme of industrial development throughout the country. A large staff would be employed whose qualifications would primarily depend on a knowledge of mechanical engineering.

Proposals are made for the better exploitation of the forests and fisheries, the introduction of modern methods of agriculture, and in particular of labour-saving machinery. A special survey should be made of the coal position in India. Universal primary education and education of a technical kind are required. In regard to mechanical engineering, which is taken as typical of organised industries, the proposals include the establishment of a system of organised apprenticeship for four or five years. Proposals are also made for commercial and mining education and the future establishment of two Imperial colleges is adumbrated, one for the highest grade of engineering and the other for metallurgy.

The Commission favours the establishment of an Industrial Bank or Banks, but considers that the appointment of an expert Committee is necessary to deal with this subject.

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Materials for Post-War Industry.

The War Cabinet recently set up a Committee consisting of General Smuts, the President of the Board of Trade, the Ministers of Labour, Shipping, Munitions and Reconstruction, to deal with post-war priority questions. The secretary of the Committee is Col. Byrne, C.M.G., 11, Pall Mall, London, S.W. 1. A Standing Council on post-war priority has now been appointed to assist this Cabinet Committee. This Council has already had under consideration a survey of the existing stocks of the more important raw materials and is considering the question of releasing such materials from control at the earliest possible moment. The Council will consult the trade bodies concerned, so as to make the utmost possible use of their organisations in the allocation of materials. The Council consists of 16 members, the President being the Minister of Reconstruction (Dr. Addison), with Sir Henry Birchenough, K.C.M.G., as chairman. The joint secretaries are Mr. R. T. Gardiner (Ministry of Reconstruction) and Mr. J. G. Hazzeldine (Board of Trade), 2, Queen Anne's Gate-buildings, Westminster, London, S.W. 1. Among the members of the Council are Mr. W. J Larke, of the British Thomson-Houston Company, and Major J. Wormald, of Mather & Platt.

Electricity Supply.

BECCLES PUBLIC LIGHTING COMMITTEE is to consider the question of providing a supply of electricity for public and private lighting.

NEWCASTLE-UNDER-LYME Council has applied to the Board of Trade for power to increase the price of electricity in the borough beyond the present statutory maximum.

At the DARWEN CORPORATION ELECTRICITY WORKS on the 31st ult., a portrait was unveiled to the memory of the late electrical engineer, Mr. Charles Garnett.

WELSHPOOL WATER ELECTRIC LIGHTING SUB-COMMITTEE has asked an electrical engineer to visit Welshpool and report as to the provision of electricity supply in the town.

Agreements have been entered into by WOLVERHAMPTON CORPORATION for the supply of energy to the Electric Chemicals Development Committee and to Messrs. Bayliss, Jones & Bayliss.

In view of the fact that a new turbine which Shoreditch Council has on order is not yet running, Stepney Council has been recommended by the Electricity Supply Committee to extend until March 31, 1919, the agreement for the supply to Shoreditch of electricity in bulk.

At the meeting of Stepney Council on Wednesday the General Purposes, Staff and Education Committee recommended that, in lieu of the Borough Electrical Engineer and Manager's present salary and war bonus of £1,080 per annum, he be paid a salary of £1,100, and that such salary be further increased to £1,200 by two annual increments of £50.

Mr. W. W. Lackie, chief engineer of the GLASGOW ELECTRICITY DEPARTMENT, has reported that extensions of the Whitevale and Springburn sub-stations and new stations at Possilpark and Polmadie are urgently required. A site for a new sub-station for the central district is to be acquired at a cost of £13,500.

The Finance Committee of BRIGHTON CORPORATION recommends that in future the municipal trading undertakings (waterworks, tramways and electric supply) should make a fixed yearly contribution in aid of rates. It is suggested that the waterworks should pay 1 per cent. on the capital employed, the electricity 1½ per cent., and the tramways 3 per cent. In a long report on the subject, the borough accountant points out that the proposed arrangement implies that "selling prices shall be fixed so as to provide all actual outgoings, plus reserve funds."

In an address on "The Utilisation of Water Power," at the Aberdeen Rotary Club last week, the city water engineer, Mr. Cecil H. Roberts, said that water power was a national source of wealth, and it was not unlikely that before long the large water powers of this country would come under more national control. Only some 7 per cent. of available British water power had so far been developed, whereas in many other countries water power had been very considerably utilised. There were no unsurmountable engineering difficulties in dealing with the water power of the rivers' tributaries. With regard to tidal power, when the recommendations for the construction of net works of electric trunk mains materialised the question of utilising tidal power should become an eminently practical one.

On Friday last there was a conference between representatives of the Edinburgh and Leith Electric Light Committees of Edinburgh and Leith Corporations and the Leith Dock Commission for the purpose of considering the memorandum of the Ministry of Munitions with regard to the provision of more electrical power in the district. Under the scheme proposed by the Ministry, it was agreed that Edinburgh Corporation could give a definite guarantee for the supplies required by the Leith Dock Commission. With regard to the power required in Edinburgh and Leith, it was stated it might be found necessary to make an allocation of the available power between the two Corporations, but this was left over for further consideration, and a sub-committee was appointed to continue negotiations.

In connection with the question, Mr. Bruce Lindsay announced at the last meeting of the EDINBURGH ELECTRIC LIGHTING COMMITTEE that supply of current had been urgently raised on a representation from the Leith Dock Commission to Leith Council with regard to the increased power required for shipbuilding yards. The Admiralty having taken the matter up, Mr. Gridley (representing the Ministry of Munitions) reported that the needs of all parties could be met until the Portobello Station was in operation by the installation at Dewar-place station of a 5,000 kw. set and an additional cooling tower. He urged an immediate conference and that the necessary plant should be ordered without an hour's delay. He estimated that the total cost would be £70,000, but the engineer (Mr. Newington) thought the cooling tower could be dispensed with, and his estimate was £55,000. They would enter into immediate negotiations with Leith Town Council (who might share the capital expenditure) and the Dock Commission.

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Last week HALIFAX CORPORATION adopted a report of the Electricity Committee recommending that the borough electrical engineer and the borough-engineer be instructed to prepare plans and specifications for a new electric power station at Copley. The Mayor pointed out that the Council had bought the site at Copley as a sort of insurance scheme. The decision whether a power station should be put down on the site was not entirely in the hands of the Council. The question would be decided partly in the interests of the town, but also in the national interests. Bradford, Leeds, Wakefield, Huddersfield and the Yorkshire Electric Power Company were all preparing plans for the future, because they realised that in any future national inquiry they would have no locus standi unless they had plans and specifications ready.

A meeting of the local members of the ELECTRICAL POWER ENGINEERS ASSOCIATION was held at Bristol on Friday last, under the chairmanship of Mr. A. J. Ostler (sub-station superintendent, Bristol Corporation Electricity Department). The following were elected to act as a temporary committee: Messrs. A. J. Ostler, S. Hotchkiss, T. F. Wells, E. P. Kelly and F. J. Elliott (hon. secretary). This Committee is entrusted with the arrangements for a mass meeting of engineers engaged in the production, transmission, distribution and utilisation of electrical energy, to be held in Bristol sometime during November, when it is proposed to inaugurate a local section of the E.P.E.A. The hon. secretary, whose address is 3, Glena-avenue, Knowle, Bristol, will be pleased to answer any enquiries in connection therewith.

Last week the STOKE-ON-TRENT ELECTRIC SUPPLY COMMITTEE recommended extensions of plant at the central electricity works, at an estimated cost of £102,000. In a report by Sir John Snell it was stated that the proposed extension would only meet the needs of the district for the next two or three years. He did not consider the Corporation were justified in incurring any expenditure other than was absolutely necessary on the present station, the site of which was not suitable for a large power station. The Corporation should make no further extensions at the present power-house. A more suitable site should be found for a generating station, the four local stations should be shut as soon as possible, and the Council should be prepared with a well-considered scheme to supply electricity within a wide radius of the borough.

The Council decided to adopt the recommendation to put in a 3,000kw. generating set at the existing station and to consider the other portions of Sir John Snell's report on a future occasion.

Electric Traction.

Last week the employees of the BRADFORD Corporation tramway presented the retiring general manager (Mr. C. J. Spencer) with an illuminated address, a clock and bronzes.

EDINBURGH Tramways Committee has instructed the Corporation tramway manager (Mr. R. S. Pilcher) to draw up a report on the fares to be charged when the tramway system is taken over by the city.

By the casting vote of the Lord Provost GLASGOW CORPORATION decided last week to allow the tramways department to make an experiment in the carrying of parcels on the route to Uddington. The parcels will be carried on a special car.

It is proposed to construct a light railway from BANFF by Tipperty, Brydock, Blacklaw, Aberchirder, Bridge of Marnoch and Bogniebrae to HUNTLY, or by Bridge of Forgue to ROTHIENORMAN, or to both these places. Meetings of representatives of Banff County and Town Councils and other local authorities have been held and it is probable that a provisional order will be applied for.

The ACCRINGTON ELECTRICITY AND TRAMWAYS COMMITTEE has considered an application from the National Transport Workers' Federation for an increase of the war wage paid to males and females 18 years and over to 35s. per week, and that youths and girls under that age be paid half the total war wage received by employees over 18. They have instructed the Town Clerk to forward to the Municipal Tramways Conference a strong protest against these proposals, and urging the conference to oppose the demand to the utmost.

The following expenditure on the LONDON COUNTY Council tramways has been sanctioned for the 3 months ended Sept. 30: Re-winding of armatures, £5,350; purchase of articles for tramway maintenance and the execution of small works and repairs, £78,796; purchase of track rails, £2,500, repair of cable, £450; and purchase of metals, £2,808.

Arrangements have been completed for the sale to the Sheffield Corporation of 10 tramcars at £550 each. The Highways Committee have approved the settlement at £439 19s. 7d. of the payment to be made by Bexley Urban Council in respect of five class E1 cars loaned to it in 1915 and have authorised the loan to that Council of six class B cars on similar terms to those governing the previous loan.

Imperial and Foreign Notes.

The MITTAGONG (N.S.W.) COUNCIL will borrow £5,000 for an electric supply undertaking.

At Queanbeyan (N.S.W.) the Council proposes to borrow £20,000 for an electric lighting system.

The city electrical engineer of AUCKLAND (N.Z.), Mr. Alex. Wyllie has submitted to the Council a report dealing with the proposed hydro-electric scheme, which is estimated to cost between £1,500,000 and £2,000,000.

The VICTORIAN Minister for Water Supply (Mr. Clarke) recently received a deputation from the North Eastern shires urging that a company whom they represented should be given a 50 years' concession for carrying out the Kiewa power scheme. Mr. Clarke said he was convinced that the Ministry would agree to the proposed arrangement, subject to certain conditions.

A summary of the progress made during the past year in rural telephone construction in Saskatchewan (Canada) shows that during the year ended May 1 last 206 new companies were added, bringing the total number of companies in operation up to 958. During the year 11,724 new subscribers were added, making the total 35,555. The pole mileage was increased by over 11,009 miles, bringing the total to 35,865 for the province. Every farm of any size in many districts is now linked up with the telephone system of the province.

At June, 1917, the capital expenditure of the LAUNCESTON (TASMANIA) electric supply department was £169,297, the reserve and sinking funds being £48,979. Revenue for 1916-17 and 1915-16 respectively was £23,957 and £23,628, and total costs were £11,279 and £10,532. After meeting capital charges the net profit £3,048 and £4,550; units sold were 3,129,988 and 3,027,669, maximum load 1,313 kw. and 1,186 kw.

Capital expenditure on tramways is £95,166. Contributions to sinking and reserve funds amount to £9,351. Revenue was £23,139 and £21,372, working expenses were £17,515 and £16,670, and net result was a profit of £632 for 1916-17 and a deficit of £45 for 1915-16. Passengers carried were 2,733,539 and 2,593,512 and car-miles run 390,038 and 384,123.

The residents of SANTA ELENA (Buenos Ayres, Argentina) have decided to adopt public electric lighting.

A company is being formed at LAPRIDA (Province of Buenos Ayres, Argentina) for establishing electricity supply works.

A concession has been granted to Senor F. Escalera for the erection of an electric power house at Cosquin, Cordoba, Argentina.

At SANTIAGO DE CHILE a company has been formed for the manufacture of incandescent lamps. The initial results are said to be satisfactory.

A company at REYKJAVIK (Iceland) has decided to install hydro-electric works for the utilisation of the Ellida river. The expenditure is estimated at 7,000,000 crowns.

The CHILEAN STEAMER "CORONEL" (ex "Tarapaca," previously employed as a cable steamer) has been sold to Argentine buyers. This vessel is a steel screw steamer of 568 tons net and 1,120 gross register, and was built at Leith in 1893.

The construction of a canal between PARIS and the sea at DIEPPE is projected. The canal, which would be about 102 miles long, would accommodate the largest boats at present traversing the French waterways, which carry 1,400 tons and are 88 metres in length, with a draught of 3 metres when loaded. The barges would be hauled by electric locomotives running on a track alongside of the canal, or on a roadway.

The Government message submitted to the Congress of ARGENTINA in regard to the draft of the Wireless Telegraphy Law states that the proposed Law is the same as that which was submitted to Congress two years ago, although it differs in form. The law is considered necessary to the Executive Power in order to organise the service of radiographic communication. Argentina is one of the countries which must reap most benefit from the employment of radio-telegraphic means of communication, and the necessity of means of communication in connection with the defence of the country, which can only be met by the utilisation of wireless telegraphy.

It is announced that the SWISS FEDERAL AUTHORITIES have assumed control of the supply of electrical energy, and they will also take measures to ensure a rational and economic use of Swiss water-power. The completion of hydro-electric works will be expedited, and the building of new works will be arranged. If necessary, the authorities will instruct existing supply works to pool their supplies, and where there is a shortage of power the authorities will prescribe the necessary economies. The authorities will settle all disputes as to the use of current, and certain undertakings will be exempted from a reduction of their power. If necessary, the authorities may requisition at fixed prices any material, machines or tools necessary for the production or transmission of electric power.

Miscellaneous.

The London offices of the Record Engineering Company have been removed to Donington House, Norfolk-street, Strand, W.C. 2.

The Coal Controller has reduced by another 25 per cent. the lighting allowances in hotels, restaurants and large shops in London and the big provincial towns.

The following import duties are now in force under the JAPANESE CUSTOMS TARIFF as the result of recent re-classification: Electric pianos, 40 per cent. ad val. (No. 557-4 of Tariff); iron electric horns, 20 per cent. ad val. (No. 604), flexible electric cord, 40 per cent. ad val. (No. 635-6).

The following are amongst recent additions to the STATUTORY LIST of firms and persons with whom trading by firms and persons in the United Kingdom is prohibited: *Chile*—Cia de Tranvias Electricos de Valparaiso (Valparaiso); *Mexico*—Cia Electrica y Tranvias, S.A., (Asguascalientes).

At HUDDERSFIELD last week, a fitter named Arthur Ernest Briggs was fined £10 for stealing 16 units of unmetered electricity, of the value of 6s. 8d., the property of the Huddersfield Corporation. It was stated that in June last year Briggs had his electric supply cut off for non-payment of his bill. A constable subsequently observed electric light burning in the house, and it was found that accused had broken the seals, connected the fuses and tampered with the meter. The indicator showed that 16 units had been consumed since the mechanic had disconnected the supply

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The award of the CONCILIATION AND ARBITRATION BOARD FOR GOVERNMENT EMPLOYEES, which was issued last week, gives to London telephonists of 18 years of age and over a temporary increase of 3s. per week, and to London women telegraphists and counter clerks a temporary increase of 1s. in cases where the wages do not exceed 28s. per week. The cases of provincial telephonists and telegraphists are to be settled between the Post Office Clerks' Association and the Department, by agreement, if possible, on the lines laid down by the Board for London. The Board have deferred dealing with the question of a permanent revision of the wages scale until after the war.

For next year's BRITISH INDUSTRIES FAIR the Board of Trade have again been able to secure from the Port of London Authority the great warehouses in Pennington-street, which proved so satisfactory for this year's fair. The Fair, which will open on the last Monday in February (Feb. 24), and will remain open until Friday, March 7, will again be restricted to the same trades which participated in the last three fairs—namely: Glass and pottery, paper, printing and stationery; fancy goods; toys. Eligible manufacturers who have not received application forms should communicate at once with the Director, British Industries Fair, 10, Basinghall-street, E.C. 2.

At the Barking Public Baths Concert Hall on Friday last the Union Cable Company gave a first SMOKING CONCERT to its employees and friends. After an excellent entertainment, given by the "What-Nots" pierrettes and pierrots, Mr. J. Snow Huddleston, general manager of the company, said their factory was doing its best to produce cables for the fighting forces, and it was the duty of all to work hard to turn out as much as possible. After the troublesome preliminaries of permit and priority had been settled, it was intended to proceed with a scheme for setting up a canteen in which the employees could get food during the coming winter, and a works committee was being instituted to provide a channel of communication between the employees and the management.

Tenders Invited and Accepted.

WARRINGTON ELECTRICITY AND TRAMWAYS COMMITTEE invites tenders for Underfeed Mechanical Stokers. Specifications from the Engineers, and tenders to the Chairman by noon Nov. 19.

BEDFORD Corporation require tenders by noon Nov. 13 for the supply and erection of two water-tube boilers, mechanical stokers and induced draught plant. Specifications, &c., from the Electrical Engineer.

The SLIGO, LEITRIM & NORTHERN RAILWAY COMPANY require tenders by 10 a.m. Dec. 1 for 12 months' supply of stores, including electric telegraph materials, metals, rubber goods, leather belting, &c. Forms of tender from the Secretary, Enniskillen.

CROYDON CORPORATION has accepted the tender of W. Boby for water softening plant, at £900.

WESTMINSTER Guardians have placed an order with Pope's Electric Lamp Company for 12 months' supply of electric lamps, fittings, &c.

HAMMERSMITH (LONDON) BOROUGH Council has accepted the tender of Callender's Cable & Construction Company at £942 5s. for the supply of cable.

STEPNEY (LONDON) ELECTRICITY SUPPLY COMMITTEE has accepted the tender of W. T. Henley's Telegraph Works Company for the supply of 220 yds. of cable at £179. 10s.

Appointments Vacant and Filled.

Wigan Corporation requires a rolling stock and works superintendent for its tramways department. Salary £250, rising by annual increments of £25 to £300 per annum. Applications to town clerk (Mr W. H. Tyrer) by Nov. 16.

Applications are invited for the position of professor of physics in the University of Cape Town. Salary £800 per annum. Applications by Jan. 1 to the High Commissioner for the Union of South Africa (32, Victoria street, London, S.W.1), from whom particulars can be obtained.

Mr. J. F. Croft, of Fenton, has been appointed manager and secretary of the Stone Gas & Electricity Company.

Mr. Donald Macdougall, superintendent of GREENOCK CORPORATION ELECTRICITY WORKS, has been promoted to the position of chief assistant engineer, at a salary of £400 per annum.

Bankruptcies and Liquidations.

Edmund Chas. Sparkes, electrical manufacturer's agent, 118, Wardour-street, London, W., has been adjudicated bankrupt.

Vulcanised Fibre, Ltd., is being wound up voluntarily and Mr. C. Cooper, 60 & 62, Spring-gardens, Manchester, has been appointed liquidator.

Claims against the R.E.T. Construction Company, Ltd., are to be sent by Nov. 30 to the liquidator, Mr. Alfred Page, 28, King-street, Cheapside, London, E.C.

A first and final dividend of 3s. 5½d. is payable at the Official Receiver's office, Figtree-lane, Sheffield, in the liquidation of the Rotherham Electrical Engineering Company, Ltd., Tivoli-buildings, Rotherham.

A petition for the winding up of the Beck Engineering Company, Ltd., has been presented by Mr. S. W. Donne, Arterbery-road, Wimbledon, and will be heard in the Royal Courts of Justice, London, W.C., on Nov. 12.

Claims are to be sent to Mr. J. R. Atkins, 14, St. Ann's-square, Manchester, preparatory to payment of final dividend under a deed of assignment executed on June 13, 1918, by Saml. Hill Barton, trading as the Engineering Supplies Company, 11, King-street W., Manchester.

Companies' Meetings and Reports, &c.

An interim dividend of 10 per cent. per annum, tax free, has been declared by SIEMENS BROS. & Company.

At a board meeting of the EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH COMPANY, LTD., on Tuesday, Mr. John Henry Wilson, C.B.E., was elected a director of the company.

During the week CALLENDER'S CABLE & CONSTRUCTION COMPANY, LTD., invited applications for an issue of £200,000 6½ per cent. cumulative preference shares at par and £50,000 ordinary shares at £7 per share. The issues were over subscribed, and the lists were closed on Tuesday.

At the recent annual general meeting of ERINOID, LTD., the chairman (Mr. A. Binnie) said the Company was paying a dividend of 10d. per share (or 16⅔ per cent.) tax free. During the year their sales had increased rapidly, and were almost double the total for the preceding year. The year's profits (£34,000) showed an increase of £14,000. Their only anxiety was the constant rise in the cost of raw materials and working expenses. Theirs was a new and a "key" industry, and therefore they were not dividing the whole of their profits in dividends, as they wished to place their business on a sound basis. They were appealing to the Board of Referees on the question of profits. The working of the Excess Profits Act and the method of computing the pre-war standard of profit worked very unfairly against new industries, as they were denied the opportunity of building up working capital or making reserves to write down stocks and thus be able to meet competition after the war.

The report of DRAKE & GORHAM, LTD., for the year ended June 30 last, states that, after payment of all charges, including bonuses to staff, allowances to those who have joined the National Forces and making provision for contingencies, the net profit is £18,781. 10s. 2d. With £2,295. 11s. 7d. brought forward, the total is £21,077. 1s. 9d. It is proposed to pay a dividend at rate of 7½ per cent. for the year (£9,375), to write down goodwill by £5,000, and to carry forward (subject to excess profits duty) £6,702. 1s. 9d. The turnover constitutes a record in the history of the firm, contracts consisting mainly of work for the Admiralty, War Office, Ministry of Munitions, Air Ministry and other Government departments. The business of the wholesale trade department shows an increase of about 30 per cent. on last year's figures, and covers the supply of electrical goods of all kinds to municipalities, tramway companies and contractors. During the year the warehouse was removed to 67, Long Acre, and manufacturing has for some months been in full operation at the new premises at Newington Causeway.

In the report of DICK, KERR & Co., LTD., it is stated that the profits earned during the 12 months ended June 30, 1918, amount to £87,916, which added to sum brought forward (£36,074) make a total of £123,990. Out of this sum the debenture interest and trustees' fees have been paid, and there has been reserved the sum required to provide for the premium payable on the redemption of the present debenture stock. These items absorb £10,129, leaving £113,860. The dividend of 6 per cent. per annum on the preference share capital (£21,000) has been paid, and it is proposed to pay a dividend of 10 per cent. per annum on the ordinary share capital (£30,000), to supplement special reserve for contingencies by £25,000 and to carry forward the balance of £37,860. Although the amount of excess profit levy under the Munitions of War Act has not been finally settled, the directors believe that the reserves for extra depreciation, special taxation, &c., are sufficient, and they therefore feel justified in recommending the payment of a dividend on the ordinary shares. All the works have been fully occupied during the year, although in the case of the United Electric Car Company a considerable portion of the time has been occupied in extensions and alterations necessary to produce important work of a nature specially suited to that establishment.

New Companies.

BRITISH METAL CORPORATION LTD (151,841).—Reg. with nominal capital of £5,000,000 in 500,000 shares of £10 each. The objects are to buy, sell, manufacture, crush, smelt, calcine, refine, prepare for market and deal in ores, metals, minerals, mineral substances and similar products, to carry on any other metallurgical operations and to act as capitalists, financiers, &c. The signatories are Cecil R. Rudd, C. W. Fielding, Chas. Sale, Vivian H. Smith, A. J. H. Smith, A. W. Tait and W. L. Tennant. Share warrants to bearer are prohibited. No share may, without the consent of the Board of Trade, be held by any enemy or by any member in trust for, or on behalf of, or in any way directly or indirectly at the disposal of or under the control or directions of any enemy or enemy State. The number of Directors is not to be less than three nor more than 10. The Treasury has the permanent right to be represented by one director. The first directors are to be appointed by the subscribers.

BRITISH STEEL CORPORATION, LTD. (151,781).—Private company. Reg. Oct. 26, capital £1,000,000 in £1 shares, to carry on the business of iron smelters, engineers, metallurgists, manufacturers of and dealers in iron and steel, &c. Reg. office: 70, Lombard-street, E.C.

HOWARD, REASON & COMPANY, LTD. (151,759.)—Private company. Reg. Oct. 24, capital £5,000 in £1 shares (500 deferred), to take over business of scientific glass blowers carried on by Howard, Rawson & Company, and to carry on the business of manufacturers of all kinds of glassware. Reg. office: 10, Bush-lane, E.C. 4.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

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CONTENTS.

NOTES	585
Arrangements for the Week	587
Electric Furnaces in Metallurgy. Illustrated	588
Electrical Engineering as Taught in American Colleges. By Alexander Gray, M.Sc., Whit.Sch.	591
Undamped Currents in "Super-Conductors"	593
The Semi-Diesel Engine	594
The Works of the Union Cable Company. Illustrated	594
South Shields Electricity Supply	595
TECHNICAL TEACHING IN THE UNITED STATES	596
Dimensions of Transformers. By A. R. Low	597
Electricity Supply in the Potteries	599
Australian Trade in 1917	600
Patent Record	601
Volunteer Notices	601
Demobilisation Problems	601
LEGAL INTELLIGENCE	601
Commercial Topics	602
Electricity Supply	602
Tenders Invited and Accepted	604
Companies' Meetings and Reports	604

Notes.

Peace!

THE sudden relief, last Monday, with which the nation passed from war to peace, takes more than a day to realise. Until a few weeks ago peace seemed still to be far distant. Well may we give thanks to Almighty God that our freedom remains, that the years of suspense are at an end, and that the sacrifice has not been in vain. Once again we may look calmly at the future and at the problems before us. In 1914 the sudden outbreak of war found us totally unprepared. Now in 1918 peace has come in equally dramatic fashion. Can we say that we are prepared for this event, which we have so ardently desired during the past four years? It must be admitted that we are not, although a certain amount of work has been done which will be of great utility. We must also admit that difficult times are ahead. During the war we have seen the co-operation of all classes and increasingly a spirit of give and take. During the period of reconstruction there will not be the same call for patriotism, and yet there will be a very great need for give and take and for a realisation that the salvation of this country depends upon the co-operation of all classes. There is, we regret to say, a tendency towards Bolshevism in certain quarters, notwithstanding the terrible straits into which this form of idealism (?) has led countries where it has spread. It is essential that as a community we should remain calm and restrained in these early days of peace, as we have in the days of war. Above all, it is essential that Capital and Labour should make a serious attempt to work in cordial co-operation. Labour must realise that it is one thing to work for the State with inflated currency and with the semblance of prosperity which in the long run spells ruin; and it is another to work for private enterprise in competition on a sound basis. It is essential also that the employer should realise the changed conditions which have resulted from the past four years, and that there are many legitimate demands of Labour which must be conceded.

Electric Power Supply.

LEAVING these more general questions, we may turn for a moment to the particular industry of electric power supply. We understand that the Government are now requesting all electricity supply authorities to send in an estimate of their immediate requirements. Under present conditions it need scarcely be supposed that authorisation can be given for all the plant that is desired. Nevertheless, it is highly desirable to form some opinion as to the precise position. It is difficult at the moment to form an opinion as to whether the present demands for power will continue, whether plant that has so far been installed will in some cases be sufficient for a time, or whether it is desirable forthwith to put down further plant. The only means of arriving at something like sound conclusions is to ask each authority to outline their requirements. At the same time this opens up a possible danger. The scheme outlined by the Board of Trade Committee is not favoured by every authority, and such authorities will make their demands irrespective of any scheme that will go forward in the near future. This brings us to an extremely important question. What is going to be done about the national scheme? Is it going to be allowed to remain dormant during an election and for six or nine months thereafter while a Bill is hammered out and is duly opposed by numerous vested interests? We sincerely trust not. If this course is to be followed, the future of electricity supply will be even more difficult than it is at the present time. If useless expenditure is to be saved, action must be taken forthwith. It must be remembered that in many cases extensions cannot be delayed. The output of electricity works has increased enormously during the war, plant has been subjected to serious overrunning, and in many cases this has led to actual breakdown. The need for more plant at the earliest possible moment is urgent. Yet is such plant to be installed irrespective of whether it will be suitable to form part of a comprehensive scheme? It appears to us that the only satisfactory course to follow is to introduce emergency legislation. Such legislation need only deal with, possibly, some of the more important areas, and would place certain restricted powers in the hands of, say, a committee. This committee should be able to decide such points as the locality of large generating stations, whether a new station should be laid down or whether some existing station should be enlarged. Little more than this need be decided at the moment. The important point would be to avoid the extension of inefficient stations and the installation of plant which would not work into the final scheme of electric power.

Conductors Without Resistance.

IN another column we publish some remarkable results obtained by Prof. KAMMERLINGH ONNES at the University of Leyden. It will be remembered that a few years ago Prof. ONNES found that if mercury were cooled to a very low temperature its electrical resistivity became extremely small and that a current once set up would die down very slowly. The more recent experiments are an extension of this work. The conclusion had been reached from theoretical

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reasoning that the specific resistance of mercury, although still measurable at 4·25 deg. abs., would become negligible at 2 deg. Experiments, however, revealed the fact that a critical temperature was reached at 4·19 deg. abs., at which point the resistance fell suddenly to an almost negligible value. Below this temperature it was found possible to pass a current at a density of 1,000 amperes per square millimetre through a conductor 1 metre long without any appreciable difference in potential at the ends. But there is a further interesting fact, that this super-conductivity depends not merely upon temperature, but also upon current density. If this is above a certain critical value the super-conductivity disappears. An interesting development of these properties is the possibility of obtaining exceedingly high magnetic fields, which have hitherto been limited in practice by the heating of the coils. Prof. ONNES, using only 1,000 turns of wire, and an iron-free magnetic circuit, has obtained a field of 100,000 gauss; but here again there is a critical point, for if the strength of field exceeds a certain value the super-conductivity again disappears. Among the interesting figures that have been obtained, we may mention that the resistance of the lead spiral which was used fell to one-twenty billionth of an ohm, compared with 736 ohms at a normal room temperature. The resistance was so small that an appreciable current (initially about 0·6 amp.) would continue to flow for about 4 days. Such experiments must be of the greatest importance in clearing up our ideas on the mechanism of conductivity.

"Telegraphy, Aeronautics and War."—In Mr. Bright's letter on this subject last week, the words "the former," in the ninth line from the end, should read "to form."

Fixation of Nitrogen.—The Japanese Government has decided to establish a laboratory for the study of questions relating to the fixation of atmospheric nitrogen. Hitherto 20 million yens worth of ammonia for fertilisers has been imported, and it is hoped to make Japan independent of foreign supplies.

A Near Thing.—A remarkably close approximation to an exact prophecy of the end of the Great War is found in the motto for the day of the Sun Electrical Company's desk calendar. For Tuesday, Nov. 12, it reads: "Yesterday's successes belong to yesterday with all yesterday's defeats and sorrows. The Day is here, the Time is Now." This leaves H. G. Wells, Old Moore and the minor prophets far behind!

The Industrial Reconstruction Council.—A Conference on "The Trade Union of the Future" will be held under the auspices of the Industrial Reconstruction Council on Tuesday, Nov. 19, at 6 p.m., in the Hall of the Institute of Journalists, 2 & 4, Tudor-street, E.C. 4. The subject will be introduced by Mr. George A. Isaacs, General Secretary of the National Society of Operative Printers and Assistants, after which the discussion will be open. No tickets are necessary.

Asbestos for Boiler Settings.—According to the "Electrical World" asbestos insulation between courses of brick settings in boilers is useful in reducing air leakage and conserving heat. Firebrick will withstand temperatures up to 3,000 F., but conducts heat much more rapidly—apparently about six or ten times as readily—as asbestos felt. The conductivity of red brick is five times as great as that of felt. The chief drawback of asbestos insulation seems to be its tendency to disintegrate at high temperatures. However, provided a temperature does not exceed 1,800° C., the material will hold together sufficiently well.

Daylight Saving and the Sale of Electric Fans.—A somewhat curious effect of daylight saving is reported in the United States. The sale of electric fans in Ohio is said to have broken all records this year, and this is ascribed to a change in the business man's habits. The alteration in clock-time means that he returns earlier to his home by the sun, with an extra hour before the coming of darkness. The transition from a fan-cooled office to a home with no electric breeze has made the need for a fan more conspicuous and led to a marked increase in the sales of fans for household use. Thus in the month of June one New Orleans company sold 297 fans as compared with 189 sold in the same month last year.

Ground Connections for Electrical Systems.—An investigation of methods of grounding to protect persons from dangers associated with electrical circuits has recently been completed by the Bureau of Standards. The results are published in a technological Paper (No. 108). The results of both laboratory and field work are given, the field work including a large number of measurements of the resistance of ground connections found in service in cities located in different parts of the United States between the Atlantic Coast and the Rocky Mountains. The general conclusion is reached that unless water pipes are available to which electrical circuits may be connected, it is difficult by other methods to make them equally safe without going to almost prohibitive expense—except in places where the natural condition of the soil is favourable towards making ground conditions with driven pipes or plates. An appreciable degree of protection with driven pipes may be obtained at moderate cost in nearly all places, but the comparative advantages of using water pipes are so great that wherever they are available connection to them is especially recommended.

Royal Society.—The following Fellows have been recommended by the president and Council of the Royal Society for election into the Council for the ensuing year at the anniversary meeting on Nov. 30: *President*, Sir Joseph Thomson; *Treasurer*, Sir Alfred Kempe; *Secretaries*, Prof. Arthur Schuster and Mr. William Bate Hardy; *Foreign Secretary*, Prof. William Herdman; *Other Members of the Council*, Sir George Beilby, Prof. Vernon Blackman, Mr. Charles V. Boys, Sir James Dobbie, Sir Frank Dyson, Dr. Martin Forster, Prof. Frederick Gamble, Dr. James W. L. Glaisher, Sir Richard Glazebrook, Sir Alfred Hall, Sir William Leishman, Prof. William J. Pope, Dr. W. H. R. Rivers, Prof. Ernest Starling, Mr. James Swinburne and Prof. William W. Watts.

Among the Papers on Physics read at the meeting yesterday were the following:—"The Light Scattered by Gases: Its Polarisation and Intensity," by the Hon. R. J. Strutt, F.R.S., and "An Investigation of the Ionising Power of the Positive Ions from a Glowing Tantalum Filament in Helium," by Dr. F. Horton and Ann C. Davies.

Institution of Electrical Engineers.—At the first meeting of the session, on Thursday, Nov. 7, at which Mr. L. B. Atkinson delivered the Tenth Kelvin Lecture on "The Dynamical Theory of Electric Engines," the president (Mr. C. H. Wordingham) moved, and the members passed, a vote of condolence with the relatives of the late Prof. Bertram Hopkinson (member) and Mr. J. O. Callender and Mr. Edward Russell Clarke (associates), whose deaths had occurred since the close of the last session. Mr. Wordingham said the Council had decided to set up a Committee to consider the question of a memorial to members of the Institution who had fallen in the war. The Committee consisted of the president, the four vice-presidents and a number of members, some from within and some from without the Council, who had suffered bereavement themselves by losing relatives in the war.

It had also been decided to establish a Technical Co-operation Committee, which would have referred to it all matters relating to the relations of the Institution with foreign countries, the object being to secure interchange of experience between British electrical engineers and the engineers of Allied countries, and to endeavour to bring into harmony British and foreign practice when the question of rules arose. Uniformity was particularly desirable in rules for installations on ships.

A complete proof of the Kelvin lecture is not yet available, so that its consideration in our columns must be postponed.

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Obituary.

W. L. PREECE.—We regret to record the death on the 10th inst. of Mr. William Llewellyn Preece, eldest son of the late Sir William Preece. He was born at Southampton in 1866, and after early education at private schools, he went in 1882 to King's College School, where he spent some two years, and then went to Germany for a year. In 1885 he studied at the Hanover-square School of Electrical Engineering, and in 1886 he joined the staff of the telegraph department of the Midland Railway Company, under the late W. E. Langdon. In 1892 he became chief assistant to Mr. Langdon, but in 1898 he resigned and joined Sir William Preece, Major Cardew and his brother (Mr. A. H. Preece) in the firm of Preece & Cardew, consulting engineers. Subsequently (in 1909) Sir John Snell joined the firm, and in 1915 Mr. John H. Rider, the firm becoming Preece, Cardew, Snell & Rider. Mr. W. Llewellyn Preece devoted most of his time as a member of the firm to telegraph, telephone and wireless telegraph matters. This work comprised telegraphs and telephones and wireless telegraphy in all the principal Colonies and Dominions, including those under the Crown Agents and the High Commissioners for South Africa and New Zealand. He was responsible for various wireless telegraph stations, chiefly for the Colonial Office at Aden, Fiji, Ceylon, Solomon Islands and (conjointly with Capt. Brunot, of the French Government) for the New Hebrides. In 1912 he undertook a special investigation for the Federated Malay States Government of the telephone and telegraph system in that Colony. He also visited Trinidad and other Colonies to report on similar questions. He gave evidence for the Post Office before the Parliamentary Committee upon the Marconi contracts. In 1917 he received a commission in the Navy as Lieutenant in the R.N.V.R., and his principal work has been in connection with scientific devices for detecting the presence of submarines. Mr. Preece read a paper in 1915 before the Institution of Electrical Engineers upon "Telephone Troubles in the Tropics." In 1914 he revised Preece and Sivewright's well-known text book on "Telegraphy," and he has recently been engaged on a biography of Sir William Preece. Mr. Preece was elected an Associate Member of the Institution of Civil Engineers in 1897 and a full member in 1907. He became an Associate Member of the Institution of Electrical Engineers in 1887; a full member in 1897, and he was a member of the Council up to his death. He was also a member of many other scientific institutions. Mr. Preece has been for some years in indifferent health, and there is little doubt the strain of his work at the Admiralty and at Queen Anne's Gate proved beyond his strength. His death was due to pneumonia following influenza. He leaves a widow and a family of three sons and four daughters. A memorial service was held at noon yesterday at Christ Church, Victoria-street, and the funeral took place at Carnarvon.

PROF. H. E. J. G. DU BOIS.—The death is announced of Prof. H. E. J. G. Du Bois. Deceased who was born at Velp, Holland, in 1863, was educated at Delft, Glasgow and Strasburg. After studying mechanical engineering at Delft Technical High School and working in the physical laboratory of Prof. Bosscha as well as in an engineering works, Dr. Du Bois went to Glasgow, where he attended Lord Kelvin's lectures. In 1885 he went to Strasburg University and worked in the new Physical Institute under Prof. A. Kundt. In 1887 he graduated with a dissertation on "Magnetic Circular Polarisation in Cobalt and Nickel." He afterwards carried out investigations on Kerr's magneto-optic effect, magnetism of matter and kindred subjects, partly under Dr. F. Kohlrausch. In 1889 he followed his former teacher to Berlin, where he worked on electro-magnetism, radiant heat and optics, and directed the research work of advanced students. He published a series of contributions on the theory and practice of the magnetic circuit, forming the basis of a work on the subject, an English edition of which was brought out by Messrs. Longmans in 1895. He was appointed a "Privatdocent" in Berlin University in 1892, and professor of applied physics in 1896. From 1901 he held the chair of mathematical physics in Utrecht University, whence he returned to Berlin in 1905. In the Physico-Technical Institute, which had been founded in 1894 (now the "Bosscha Laboratory") he carried out research work. In the laboratory electromagnetic and optical work is chiefly being carried out by advanced workers from different countries, due regard being paid to practical applications and design of apparatus, such as multi-lamella r iron-clad galvanometers, magnetic balances, electromagnets for strong fields, and for various surgical and ore separating purposes, &c. Researches were carried out by Prof. Du Bois on magnetic shielding, the resistance of bismuth, nickel and graphite in the field, magnetic properties of matter, the latter forming the subject of a report to the International Physical Congress in 1900. Amongst further subjects were the absolute susceptibility or water, the kinetic theory of magnetism, magneto-chemical and magneto-crystallic work, a variety of magneto-optic phenomena, especially Kerr's phenomena as well as the Zeeman and allied effects, which Dr. Du Bois reported upon to the International Electro-radiologic Congress of 1910. In April, 1912, he delivered the third Kelvin lecture before the Institution of Electrical Engineers. He was a member of the Royal Academy of Amsterdam and the Holland Society of Sciences.

M. W. O'CONNELL.—We regret to announce the death of Mr. M. W. O'Connell, director and secretary of Pope's Electric Lamp Company, Ltd. The deceased, who was in his 48th year, died on Friday morning last from an attack of pneumonia after a short illness. The late Mr. O'Connell had been connected with the electric lamp industry for the last 35 years, having had a wide and varied experience, not only in this country, but in France, Holland and Germany; and there is no doubt that his loss will be severely felt both from a commercial point of view, and by the great number of people with whom he came into contact.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service, are reported :—

Second-Lieut. Geoffrey K. P. Wood (Lancs. Fusiliers), who was born in 1899, and was the eldest son of Mr. A. P. Wood, managing director of the Lancashire Dynamo & Motor Company and the Lancashire Ordnance & Accessories Company is reported killed. He was educated at Bowdon and Malvern Colleges, and passed out of Sandhurst in August last. He met his death on Nov. 1 while leading his platoon "over the top."

Lieut. John Albert Lamb (Yorkshire Regt.), formerly a conductor on the Doncaster tramways, was killed on Oct. 14.

Personal.

Mr. H. B. Renwick, Director of Feeding Stuffs since September, 1917, has resigned in consequence of the urgent demands on his time in connection with problems which are arising in respect of the electric supply of the country.

The King has presented the EDWARD MEDAL to John Garner, a stoker in the employ of the British Thomson-Houston Company, for entering the boiler house which was filled with steam and water in consequence of the explosion of one of a battery of seven boilers, and in which either of the remaining two boilers under steam was likely to explode, and assisting to safety an injured man whom he found lodged on a projecting beam.

MILITARY HONOUR.—Lieut. J. Gray (Royal West Surrey Regt.), son of Mr. James Gray, managing director of the Electric Construction Company, has been awarded the Military Cross. He has repeatedly distinguished himself in action and led his company under intense machine-gun fire.

Arrangements for the Week.

FRIDAY, Nov. 15th (to-day).

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Adjourned discussion on "A Law Governing the Resistance to Penetration of Metals which are Capable of Plastic Deformation, and a New Hardness Scale in Fundamental Units," by Prof. C. A. Edwards and Mr. F. W. Willis; "The Value of the Indentation Method in the Determination of Hardness," by Mr. R. G. C. Batson; and "The Ludwik Hardness Test," by Dr. W. C. Unwin, F.R.S., and also a Paper will be read, if time permits, on "Electric Welding," by Mr. T. T. Heaton.

ELECTRO-HARMONIC SOCIETY.

6.15 p.m. At the Holborn Restaurant, London, W.C. Concert (Ladies' Night).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

6.15 p.m. At the Literary and Philosophical Society, Newcastle-on-Tyne. Address on "Scientific Research in Connection with Marine Engineering and Shipbuilding," by Sir Frank Heath, K.C.B.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. Annual General Meeting. Paper on "Some Notes on Newspaper Printing Presses," by Mr. H. J. Coventry.

TUESDAY, Nov. 19th.

INSTITUTION OF CIVIL ENGINEERS.

5.30 p.m. At Great George-street, London, S.W. Paper to be read on "The Tata Hydro-Electric Power Supply Works, Bombay," by Mr. R. B. Joyner, C.I.E.

WEDNESDAY, Nov. 20th.

ROYAL SOCIETY OF ARTS.

4.30 p.m. At John-street, Adelphi, London, W.C. Inaugural Address on "Science and the Future," by Mr. A. A. Campbell Swinton, F.R.S.

LIVERPOOL ENGINEERING SOCIETY.

8 p.m. At the Royal Institution, Colquitt-street, Liverpool. Paper on "Education in Relation to Industry, and with Particular Reference to Engineering," by Mr. A. E. Berriman, O.B.E.

THURSDAY, Nov. 21st.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "The Use of High Pressure and High Temperature Steam in Large Power Stations," by Mr. J. H. Shaw.

FRIDAY, Nov. 22nd.

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. Paper on "Cohesion," by Dr. H. Chatley. Also the following Papers by Mr. A. Campbell, B.A.: "Note on the Linguistic Nomenclature of Scientific Writers;" "A Method of Comparing Tuning Forks;" "Low-Frequency Microphone Hummers;" and "A Simple Tuning Fork Generator for Sine-Wave Alternating Currents."

INSTITUTION OF ELECTRICAL ENGINEERS. STUDENTS' MEETING.

7 p.m. At King's College, Strand, London, W.C. Paper on "The Permeability of Faintly-Magnetic Materials," by Prof. E. Wilson.

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Electric Furnaces in Metallurgy.

THE HÉROULT FURNACE.

It will generally be admitted that the war has brought the electric furnace into prominence very much more quickly than would have been the case under normal conditions in this country. This is due to a variety of causes. One reason is that these furnaces are particularly suited for the production of special alloys, and such alloys have been in very great demand. Another reason is the large amount of steel scrap that has been available during the war. It has therefore come about that, whereas the electric furnace was used somewhat experimentally before the war, it is now being used commercially in increasingly large numbers. So far as the Héroult furnace is concerned, this is shown in a striking manner by the graphic record in Fig. 1. Since the outbreak of war the number of Héroult furnaces in Great Britain has increased from five to fifty-four, and the transformer capacity from 3,500 to 50,000 k.v.a. The present output is at the rate of about 150,000 tons per annum, and this amount should be almost doubled before the end of the year.

As an example of the extent to which these furnaces are now being used, we may take the works of Messrs. Hadfields (Ltd.), of Sheffield, who have what we believe to be the largest electric steel department in this country. In this department there is a battery

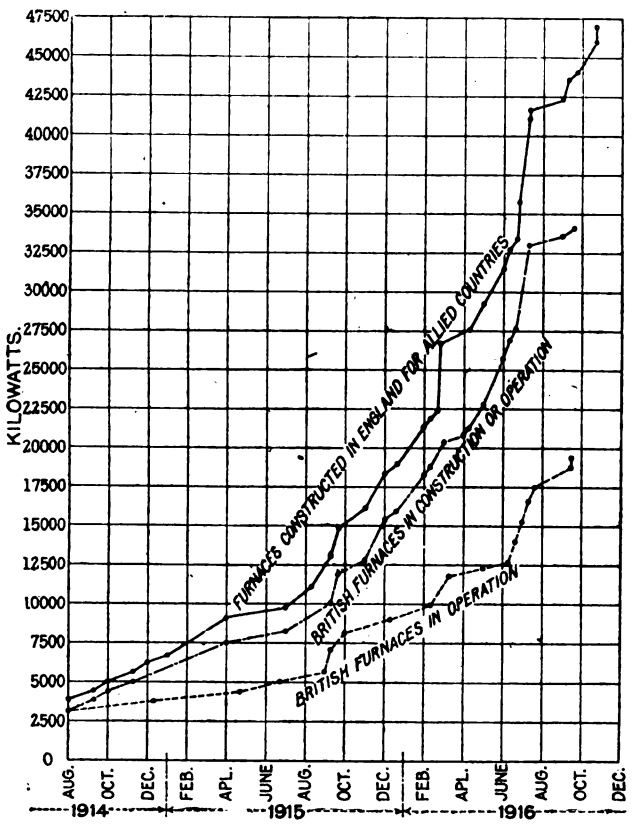

FIG. 1.—PROGRESS IN CONSTRUCTION OF HÉROULT ELECTRIC STEEL FURNACES.

of 11 Héroult furnaces modified specially to suit the work of the company. The steels produced are of the nature of special alloys, known as their Era Resista and many other brands They are of the highest quality, and are particularly suitable for automobile, aeroplane and other similar work. As a remarkable instance of the high quality of their products, it may be stated that Messrs. Hadfields recently produced steel having tenacity which reached the exceedingly high figure of 125 tons per square inch, 14 and 15 lbs. Izod Shock test. This steel produced an elastic limit of no less than 64 tons with Yield Point of 106 tons per square inch. It is found by Messrs. Hadfields that, in times like the present, when special metals and alloys are required and are scarce, electric melting is most valuable. By means of electric energy, material can be used which would otherwise be wasted, thus saving both material and money. In the hands of a skilled staff, all kinds of special steel can be manufactured with great regularity of composition.

TYPES OF HÉROULT FURNACES.

The Héroult furnaces are of the type in which the current jumps from an electrode through the slag to the metal and thence back through the slag again to a second electrode (taking the case of the single-phase furnace), no bottom electrode being used. The size of the furnace depends on the requirements. A number of sizes are available, and of these we give some details below.

10 *cwt. Furnace.*—This size of furnace is specially suitable for making high-speed steel or very light castings. The electrodes are graphite of 5⅛ in. diameter.

The power used with the furnace varies from 200 to 400 k.v.a. With the latter a heat can be made in from 1¼ to 1½ hours.

The furnace is arranged so that the body can be removed and a spare body already lined kept in readiness, so that no delay is necessary for repairs.

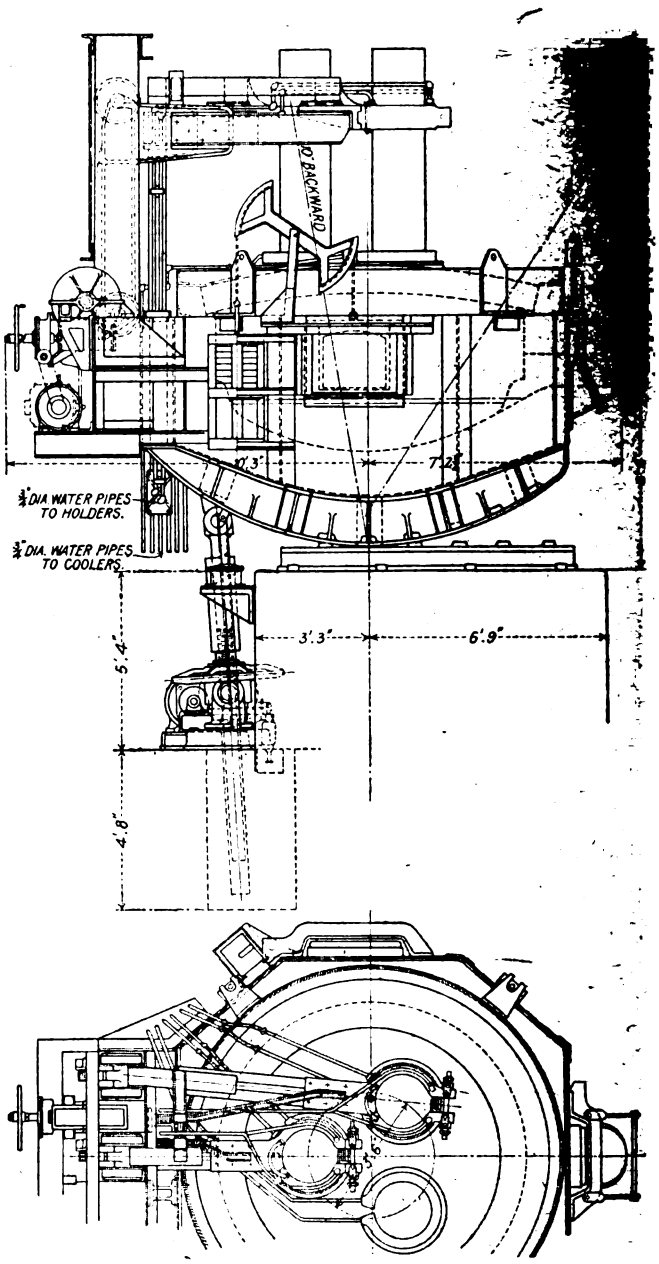

FIG. 2.—GENERAL ARRANGEMENT OF 6-TON ELECTRIC FURNACE.

1½–2 *ton Furnace.*—This size of furnace is suitable for making high-speed and other tool steels, special steels of which comparatively small quantities are required and small castings. It is of the three-phase type, with three electrodes. The electrodes are of graphite, usually of 6 in. diameter.

The power used with this furnace varies from 450–600 k.v.a., and the number of heats per day of 24 hours varies from five to seven, according to the power available, the degree of refining, &c.

3–3½ *ton Furnace.*—This furnace is suitable for making alloy steels and carbon steels, and for foundaries where a fair proportion of the castings are of medium weight, say 1 cwt. or more. High-speed steel is also being made in large quantities in furnaces of this capacity,

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but many firms do not care to make such large heats of tungsten steels.

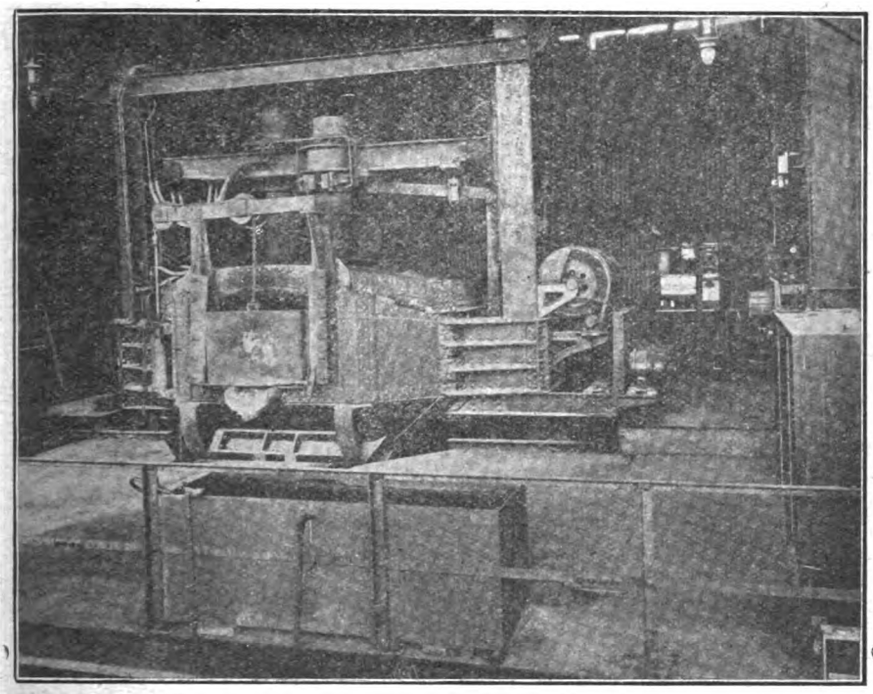
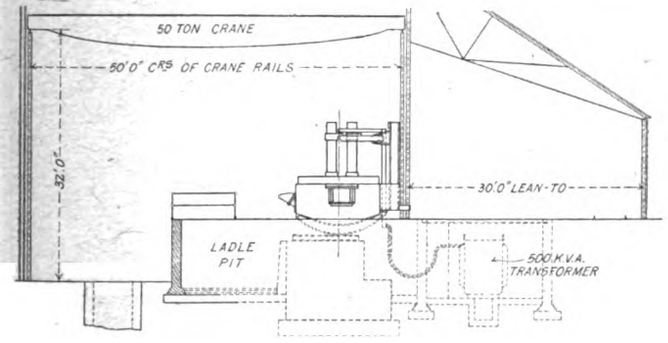


FIG. 3.—A 10-TON HÉROULT FURNACE.



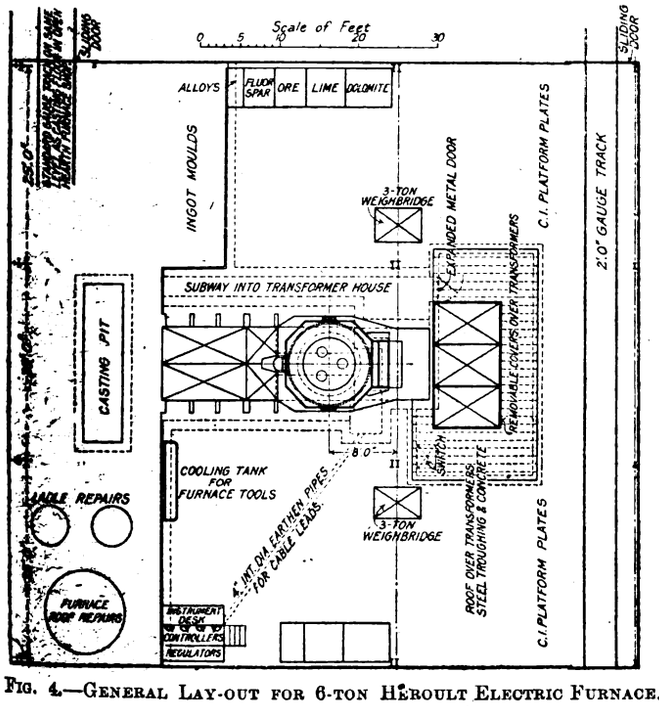


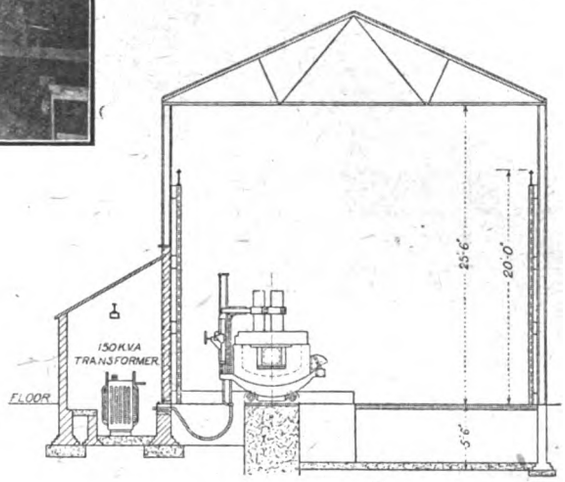
FIG. 4.—GENERAL LAY-OUT FOR 6-TON HÉROULT ELECTRIC FURNACE.

The transformer capacity varies from 600–900 k.v.a., and the output is from four to five heats per day. With transformers of 600 k.v.a capacity, an average of about 80 tons of ingots per week has been maintained over prolonged periods, and with transformers of more power the output would be correspondingly increased.

For this size of furnace many metallurgists prefer the use of amorphous carbon electrodes of 14 in. or 16 in. diameter. If graphite electrodes are used they should be of 7 in. or 8 in. diameter. The use of carbon or graphite electrodes depends largely on the supply available and the relative cost. Graphite electrodes are more expensive per ton, but the consumption is only about half that of carbon electrodes. Generally carbon electrodes are preferred for technical reasons, but on the other hand, graphite electrodes are easier to handle.

6–7 *ton Furnace.*—This size of furnace is th most widely used both in England and in the United States. It is especially suitable where considerable quantities of alloy or carbon steels are required. At one shop in Sheffield eight of these furnaces are now in operation. The transformers vary in capacity from 1,200 kw. to 1,800 kw., and the output from three to five heats per day.

For this size of furnace, carbon electrodes of



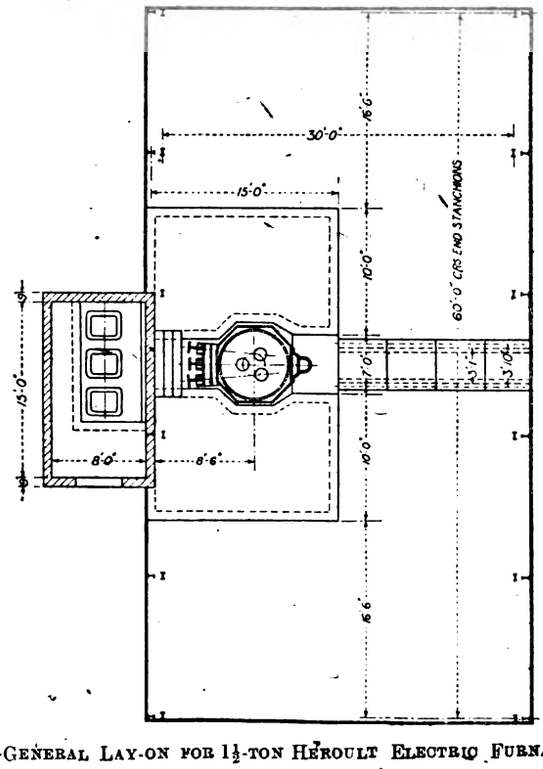


FIG. 5.—GENERAL LAY-ON FOR 1½-TON HÉROULT ELECTRIC FURNACE

18 in. to 20 in. diameter are recommended. If graphite electrodes are used they should be of 9 in. or 10 in. diameter.

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Fig. 2 shows a 6-ton furnace in detail.

10–12-*ton Furnace.*—This furnace is of a different design to the other furnaces described, the charging door being placed at the back of the furnace instead of at the sides.

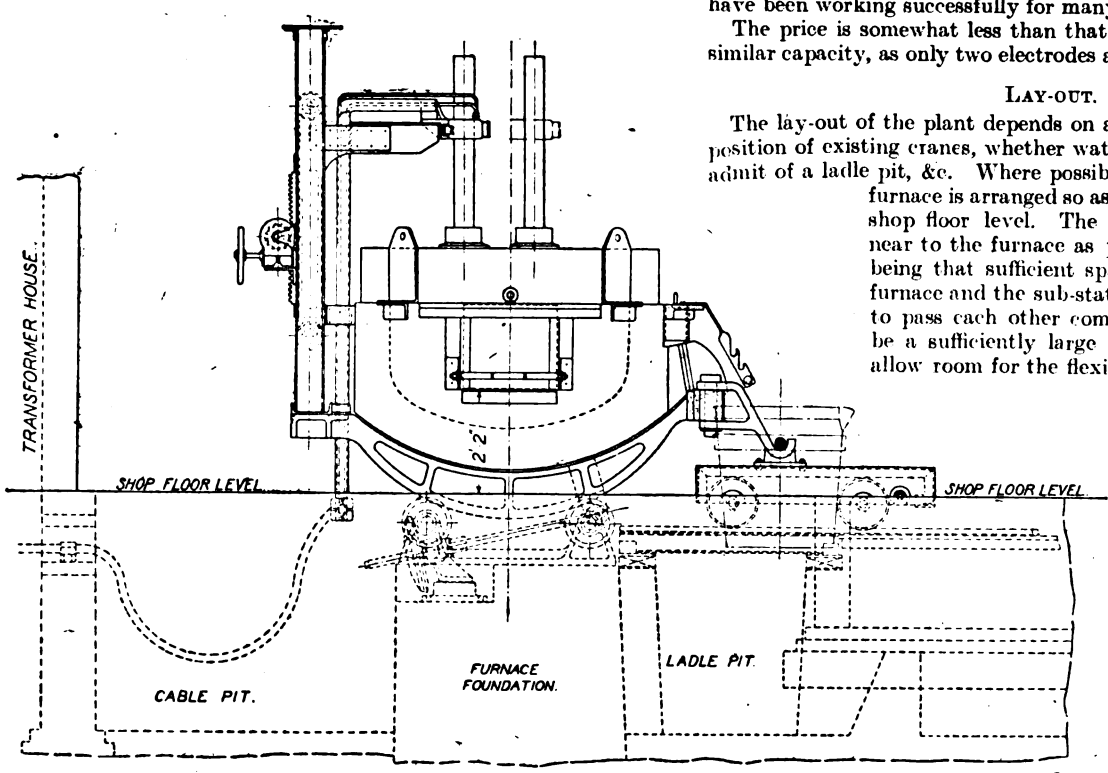

FIG. 6.—ELEVATION OF FURNACE SHOWING SPECIAL ATTACHMENT FOR LADLE.

Furnaces of this type are being used for making alloy and carbon steels, and four of these furnaces are now being erected for a Sheffield firm for refining molten steel from open-hearth furnaces. These furnaces are specially useful where large ingots are required. The power varies from 1,800–2,400 kw. When melting cold scrap about four heats per day can be made, and with hot metal about 10 heats per day can be refined.

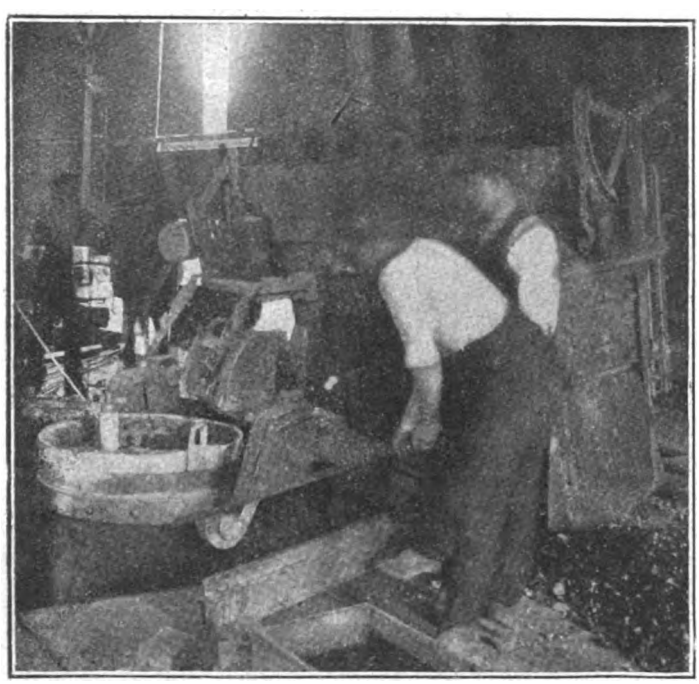

FIG. 7.—VIEW OF LADLE ATTACHMENT.

Furnaces of 15, 25 and 35 tons capacity are also in operation in the United States and on the Continent. Fig. 3 is a view of a 10 ton furnace

Single-phase Furnaces.—All the furnaces above mentioned are suitable for use with three-phase current. The supply available is usually three phase, and static transformers are used to obtain the necessary low voltage If the supply is single phase, the makers recommend a two-electrode single-phase furnace. A number of these are in operation, and furnaces of 1½, 3 and 5 tons capacity have been working successfully for many years.

The price is somewhat less than that of a three-phase furnace of similar capacity, as only two electrodes are required instead of three.

LAY-OUT.

The lay-out of the plant depends on a number of factors, such as position of existing cranes, whether water is too near the surface to admit of a ladle pit, &c. Where possible, the platform level of the furnace is arranged so as to be 6 in. to 1 ft. above the shop floor level. The transformers are placed as near to the furnace as possible, the limiting factor being that sufficient space is required between the furnace and the sub-station wall to allow two men to pass each other comfortably. There must also be a sufficiently large pit behind the furnace to allow room for the flexible conductors. The transformers are usually placed below floor level in order to shorten the length of the low-tension conductors.

The transformers are generally connected in star on the high-tension side, and mesh on the low tension, though in some cases they are also meshed on the high-tension side. Two interlocked switches are used to obtain either of two voltages, the higher for melting and the lower for refining. All the high-tension material is placed on the sub-station side of the wall, the two switch handles alone being on the furnace side. There is, accordingly, no danger of shock to the workmen, as the low-tension voltage is only 90 volts.

Fig. 5 shows approximately the space required for a 1½-ton furnace when making ingots, assuming that a storage space is provided outside the building, and that ingots can be removed promptly. The building shown does not contain sufficient floor space if castings are to be made. The space required would vary with the size of the castings and the plant used. Fig. 4 shows the lay-out for a 6-ton furnace.

The equipment in all large foundries will, of course, include an overhead crane. In small shops, however, this is not always available, and for this reason an arrangement has been adopted for small furnaces by which a ladle can be conveniently brought to the furnace and held in position by an attachment, as shown in Fig. 6. This is shown also in Fig. 7.

(To be concluded.)

Effect of Temperature and Gaseous Atmosphere on Insulating Resistances.—An account of some measurements of the resistance of some metallic oxides, at high temperatures in a vacuum and in a nitrogen atmosphere, was recently contributed by Dr. E. Podszus in the "Verhandlungen der Deutsch. Physik. Gesellschaft" of Oct. 30, 1917. The materials were compressed into small rods, and heated in a small electric furnace utilising a spiral of tungsten tape, suspended in a glass globe, which was evacuated to 1 mm. or 2×10^{-4} mm. of mercury, or filled with nitrogen at atmospheric pressure The spiral was electrically heated up to 2,000° C. The oxides examined included CaO, MgO, Al_2O_3, ThU_2, and boron nitride BN. The resistance invariably decreased as the temperature was raised, in the case of calcium oxide from 1,330,000 ohms at 1,510 deg., to 80,000 ohms at 1,690 deg.; in most cases (alumina excepted) the resistance was smaller (only about half) in the nitrogen atmosphere than in the vacuum. The boron nitride, on the other hand, showed much higher resistances in the nitrogen than in the vacuum. Dissociation of the compounds and thermoionic currents would affect the resistance, and the author concludes that the thermoionic emission as well as ordinary evaporation enters into the problem.

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Electrical Engineering as Taught in American Colleges.

By ALEXANDER GRAY, M.Sc., [Whit.Sch.

Much has been written on the subject of "Engineering Education in America," but it is thought that explicit information on the training of electrical engineers would not be without interest to readers of the London ELECTRICIAN.

The majority of American electrical engineers are university graduates; the draughtsmen, foremen and electricians are trained by the trade schools and the correspondence schools. Evening class work is in its infancy and the standard is low. The college trained engineer, as a rule, attends the grammar school until about 14 years of age, then goes to the high school for four years, to the university for four years, and finally has two years of practical training in the shops or with the central station and construction companies. The young engineer is, therefore, about 24 years of age before his training is complete.

The standard of the grammar school and of the high school is somewhat lower than in the British Isles, so that four years are required for the university work. During the first two years the studies are of a general character, and include mathematics, physics, chemistry, English, shop work, mechanics and drawing. During the last two years the student has to specialise in some one branch of engineering, such as civil, electrical, industrial, mechanical, mining or transportation, and the studies are almost entirely of a technical character.

Entrance Requirements.—Each applicant for admission to the engineering school must show that he possesses a good general education, and he can do this either by passing the university entrance examination or by presenting an acceptable school certificate. The list of subjects required for entrance to the four-year course of a high-grade school such as that at Cornell University is

Mathematics	Four units, including advanced algebra and trigonometry.
English	Three units.
Foreign language	Three units of one language.
History	One unit.
Elective subjects	Four units.

The "unit" is a recognised term used in America to indicate that the student has studied the subject five hours a week for one year; two hours of laboratory practice are considered the equivalent of one hour of class work. The required 15 entrance units can seldom be obtained by less than four years of high school work.

The success of an engineer depends largely on his ability to meet men of education and culture on equal terms, and, since the work of the four-year course is almost wholly technical, it is necessary that the student before entering college should have a thorough general education. Those who have not this thorough preparation are advised to take a five-year course, so as to spend about one year in the college of arts.

It has already been pointed out that certificates of work done in public or private schools may be accepted in lieu of passing entrance examinations if the university authorities are satisfied with the standing of the school. The record of all students who enter by certificate are closely watched, and when it is found that the graduates of a certain high school are not making satisfactory college records, the principal of that school is notified that he must raise the standard, otherwise the entrance privilege will be denied to his pupils. A high school may thus have a passing grade of 75 per cent., but the principal will not certify that the student can meet the entrance requirements of the larger universities unless he obtains a passing grade of perhaps 85 per cent. Those who cannot obtain this high mark are accepted by universities that have somewhat lower entrance requirements.

The Courses.—There is some variety in the type of instruction offered to electrical engineering students at the different universities. In most cases, however, the work of all engineering students is practically the same for the first two years. A typical course is given below. The entrance requirements for such a course include English, foreign languages and a thorough knowledge of mathematics, including advanced algebra, plane and spherical trigonometry, plane and solid geometry. If this entrance requirement is not met, the course must be expanded into a five-year course.

Four-Year Course in Electrical Engineering.

Subjects.	Credit hours.			
	1st year.	2nd year.	3rd year.	4th year.
Mathematics	12	...	...	...
Physics	6	8	...	...
Chemistry	6	5	...	...
Drawing	6	8	...	...
Shop work	3	3	...	...
Surveying	2	...	...	...
General engineering	4	...	...	...
English (engineering reports)	...	2	...	...
Applied mechanics	...	8	...	...
Electrical engineering	...	2	8	22
Materials	...	3	...	...
Machine design	...	...	10	...
Mechanical engineering	...	...	12	4
Hydraulics	...	...	4	...
Business law	...	...	2	...
Industrial organisation	...	...	2	...
Economics	...	...	...	4
Electives	...	...	...	8

The unit of one credit hour adopted by most American colleges may mean—

(*a*) One lecture per week for one term of 16 weeks, with the necessary homework problems and class examinations.

(*b*) One recitation on assigned work. This work generally requires two hours of preparation, and the student may be called on in class to work out problems at the blackboard.

(*c*) One computing or drawing period of three hours.

(*d*) One laboratory period of three hours.

(*e*) Three hours required in preparation of laboratory reports.

Eighteen hours of university work, therefore, means 54 hours of actual work per week, and this is about as much as any students hould be allowed to carry.

There has been a good deal of discussion as to the advisability of teaching shop work in the university, the claim being made that more shop work can be learned in the factory in one week than in a whole university course. This may be the case where shop work is badly taught, but is not so when the object of the instruction is to familiarise the student with modern shop operation and processes, and with the workability of materials used in engineering construction, to give him information on the principles of manufacturing, duplication of parts and in the selection and arrangement of shop equipment. In the foundry, for example, besides receiving instruction in moulding, core making, mixing of metals, &c., consideration is given to the methods and appliances for sweep work and production in large quantities. In the machine shop, instruction is given in the use of semi-automatic and automatic machines, a few standard pieces turned out in large quantities being made for local manufacturers. The administration of the shop is intended to illustrate proper methods of shop management and operation, and to give the student a general idea of time keeping, piece work, premium work and other wage systems.

The work in the shops is all done from working drawings, and the courses in drawing, design and shop work are so organised as to secure the close correlation of these subjects.

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First Term Schedule.

Third Year.—Electrical Engineering.

Week.	Lecture and recitation topic.	Reference.	Computing room topic.	Laboratory topic.
1	Resistance	Art. 21–30	Resistance	Study of laboratory wiring.
2	Wiring and illumination	Art. 381, 390, 392, 399	Wiring of buildings	Fuses and circuit-breakers.
3	Linedrop	Art. 28–31	Wiring of buildings	Measurement of resistance.
4	Work and power	Art. 16–20	Wiring of buildings	Study of meters.
5	Rheostats	Art. 32–38	Rheostat design	Tests of iron.
6	Magnetic circuits	Art. 39–41	Magnetic circuits	Electromagnets.
7	Magnetic circuits	Art. 42–44	Examination	No-load tests on motors.
8	Electromagnets	Art. 46–56	Design of electromagnet	Starters and controllers.
9	Direct-current generators	Art. 12–16, 63–68	Generator problems	No load tests on generators.
10	Direct-current Armature windings	Art. 57, 62, 69	Generator problems	Armature winding.
11	Commutation	Art. 70–74	Generator problems	Generator load tests.
12	Armature reaction	Art. 75–79	Generator problems	Generator load tests
13	Direct-current generator characteristics	Art. 80–85	Generator problems	Motor load tests.
14	Direct-current motor operation	Art. 86–92	Motor problems	Motor load tests.
15	Direct-current motor characteristics	Art. 93–104	Motor problems	Speed control.
16	Efficiency and losses	Art. 105–112	Examination	Stray power tests.

The text for recitation is Gray, "Principles and Practice of Electrical Engineering; and for laboratory is Karapetoff, "Experimental Electrical Engineering."

Methods of Instruction.

Theoretical instruction is given in lecture and in recitation classes. The tendency of the lecture system is to make the student procrastinate and put off studying the subject until just before examination time, when much cramming has to be done. If the course happens to be one in which three or more lectures are given each week, the student becomes swamped, and cannot get the full benefit of the lectures, because he has not mastered what has gone before. Because of this, the large classes are subdivided into groups of about 15 men each and placed under capable instructors. The work of the recitation is assigned in a particular text, and the student is expected to put in at least two hours of preparation, and then in the recitation to present his difficulties, and have them discussed by the instructor. It might seem that this works a hardship on the able student, because he is held back to the speed of the average student; but this is not necessarily the case if the recitation groups are selected so that the able men discuss more difficult problems during the recitation hour. A two-hour course if given to a large class will generally consist of one lecture and one recitation each week. The lecturer will treat the subject broadly, and will leave the details for the recitation hour. The student does not have to take lecture notes, because he is examined on the work of the recitation, and that work follows a good text book.

American students object to the taking of lecture notes, and will generally arrange that when a text book is not closely followed the teacher shall hand over his notes to a student committee, which will have copies made and sold to the members of the class.

A large number of problems are set for home work during the first two years. The number of such problems is reduced for advanced students, and the laboratory and design classes are arranged so as to give a thorough drilling in the application of theory. In the engineering laboratories the men work in groups of three, but each student has to hand in for correction a written report, which must include the theory of the experiment, the experimental results and a discussion of these results. The men are left to their own initiative, and the laboratory instructor is supposed to maintain discipline and be available for reference; but is not supposed to instruct the students or to help them in the carrying out of the experiment.

The complete schedule of work is made out at the beginning of the term under the supervision of the head of the department, and this schedule, the result of experience with previous classes, is adhered to rigidly, so that a teacher cannot allow himself to be side-tracked, nor is there the usual rush at the end of the session to cover the necessary ground. A typical schedule for the first term of the third-year electrical work is given below, as also are samples of the instruction sheets which are handed to the students in the computing room and in the laboratory.

Third Year.—Electrical Engineering.

Problem Work for 11th and 12th Weeks in Computing Room.

Subject: No-load Characteristics of Direct-current Generators.

The following data are given for a direct-current generator:—

Poles	Four.
Output	25 kw.
Volts	120
Speed	900 revs. per min.
Slots	49.
Conductors per slot	Eight (0·06 × 0·32 in.)
Coils	98 (multiple winding).
Turns per coil	Two (mean turn = 50 in.).
Commutator bars	98.
Brush studs	Four.
Brush shift	18 electrical degrees.
Pole enclosure	0·7.
Shunt field winding	1,400 turns per pole of No. 14 B. & S.

1. Plot the no-load saturation curve from the following data:—
   Volts: 6, 20, 40, 60, 80, 100, 110, 120, 125.
   Field current: 0, 0·14, 0·36, 0·59, 0·9, 1·4, 1·85, 2·87, 3·6.

2. If the speed is constant at 900 revs. per min., plot no-load terminal voltage against resistance of the field coil circuit for the following cases:—
   (*a*) Separately excited from a 110-volt line.
   (*b*) Self-excited and shunt connected.
   (*c*) Self-excited and compound connected.

   Which machine is most sensitive to field rheostat adjustment?

3. Specify the graded field rheostat to change the voltage from 120 to 40 volts for the three connections. The resistance of the shunt field winding is 35 ohms.

4. With the field circuit rheostat short-circuited, find the terminal voltage at speeds of 225, 450, 900 and 1,250 revs. per min. if the machine is
   (*a*) Separately excited from 110 volt mains.
   (*b*) Shunt-excited.

Which machine is most sensitive to change of speed, and explain why it is so without mathematics and without reference to the figures found above.

Subject: Load Characteristics of Direct-current Generators.

1. Draw the external characteristic from no load to 50 per cent. overload for the above machine when separately excited. The no-load E.M.F. to be 120.

2. Find the number of series turns required for flat compounding, and find the size of wire for the series coils, allowing 1,000 amperes per square inch. Why can the current density in the series coils be greater than in the shunt coils, in which it is 888 amperes per square inch?

3. Draw the external characteristic of the above machine as a shunt generator, the no-load E.M.F. being adjusted to 120 volts.

Laboratory Work for 11th and 12th Weeks.

Subject: Direct-current Generator Characteristics (non-Interpole Machine).

Object: To determine how the terminal voltage of a constant-speed generator varies with load.

(*a*) The machine separately excited.
(*b*) The machine shunt excited.
(*c*) The machine compound excited.

Reference: See Karapetoff, "Experimental Electrical Engineering"; Gray; "Principles and Practice of Electrical Engineering," pages 71–77.

Note.—The terminal voltage should be adjusted to the same value on no-load for each test. Do not forget to measure the cold and hot resistances of the armature circuit.

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Report: The report should contain, in addition to the original data sheet,

(*a*) Object of experiment and list of apparatus used,
(*b*) Short outline of theory,
(*c*) Answers to specific questions given below,
(*d*) Diagrams of connections, using standard conventions,
(*e*) Observed and computed data, with sample computations,
(*f*) Curves prepared in accordance with practice,
(*g*) Discussion,
(*h*) Original data sheets.

Note that the theory must not be copied directly from the text, nor should the report be a disjointed set of answers to questions. The curves and data must be in ink, and the final grade of the report will depend on the accuracy and clearness with which it is expressed, the neatness and orderliness of the arrangement, and the way in which the work is carried out in the laboratory.

Questions—

1. Why does the terminal voltage of a separately excited generator decrease with increase of load? How much of the drop at full load is due to armature resistance?
2. Why is the voltage drop greater in a shunt than in a separately excited generator?
3. What would be the effect of shifting the brushes further forward from the neutral portion?
4. What is the principal advantage of the compound generator?
5. How would the terminal voltage of a compound generator vary with increase of load if the series field coils were connected so as to oppose the shunt coils?
6. If the generator is over-compounded while flat compounding is desired, what can be done to fix the machine?
7. If the voltage of a shunt generator builds up when the generator rotates in a given direction, will it build up if the direction of rotation is reversed?

(*To be concluded.*)

Undamped Currents in "Super-Conductors."

An interesting account is given in the "Sweizerische Elektrotechnische Zeitschrift" of some remarkable experiments conducted by Prof. H. Kammerlingh Onnes, at the University of Leiden. In ordinary circumstances, as is well known, a strictly undamped electrical current cannot exist. The oscillating currents which may be set up in a resonant circuit die away in a short interval of time, unless a continuous supply of energy is available. Such circuits always contain appreciable resistance, so that the damping factor is never nil.

Prof. Kammerleigh Onnes, however, has contrived to produce what he terms a "super-conductor"—*i.e.*, a conductor without appreciable resistance—by the application of extremely low temperatures. Granted the possibility of such a conductor, one must also assume the possibility of maintaining a continuous current without an appreciable E.M.F. From purely theoretical considerations it has been deduced that the specific resistance of mercury, at 4·25° Abs. would still be measurable, but at 2° Abs. would become negligible. Experiment, however, elicited the interesting result that when the temperature was reduced to a certain point—viz., 4·19° Abs.—the resistance fell suddenly to an almost immeasurable value. This marks the transition from conditions of normal conductivity to "super-conductivity." Once the temperature fell below this critical point it was found possible to pass a current at a density of 1,000 amperes per square millimetre through a conductor 1 metre long without any appreciable difference of potential between the ends.

Super-conductivity, however, is not merely a matter of temperature, but also involves a certain minimum critical current density. If this critical current density is exceeded the condition of appreciable conductivity suddenly appears, and the production of appreciable heat through the passage of the current increases the resistance still further so that a sudden rise in the P.D. between the ends of the conductor, and a corresponding diminution of the current takes place. Slightly below the critical temperature the permissible current density is very low, but by cooling the metal further the current density may be allowed to assume a considerable value.

Such a super-conducting closed circuit affords an opportunity of proving by experiment the qualities attributed in electrical theory to a resistance-free circuit. As mercury presents certain drawbacks it was found preferable to work with other metals—for example, tin—for which the critical temperature is 3·8° Abs., or lead, for which the critical temperature is 6° Abs. Of special interest among the phenomena rendered possible by such circuits is the possibility of producing quite easily magnetic fields of enormous strength. Hitherto, the limitations of heating have prevented a value exceeding about 60,000 gauss being attained. Prof. Onnes, using 1,000 turns of lead wire 0·1 mm. thick, and an iron-free path 1 cm. diameter and of similar length, attained an induction of 100,000 gauss in air, with the expenditure of only 1 joule of electrical energy. Here again an interesting new phenomenon came to light, namely, that there is a certain critical field strength (about 1 kilo-gauss for lead at 1·8 Abs.) beyond which the resistance suddenly rises, and heat is developed. The further one proceeds below the critical temperature the higher is the critical strength of field.

The ends of the lead spiral were next welded in the oxy-hydrogen blow-pipe, whereby the necessary junction of super-conductivity could be attained. In this way a circuit having only the so-called "microresidual" resistance was produced, and the spiral was actually found to have a resistance of only one twenty-billionth of an ohm, as compared with 736 ohms at normal room-temperature. In this circuit it was possible to excite a current of 0·6 ampere, which lasted for several days. The lead spiral in the "kryo-state" (from Greek kryos, cold) was enclosed in a field of 200 gauss, and cooled to 1·8° Abs. By the rapid removal of the field a current was generated, the existence of which was proved by the fact that turning the spiral about a vertical axis deflected a compass-needle in the vicinity. Repetition of the experiment with a substitution coil (at ordinary temperature) carrying a known current showed the existence of a current of the order of 0·4-0·6 ampere flowing in the lead spiral. It was further shown that the diminution in the current resulting from the remaining micro-resistance only amounted to 1 per cent. per hour, so that the current would flow in appreciable strength for about four days. As soon as the spiral was removed from the liquid helium and its temperature allowed to rise, the current vanished almost instantaneously.

It was next of interest to ascertain how the super-conductor would behave when it was attempted to generate an alternating E.M.F. in it. For this purpose a powerful magnetic field (but still within the critical value) was brought close to the lead spiral and then withdrawn again. As was to be expected, the two inductions counteracted one another, only a very minute current remaining. Next, the experiment was repeated with a more powerful field, corresponding to about twice the critical current. The approach of the field naturally induced an initial current, which rapidly fell to the critical value. The withdrawal of the field, which likewise would induce a current of twice the critical value, but in the opposite direction, resulted in the elimination of the existing current and the final exciting of a current in the opposite direction and of about the critical value. The repetition of this experiment with very powerful fields led to similar results.

All these phenomena are completely in accord with the hypothetical qualities assigned to a super-conductor. The conditions were verified in yet another way by connecting a ballistic galvanometer to the ends of the lead spiral. The approach of a field as before excited a steady current in the spiral, which revealed itself by the deflection of the adjacent compass-needle. The junction of the two ends of the spiral was suddenly broken, and this resulted in a momentary deflection on the galvanometer and the return of the compass-needle to its original position. The interruption of the short-circuit between the galvanometer connections at once produced a condition of ordinary conductivity and the annihilation of the current; the self-induced current would only persist for about one hundred-thousandth of a second after the cessation of the inducing E.M.F. All these phenomena recall Maxwell's theory of a frictionless mechanism which in these days can be extended to the electron theory. When an electric current consists simply of the flow of electrons between the molecules of a conductor, we have undoubtedly to do with a frictionless current and a condition of super-conductivity. The electrons once set in motion travel in a closed circuit without any E.M.F. just as in the Maxwell theory of matter rotating rings are formed, the motion of which continues without intermission; but if the least resistance is introduced this form of perpetual motion mechanism is brought more or less quickly to a standstill.

Paper Driving Belts.—In the "Bulletin" des Usines de Guerre some particulars have been given of the paper substitute driving belts which are being introduced into German workshops. The belts appear to be giving satisfaction and are woven or braided. The woven paper belts may be either of the paper fabric or paper thread type. The fabric is first cut into bands and a core of strengthening material, either cotton or sheet metal, is interposed. The core is surrounded with paper strips, and the whole sewn with strong thread. The tensile strength of the woven belts, is stated to reach 100-125 kg. per centimetre width.

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The Semi-Diesel Engine.

At a meeting of the Diesel Engine Users Association on Oct. 24, 1918, Mr. James Richardson read a Paper on "The Semi-Diesel Oil Engine," which he defined as an internal combustion engine using oil fuel, but having an uncooled portion of the combustion chamber at high temperature to help in the vaporisation and ignition of the injected fuel. The chief claim of the Semi-Diesel Engine was its simplicity Most engines of this type were made on the two-stroke principle and were confined to comparatively low powers per cylinder. Air injection of the fuel had been found to lead to complications in compressors, &c., and the modern type of engine worked on the "solid" injection principle in combination with the hot bulb for vaporising and igniting the fuel. Air compressors were, however, sometimes used on Semi-Diesel engines. To replace the *water drip* in cooling the combustion chamber, the advantage claimed for high compression, *i.e.*, economy in fuel and a higher mean effective pressure per cylinder, was counterbalanced by the advantage of low compression in the more even turning moment and a higher mechanical efficiency. The higher the compression the greater the loss due to piston friction, a larger number of rings being required. Hence the mechanical efficiency was low compared with that of the steam engine.

As regards fuel economy the Semi-Diesel engine gave very satisfactory results, as its cycle of operation was nearer the economical explosion cycle than that of the Diesel engine. The Semi-Diesel engine was really a constant load and constant speed engine. The *water drip* extended the range of working. A low compression engine with a fairly large bulb could run from three-quarters to full load satisfactorily, and by cutting off the water, low load could be reached. The water for this purpose should be as pure as possible. A better method, however, was to vary the point of ignition of the fuel charge to correspond with the load on the engine. Gears had been designed by means of which, in conjunction with the governor, the ignition might be varied according to the amount of fuel admitted to the engine.

In the matter of *scavenging* the efficiency was lower in the 2-cycle engine than in the 4-cycle. Probably the greatest loss in efficiency concerned the scavenging in the cylinder. The size and shape of scavenging, exhaust passages and ports, had a great effect on the efficiency, and large exhaust ports, ample passages, and a minimum of restriction in the exhaust ports were a necessity. The subject of *stroke to bore ratio* also was intimately associated with this question. *Injection* depended on several factors of which turbulence, point of cycle at which injection occurred, fineness of spray and distance of injector from hot igniting surface, might be mentioned. Practical considerations determined the period for full power running to be about 30 deg. No standard had been fixed for *fineness of spray*, although this could be too fine.

At present the Semi-Diesel engine could use most fuel oils ranging between 0·8 and 0·9 in specific gravity. Shale oil had been most frequently used. Heavy oils required pre-heating to facilitate pumping. Lubrication was carried out in almost a similar manner to the Diesel engine, the consumption working out at about 0·02 lb. per B.H.P. The starting of the engine was carried out by means of compressed air, a compression of from 80 to 100 lb. per square inch being necessary. The bulb, prior to starting, was made sufficiently hot to ignite the fuel, one impulse being usually enough to start the engine. In conclusion, Mr. Richardson referred to the recent extension of the field of application of this engine and to the increase in the size of engine and power developed. He foreshadowed great developments in the near future.

The Electric Steel Furnace.—In a Paper read last week before the Staffordshire Iron and Steel Institute, Mr. F. J. Moffatt referred to the importance of cheap power for electric furnaces. By-product recovery might, possibly, be the solution of the problem. Owing to continuous working at a fairly uniform load, power for furnaces should be supplied at very reasonable rates.

The Works of the Union Cable Company.

The various processes of cable manufacture are of interest to the engineer because they involve the use of specialised machinery, the object of which is to economise labour and to ensure accuracy in the finished product. The lay-out of a cable factory may seem simple enough at first glance, but it requires considerable thought to avoid overlapping of effort and the re-handling of raw material and semi-manufactured material. The Dagenham works of the Union Cable Company possess the primary advantage in being modern in respect of the choice of site and the lay-out of buildings. The factory is situated within easy reach of rail, and water transport, and it is not too remote from a district affording adequate labour supplies.

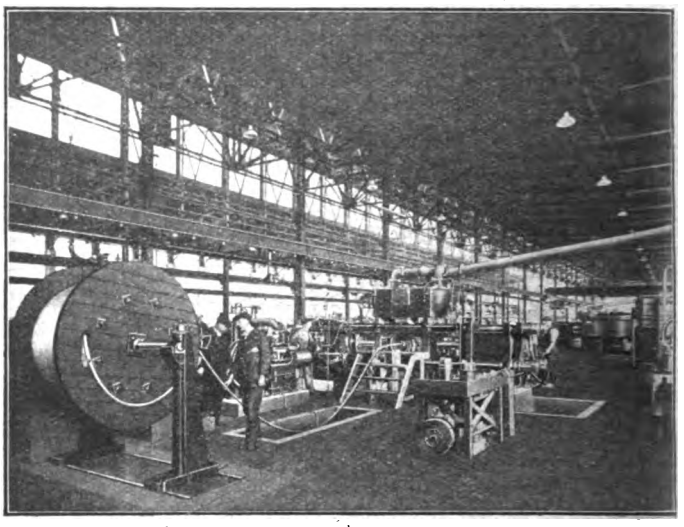

FIG. 1.—ONE OF THE LEAD PRESSES

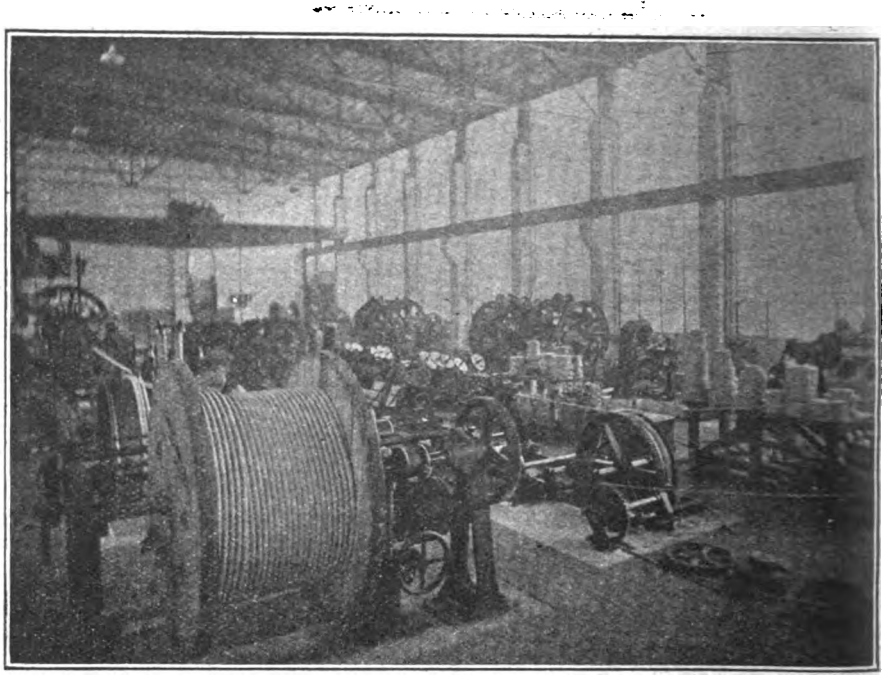

FIG. 2.—PAPER COVERING MACHINES.

At the present juncture we do not propose to describe this interesting factory in detail. We hope that an opportunity for doing this will arise in the near future. It is, however, of interest to record that the undertaking, originally the off-shoot of a Continental concern, is now entirely in British hands, and both the capital organisation and labour are genuinely British. Some few months back Mr. J. Snow Huddleston, who is well known to our readers, through his long association with the cable business, was appointed general manager. Mr. Huddleston recently showed us through the works at Dagenham, and we were able to see that they are equipped

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for the production of insulated wires and cables of every description and particularly of heavy insulated and armoured power transmission cables both high and low tension, and also lead covered, dry core telephone cables.

The works occupy a site of 8 acres, of which at present 4 acres are occupied with buildings and offices. The front building comprises on the ground floor a raw material store, and on the first and third floors are the offices, staff dining rooms and works canteen. The second floor is used as a store for cotton and other articles. The top of the building is a large water tank which supplies the works and fire hydrants.

The shops themselves are of considerable interest, and their lay-out has been arranged with a view to the continuous progress of the raw material through the various processes and machines to the finished stores. A number of modern machines are employed for stranding bare wires, for cotton and paper covering, for twinning and pairing and for the assembly of the insulated wires into the required number of groupings. These machines are all designed for rapid production, a fact which enables the company to keep to time with delivery. A separate shop is devoted to the colouring of the completed cotton covered wires and cables, these being passed rapidly through troughs containing the colour.

The main shop is equipped with modern machines for stranding, taping and armouring cables of all classes. The heavy armouring machine is particularly interesting and a large number of steel

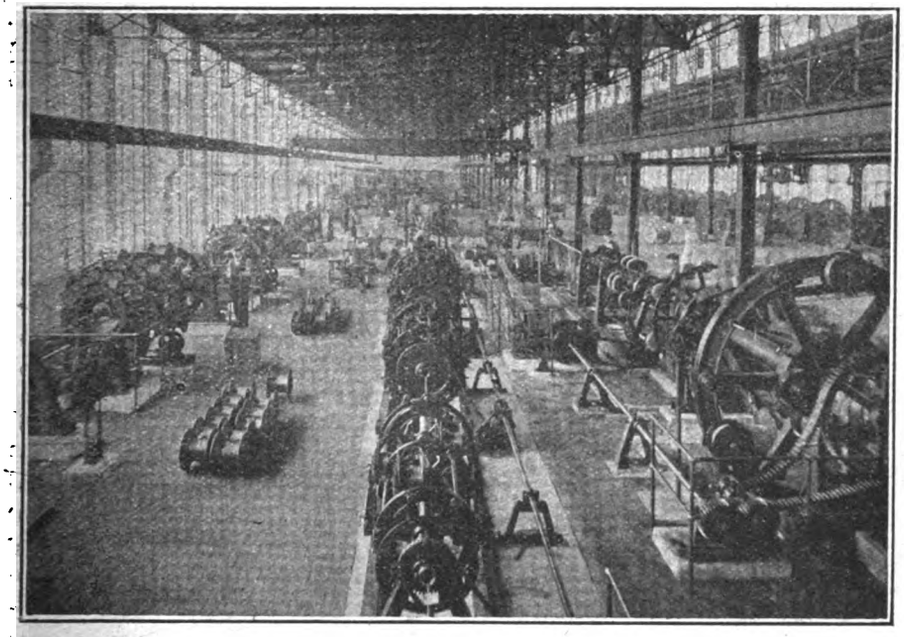

FIG. 3.—PAPER COVERING, LAYING-UP AND WIRE ARMOURING MACHINES.

wires can be laid on with this machine. At the time of our visit a two-phase "D" conductor cable was going through the shops. The machines for the manufacture of bitumen-covered cables are also of interest. The lead presses are particularly fine items in the works equipment. One of these is capable of covering cables up to 4 in. size. In both instances the gas-heated furnaces for the molten lead are monometer controlled. At one end of the main shop are the immersion tanks, and immediately above these is the test-room, which is mounted on a gallery overlooking the tanks. The test-room equipment includes a 100,000-volt transformer. Beyond the main shop and occupying the end of the works remote from the offices is the rubber department comprising masticating rolls and calenders and vulcanising chambers. In this department are also machines for the rubber covering of the conductors previous to vulcanising. The boiler house, which is in a building adjoining the rubber department, provides the steam for the various machines and for the vulcanising ovens.

The transport facilities in the works are greatly assisted by a loading platform, truck high, which extends the entire length of the factory. This is served by a single line of rails with a long turn out for marshalling processes.

The works are entirely electrically driven, the energy being obtained from the Estate Company, which supplies at 2,200 volts three-phase; this is transformed down for the motor and lighting circuits.

At the present time the works are almost exclusively employed on Government contracts, but their equipment enables them to meet the majority of the requirements for rubber, bitumen and paper insulated cables of all kinds. We are indebted to the Company for the opportunity to visit the works and also for the illustrations which show views in several of the departments.

South Shields Electricity Supply.

At the meeting of the South Shields Corporation last week the Electrical Committee reported on the subject of the power supply and upon the correspondence and negotiations with Mr. A. B. Gridley, Director of the Electric Power Supply, on the question of the extension of plant, and the proposal for the Corporation to take a bulk supply from the Newcastle-upon-Tyne Electric Supply Company. The committee recommended the Council "to decline to fall in with the decision of the Director of the Electric Power Supply, which will have the effect of forcing the Corporation to take a supply of electricity from a private company having a monopoly of supply in the adjoining area, being of opinion that such a course would be unfair and prejudicial to this municipality which has supplied electricity in South Shields for 22 years to the satisfaction of the public, and particularly in view of the recent findings of the Departmental Committees and the possible proceedings arising thereout, and they recommend the Council to authorise this committee to take every possible step to obtain the sanction of the Government departments to the necessary extension of plant."

The chairman of the committee (Ald. HENDERSON), who moved the adoption of the report, referred to their proposal to instal new generating plant, and to the efforts of the borough electrical engineer (Mr. Harry S. Ellis) to get the sanction of the Ministry of Munitions and the L.G. Board to borrow the necessary money. Those two bodies made it quite clear that before anything could be done it would be necessary to obtain the approval of the Director of Electric Power Supply. Mr. Ellis therefore saw Mr. McClellan, who contended that the Corporation should endeavour to purchase a supply of electricity rather than install additional plant. Mr. Gridley, who followed Mr. McClellan, maintained the same attitude. Ultimately, after much correspondence and interviews, their engineer was instructed to approach the Newcastle Company and ascertain what their terms for a supply of electricity would be. A quotation on a sliding scale basis was duly considered, but was not approved by the committee. Afterwards an alternative rate was submitted, which was very much more favourable, but in the engineer's opinion it would not result in any gain to the Corporation. The Director of Electric Power Supply was then asked to receive a deputation to go further into the matter. At the close of that meeting the deputation was informed that the Corporation had not established their case, and that they should endeavour once more to come to terms with the Newcastle Company, at least for a temporary supply for a period ending two years after the termination of the War. In the course of further negotiations, the company agreed to enter into a short period agreement and to supply current to the Corporation at 10 per cent. below the Corporation's own generating costs, but on condition that the Corporation paid for the cost of extending a cable from their sub-station at the St. Hilda Colliery to the electricity works, also that they should install the necessary converting plant. The cost of the cable was estimated at £2,150, and the converting plant about £7,500. There was nothing to be gained as far as the Corporation was concerned by such an arrangement.

The plant, involving an expenditure of nearly £10,000, would be practically of no use to the undertaking at the end of the period. They urged Mr. Gridley, under the circumstances, further to consider their proposal to install new plant of their own. Mr. Gridley, after a while, replied that their case had been presented to the Electrical Service Committee—a committee recently set up by the War Priorities Committee—and after full consideration they had decided it would not be desirable that their generating station should be further extended at the moment, and that they should complete arrangements for taking a supply in bulk. The committee then suggested it might be advisable that a deputation have an opportunity of laying their case before the Electrical Service Committee. They received a wire from Mr. Gridley that the Electrical Service Committee had "decided their previous decision re bulk supply should stand." As a result of further interviews, permission was given to the Corporation to install at least one new boiler at a cost of £7,500, "subject to terms being completed for purchasing the bulk supply recently under correspondence." The advantage which the Corporation would get from this arrangement would be 1,000 kw. of plant which would have cost them £17. 10s. per kilowatt. On the other hand, if the Corporation installed their own plant entirely at a cost of £40,000 they would have available plant capable of developing 3,000 kw., the average price of which worked out at £13. 6s. 8d. per kilowatt.

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Technical Teaching in the United States.

Prof. A. GRAY, of Cornell University, is well known to our readers, and his article on the teaching of electrical engineering in American colleges in our present issue will be read with interest. Our admiration for the great way in which America is taking her part in the world-war, and a growing realisation by her of what this country has already done in the war, are so strengthening the natural sympathy between Britain and "God's own country" (for the American is nothing if not a patriot) that a strong partnership is growing up between us. To the success of this partnership nothing is more essential than mutual understanding. There must be a thoughtful interchange of ideas upon all matters, and especially upon those which are fundamental. Nothing is more fundamental than education, nor is any subject more ripe for discussion.

Methods of education have for years past been more definitely standardised in America than here, and this enables Prof. GRAY to base upon the engineering course at Cornell University an outline which may rightly be regarded as typical of the courses at American colleges in general.

Shorn of the mystery with which the unaccustomed terms "unit," "credit hour," "recitation" and "condition" seem to invest it, the American curriculum appears to differ notably from that of the typical British technical school in only three points:—

1st. Four years instead of three are required for the full electrical engineering course.

2nd. Mathematics, as a separate subject, appears in the first year of the course only.

3rd. "Business law" and "industrial organisation" hold an important place in the third year; whilst "economics" and "electives" occupy nearly one-third part of the fourth year.

Prof. GRAY attributes the need for the extra year to the lower standard of grammar school and high school education in America. We can but feel, however, that the compliment thus paid to the British secondary schools is hardly deserved. Some British secondary schools may, indeed, be better than the average American high school, but many do certainly fail to equal it.

The schedule of credit hours seems in itself to provide the explanation of the additional year, for in the third and fourth years there is a total of 16 credit hours—equivalent to 24 hours' work per week for 32 weeks—assigned to "Business law," "Industrial organisation," "Economics" and "Electives" (by which we understand such subjects as elocution and psychology), and these are subjects usually excluded from the curricula of British engineering schools. It will be noted, further, that by the American system the production of educated engineers is treated far more as a standardised operation than it is by the British system, and that the time the student is expected to devote to home study is small. In other words, the American system, being more of an applied treatment and less of an induced self-development, makes less use of the students' home hours, and so occupies more years.

The restriction of mathematics as a separate subject to the first year of the course must not be taken to indicate that the study of the higher branches of mathematics is neglected. The intention is that these higher branches shall be learned rather as applied mathematics—as a part of, say, the transmission of current in cables, the propagation of electromagnetic waves in space, or the calculation of the inductance of coils—than as pure mathematics. The wisdom of this as an ideal can hardly be doubted, but of its general practicability we have grave doubts. Such a scheme, to be practicable, would demand an unlimited supply of men like KENNELLY or STEINMETZ. Failing this, we are of opinion that the best compromise is to entrust the teaching of mathematics to the mathematician, taking care that the student shall be given a good insight into branches which are higher than, in practice, he is likely ever to have to use; only thus will he retain the amount of mathematics which ordinary practical problems demand, or be able in case of special need to tackle advanced work.

The inclusion of commercial subjects, such as business law in the curriculum is beginning to be advocated in some of our own colleges. The wisdom of this can hardly be discussed in a few words, but some of the dangers which beset the introduction of such subjects ought, we think, constantly to be kept in view. In common with, say, metaphysics and psychology, subjects like business law, industrial organisation and works management suffer from lack of well-defined and generally accepted foundations. They therefore offer to an eloquent teacher a dangerously tempting opportunity for developing new theories upon which the student can ill afford to spend his time. On the other hand, should these subjects be entrusted to a teacher who is of the less eloquent, severely practical stamp, equipped with wide commercial experience, the danger is that he will overwhelm the student with masses of dry data, upon which, again, even if he could remember them, he has no right to be asked to spend his time.

Of equal interest with his outline of the curriculum is Prof. GRAY'S discussion of the methods of instruction favoured in American technical schools. It will be learned with surprise that "the student does not have to take lecture notes. . . . American students object to the taking of lecture notes, and will generally arrange that when a text-book is not closely followed the teacher shall hand over his notes to a student committee, which will have copies made and sold to the members of the class." In the experience of teachers over here it is found that the student who fails to take lecture notes—upon which he is expected to spend several hours of home study each evening—gets but little good from the lectures. The American system of recitations and of frequent test examinations may reduce the necessity for lecture notes, but we cannot think that it is their equivalent. Moreover, we feel that upon this matter Prof. GRAY'S remarks are too general. Some of the best and largest of the technical colleges in the Eastern States of America—as, for instance, the Carnegie Institute of Technology, in Pittsburgh—are even stricter in their insistence upon carefully prepared lecture notes than is the average British college. Nor is the use of text-books so universal as Prof. GRAY seems to imply.

The "recitation"—a class period in which each student in turn asks and answers questions, or is called to the blackboard to explain some point of interest—is an excellent institution; but in the opinion of experienced teachers in our own schools it has been found with us to be almost impracticable. There is a great difference between the American student and the British. The former enjoys asking questions in class and answering them—he has no objection to thinking aloud; the latter has a natural

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reserve which not only prevents him from thinking aloud, but makes him almost resent any attempt to apply the recitation method.

The place which text-books should have in engineering studies is a vexed question. Very few of the engineering text-books are written by men who are careful to follow scientific method; some are marred by loose thinking and by mis-statements, whilst others are mere compilations got together by aid of trade publications, and so possessing no educational value whatever. On the other hand, some of the finest books, written by most learned exponents of their subjects, are either too condensed or else are too full of unusual mathematics—or, at any rate, of fearful entanglements of strange symbols—to be readily used by students or even by teachers. There can be little doubt, however, of the advisability of so arranging a course of lectures in any subject that the student may, in his home study, follow one or two good text-books in conjunction with the lectures.

The brevity and conciseness of the outline Prof. GRAY has given of American college methods are made possible only by the careful and business-like organisation which has become the standard in these colleges. Part of the valuable result of this organisation is the correspondingly business-like spirit of the students—or rather student body, for there is a remarkable *esprit de corps* among the students of every American college. In these directions we are of opinion that Great Britain has much to learn from America.

Dimensions of Transformers.

By A. R. LOW.

1. The object of this article is to classify the principal problems of transformer discussion and to compare certain assumptions, methods and results.*

Single-phase shell and core transformers with copper and iron circuits of uniform rectangular section, have four geometrically independent variable dimensions, and two electromagnetic variables—the flux and current densities—in all six independent variables.

Economy of material is obtained by imposing a figure of revolution, which reduces the independent dimensions to three and the number of independent variables to five. All other quantities discussed here can be expressed in terms of these variables, and of coefficients obtained from tests and from workshop practice, and assumed constant at least to a first approximation.

Each writer has his own symbols, but all those quoted are transformed for purposes of comparison to the present writer's notation.

LIST OF SYMBOLS.

2. (There are slight differences in the notation of the writer's Papers, "Journal," I.E.E., 1909, p. 27, and 1915, p. 512.)

	Iron circuit.		Copper circuit.
Dimensions—			
Shell and core types, both sections rectangular	y, u	...	x, z
Core type figure of revolution	y, u	...	r
Shell type figure of revolution	r	...	x, z
Space factors (volume factors)	f_i	...	f_c
Mass factors	m_i	...	m_c
Cost factors	k_i	...	k_c
NOTE.—These factors measure the volume, mass and price of metal per dcm.³ of gross circuit volume.			
Flux and current densities	μ	...	ν
Loss per kg. of metal (Steinmetz)	$a\mu^{1\cdot6}+b\mu^2$		$c\nu^2$
,, ,, (Robertson)	$b\mu^2$	...	$c\nu^2$

NOTE.—$\mu = B \div 10^4$; ν = ampere lines/sq. mm. For 0·02″ Stalloy and 0·25″ × 0·5″ copper, at 50 cycles, 120°F., tests on an experimental core gave $a=1\cdot7$, $b=0\cdot5$, $c=2\cdot2$. In most cases, μ lies between 0·45 and 1·4, ν between 1 and 4, so that a, b, c, μ, ν are all of the order of unity, a considerable convenience in computing numerical values, and the only justification for introducing new symbols.

Quantities expressed in terms of the variables and coefficients:—

Gross volume of iron circuit	$A \equiv 2yu(z+x+ny)$
,, copper circuit	$B \equiv 2xz(u+y+mx)$.
Sum of net metal volumes	$V \equiv f_i A + f_c B$
,, ... masses	$M \equiv m_i A + m_c B$
,, ,, costs	$K \equiv k_i A + k_c B$
,, ,, losses	$L \equiv (c\mu^{1\cdot6}+l\mu^2)m_i A$
,, ,, (Steinmetz)	$+c\nu^2 m_c B$
,, ,, (Robertson)	$L \equiv l\mu^2 m_i A + c\nu^2 m_c B$
Mean apparent power transformed	$P \equiv hxyz\mu\nu$
	$h = 0\cdot22\sqrt{f_i f_c}$

When numerical values are assigned to x, μ, P, &c., they will be denoted by x_1, μ_1, P_1, &c.

The capital letters are introduced merely for shortness in writing down general relations, and most of the symbols have no conventional association with the quantities they represent.

3. The problem of finding minimum cost or losses when the power transformed is given may be stated in symbols.

CASE I.

4. Given $P=P_1$, find (a) minimum K,
(b) ,, L.

(a) leads to infinite dimensions and zero densities.
(b) leads to zero dimensions and infinite densities.
This case is therefore physically indeterminate.

An additional arbitrary condition may make the problem physically determinate.

CASE II.

4. Given $P=P_1$ and (a) $K=K_1$, find minimum L,
(b) $L=L_1$,, K.

Applying Lagrange's method and eliminating the indeterminate multipliers, the minimum conditions are obtained in the compact form of a matrix equation, the same for both cases (a) and (b)

$$\begin{vmatrix} \frac{\partial P}{\partial x} & \frac{\partial L}{\partial x} & \frac{\partial K}{\partial x} \\ \frac{\partial P}{\partial y} & \frac{\partial L}{\partial y} & \frac{\partial K}{\partial y} \\ \frac{\partial P}{\partial z} & \frac{\partial L}{\partial z} & \frac{\partial K}{\partial z} \\ \frac{\partial P}{\partial u} & \frac{\partial L}{\partial u} & \frac{\partial K}{\partial u} \\ \frac{\partial P}{\partial \mu} & \frac{\partial L}{\partial \mu} & 0 \\ \frac{\partial P}{\partial \nu} & \frac{\partial L}{\partial \nu} & 0 \end{vmatrix} = 0.$$

The two zeros in the third column appear because K does not contain μ or ν.

Taking the rows by threes and equating the determinants so formed to zero, 15 equations are obtained, of which *only four are independent*. These four minimum conditions, together with the two arbitrary conditions, give six equations to solve for six variables. The only difference between II. (a) and II. (b) is the appearance of $K=K_1$ as a condition in (a) and of $L=L_1$ in (b).

P is a homogeneous function of the sixth degree in $(xyzu\mu\nu)$.

K is a homogeneous function of the third degree in $(xyzu)$, being of zero degree in μ and ν.

L is a homogeneous function of the third degree in $(xyzu)$, but is not homogeneous for Steinmetz's form of hysteresis loss

* The following are specially referred to: A. R. Low, "Dimension of Transformers," "Journal," I.E.E., 1909, p. 217.; D. Robertson, "Mathematical Design of Transformers," Griffin, 1910; A. R. Low, "Dimension of Transformers," "Journal," I.E.E., 1915, p. 512; D. Robertson, "Mathematical Design of Transformers," "Journal," I.E.E., 1916, p. 142; Arnold and LaCour, "Wechselstromteknik," Vol. II., "Transformatoren."

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in μ and ν. For Robertson's approximation L becomes homogeneous and of the fifth degree in $(xyzu\mu\nu)$.

Using Euler's theorem of homogeneous functions and the ordinary rules for reducing matrices, the matrix may be much simplified before it is expanded into four algebraic equations. Examples will be found in the writer's 1915 Paper.

For generality, power, and directness, Lagrange's method is far superior to any other the writer has examined.

5. A problem in which the number of arbitrary conditions plus the number of minimum conditions is equal to the number of independent variables, is a complete problem, and the arbitrary and minimum conditions are the complete conditions. Any set of values of the variables satisfying the complete conditions is a particular solution, and all possible particular solutions taken together are the complete solution.

Rejecting all solutions containing negative, zero, infinite or complex numbers, the remaining solutions taken together are the complete physical solution.

Complete problems are physically equivalent when their complete physical solutions are identical.

So far as the writer has computed examples, there has never been more than one particular physical solution giving a unique set of physically possible values of the dimensions and densities.

6. Taking the last two rows of the matrix of section 4 with any other row, the minimum condition so obtained reduces at once to

$$\begin{vmatrix} \frac{\partial P}{\partial \mu} & \frac{\partial L}{\partial \mu} \\ \frac{\partial P}{\partial \nu} & \frac{\partial L}{\partial \nu} \end{vmatrix} = 0,$$

whence

$$\mu \frac{\partial L}{\partial \mu} = \nu \frac{\partial L}{\partial \nu},$$

giving for Steinmetz's form of hysteresis loss

$$\frac{\text{Copper loss}}{\text{Iron loss}} = \frac{cv^2 m_c B}{(a\mu^{1.6} + b\mu^2) m_i A} = \frac{0{\cdot}8a\mu^{1.6} + b\mu^2}{a\mu^{1.6} + b\mu^2} \cong 0{\cdot}845$$

(for $a = 1{\cdot}7$, $b = 0{\cdot}5$, $0{\cdot}45 < \mu < 1{\cdot}4$).

For Robertson's form of hysteresis loss

$$\frac{\text{Copper loss}}{\text{Iron loss}} = \frac{cv^2 m_c B}{b\mu^2 m_i A} = 1.$$

7. Prof. Robertson proves the relation for a much less general problem ("Treatise on Transformers," C. Griffin, 1910, Chap. III., p. 50): A given transformer operates at constant voltage; find the load for which the efficiency is a maximum. The current J is the only variable, and the single required condition is

$$\frac{\partial}{\partial J}\left(\frac{L}{P}\right) = 0.$$

Transforming to as the independent variable and writing $x_1, y_1, z_1, u_1, \mu_1$ as constant values of the other variables, the condition is

$$\frac{\partial}{\partial \nu} \frac{(a\mu_1^{1.6} + b\mu_1^2) m_i A_1 + cv^2 m_c B_1}{hx_1 y_1 z_1 u_1 \mu_1 \times \nu},$$

whence

$$\frac{\text{Copper loss}}{\text{Iron loss}} = \frac{cv^2 m_c B_1}{(a\mu_1^{1.6} + b\mu_1^2) m_i A_1} = 1.$$

As has been shown above, this result only applies to the general case II. (a), when Prof. Robertson's form of hysteresis loss is assumed, and when K does not contain μ or ν.

However, against these trebly infinite odds, it does happen to be true for the general problem of Chapter X. of the treatise, where the result is applied without any reference to Chapter III. or to the limited case for which it was obtained.

8. Case II. (a), with Prof. Robertson's approximate expression for hysteresis loss, may be stated as before; given $P = P_1$ and $L = L_1$, find minimum K. Assuming the minimum condition

Copper loss = iron loss,

Prof. Robertson proceeds to eliminate μ and ν from $P = P_1$, which may be shown as follows:—

$$P^2 = (hxyzu\mu\nu)^2 = P_1^2,$$
$$L = 4m_i b\mu^2 yu(z + x + ny),$$
$$= 4m_c c\nu^2 xz(u + y + mx) = L_1,$$

whence

$$\frac{xyzu}{4(z + x + ny)(u + y + mx)} = \frac{4bcm_i m_c P_1^2}{h^2 L_1^2},$$

which will be written for short

$$G = G_1.$$

Prof. Robertson does not state that he is eliminating the flux and current densities, nor does he indicate what advantage is gained by transforming his problem in this way.

The elimination of μ and ν is very obvious in the above notation, but in Prof. Robertson's notation it is masked by an ambiguity in his symbols, which do not distinguish between functional forms and numerical values assigned to them.

9. Applying Lagrange's method to the transformed problems: Given $G = G_1$, find minimum K. The minimum conditions may be written down in the form,

$$\begin{vmatrix} \frac{\partial G}{\partial x} & \frac{\partial K}{\partial x} \\ \frac{\partial G}{\partial y} & \frac{\partial K}{\partial y} \\ \frac{\partial G}{\partial z} & \frac{\partial K}{\partial z} \\ \frac{\partial G}{\partial u} & \frac{\partial K}{\partial u} \end{vmatrix} = 0.$$

Prof. Robertson actually writes as minimum conditions

$$\frac{\partial}{\partial x}\left(\frac{K}{G^{3/2}}\right) = 0, \quad \frac{\partial}{\partial y}\left(\frac{K}{G^{3/2}}\right) = 0., \text{ \&c.,}$$

which lead, as is easily verified, to the same equations. There are three independent minimum conditions for the transformed problem, which, together with the three conditions of the original problem, two arbitrary and one found by Lagrange's method, give six equations to solve for six variables. Rejecting non-physical solutions which may have been introduced or lost by the transformation, the complete conditions of the transformed problem must be physically equivalent to the complete conditions of the original problem obtained as in section 4 above, subject to Prof. Robertson's approximate assumption about the form of the hysteresis losses.

10. The above demonstration of equivalence was by no means easy to construct.

The writer failed in a similar attempt in his 1915 Paper, because he drew the inference from the absence of the operators $\partial/\partial\mu$, $\partial/\partial\nu$, that Prof. Robertson's mathematical design of transformers was based on an assumption of constant flux and current densities. In reply ("Journal," I.E.E., 1916, p. 150, section 15) Prof. Robertson calls the assumption absurd, which it is not, as seen in the next section. But the real point between him and the writer is whether the *inference* was absurd. Leaving aside controversy about mere mathematical style, the writer has satisfaction in according to an English author priority in solving the most general type of problem in transformer dimensions, although subject to a simplifying approximation for hysteresis losses.

In general transformer design, when low first cost is the principal factor, the flux and current densities are rated up to the permissible limits of saturation and temperature rise.

Under these practical conditions the flux and current densities vary slowly with changes in the dimensions, and may be assumed constant as a first approximation.

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CASE III.

11. The problem may be stated as follows: $P=P_1$, $\mu=\mu_1$, $\nu=\nu_1$, find minimum K. Writing down the Lagrange conditions in matrix form,

$$\begin{vmatrix} \frac{\partial P}{\partial x} & \frac{\partial K}{\partial x} \\ \frac{\partial P}{\partial y} & \frac{\partial K}{\partial y} \\ \frac{\partial P}{\partial z} & \frac{\partial K}{\partial z} \\ \frac{\partial P}{\partial u} & \frac{\partial K}{\partial u} \end{vmatrix} = 0.$$

The matrix equation gives three independent minimum conditions, which with the three arbitrary conditions constitute the complete conditions of the problem. The detailed solution will be found in the writer's Papers on Transformer Dimensions, "Journal," I.E.E., 1909 and 1915.

12. Two results found to be valid for both II. and III. may be written in the form,

$$2<\frac{z}{x}<2{\cdot}2,$$

$$2<\frac{u}{y}<2{\cdot}2.$$

The mean value 2·1 is a very good approximation for a wide range of cases.

13. Arnold and LaCour, in their volume on transformers, seem to consider the variables in the pairs x, z, y, u, and μ, ν.

This gives three limited minimum problems with five arbitrary conditions, and therefore only one minimum condition each.

IV. (*a*).—$P=P_1$, $y=y_1$, $u=u_1$, $\mu=\mu_1$, $\nu=\nu_1$, find minimum L.

The minimum condition,

$$\begin{vmatrix} \frac{\partial P}{\partial x} & \frac{\partial L}{\partial x} \\ \frac{\partial P}{\partial z} & \frac{\partial L}{\partial z} \end{vmatrix} = 0,$$

reduces to $$\frac{mx}{z-x}=\frac{(a\mu_1^{1\cdot6}+b\mu_1^{2})m_iy_1u_1}{c\nu_1^{2}\cdot m_cxz}.$$

IV. (*b*).—$P=P_1$, $x=x_1$, $z=z_1$, $\mu=\mu_1$, $\nu=\nu_1$, find minimum L.

The minimum condition,

$$\begin{vmatrix} \frac{\partial P}{\partial y} & \frac{\partial L}{\partial y} \\ \frac{\partial P}{\partial u} & \frac{\partial L}{\partial u} \end{vmatrix} = 0,$$

reduces to $$\frac{u-y}{ny}=\frac{(a\mu_1^{1\cdot6}+b\mu_1^{2})m_iyu}{c\nu_1^{2}m_cx_1z_1}.$$

IV. (*c*).—$P=P_1$, $x=x_1$, $y=y_1$, $z=z_1$, $u=u_1$, find minimum L.

The minimum condition,

$$\begin{vmatrix} \frac{\partial P}{\partial \mu} & \frac{\partial L}{\partial \mu} \\ \frac{\partial P}{\partial \nu} & \frac{\partial L}{\partial \nu} \end{vmatrix} = 0,$$

is the same as in II., and reduces as shown before to

$$\frac{\text{Copper loss}}{\text{Iron loss}}=\frac{0{\cdot}8a\mu^{1\cdot6}+b\mu^{2}}{a\mu^{1\cdot6}+b\mu^{2}}\cong 0{\cdot}845.$$

The first two conditions IV. (*a*) and IV. (*b*) are not in general the same as for the more general problems II. and III. But if conditions IV. (*a*), (*b*) and (*c*) are applied in turn repeatedly, and after each application the new values of the pair of variables found are inserted, these values will converge to the solution of the general problems in section 4.

Arnold and La Cour state their numerical results in a form which is nearly equivalent to

$$1{\cdot}5<\frac{z}{x}<2{\cdot}5,$$

$$1{\cdot}5<\frac{u}{y}<2{\cdot}5.$$

These may be compared with the closer limits found above (section 12) for the most general cases.

14. The shell type with figure of revolution resembles the Berry type of transformer, and as it is a better form than the more general type discussed above, it would be of great interest to apply the Lagrange method, under Steinmetz's form of hysteresis losses, and compare the exact results with Prof. Robertson's approximate results.

Such extensive computations would, however, be out of place in an article on general methods.

Electricity Supply in the Potteries.

As announced in our last issue, Stoke-on-Trent Corporation have decided to carry out extensions of the central power station at a cost of about £102,000. The Corporation had before them a report by Sir John Snell on the position of the undertaking, but, apart from the extension in question, consideration of the report was adjourned.

In the report it is stated that the net loss of £3,769. 2s. 7d. for the financial year ending March last arose partly from awards of the Committee on Production, which were responsible for an addition of £1,700 to the costs, and partly from the insufficient increase added to the charges. A higher percentage than the 29·6 per cent. average increase actually charged should have been made. Sir John estimates that the 60 per cent. addition imposed in April last on pre-war rates (now increased to 75 per cent. from August) would so increase the revenue that no deficit should be feared during the current year. Coal had risen from a pre-war average of 11s. 5d. per ton to 24s. 8d., an increase of 116 per cent. (the actual price at the central power house was over 29s. per ton), wages had risen over 20 per cent. during the last year, and interest was seriously higher. Therefore the charges to consumers must be reasonably increased to cover those costs. Broadly speaking, one had to pay twice as much as before the war, and the cost of electricity was no exception to the general rule. Provided the basic prices were correctly determined in the first instance, instead of a uniform percentage addition to the charges to consumers, it was fairer to charge lighting with 6 per cent. addition to each 5 per cent. addition for power; that was to say, instead of a uniform 75 per cent. which the Corporation had decided to add to all consumers, strictly speaking lighting consumers should be charged with 87 per cent. increase and power consumers 72 per cent. It would be found that on the actual sales last year—viz., 6,388,278 units for power and heat and 1,547,630 for private lighting—those additions should give the same results as a uniform 75 per cent. all round.

There were certain pre-federation contracts in the Burslem area, one of which expired in October and another in September next year, on which the Corporation were losing heavily. They ought never to have been entered into at the low prices set out, as it would not have been possible for the small Burslem station to have ever supplied power at as low a rate as ½d. The charges to consumers differed in each of the four districts of Burslem, Hanley, Longton and Stoke to an entirely unnecessary degree. The time had come when the scales of charges should be made uniform. Uniform scales would simplify the accounts and tend to reduce the cost of preparing them. Many of the numerous special contracts should be cleared off. There were five electrical systems within the borough—viz., three phase, 50 cycles: one phase, 100 cycles; and direct current 480, 460 and 440 volts respectively. The efficiency of distribution was 70 per cent. Sooner or later it would become necessary to unify these distribution systems, and the sooner the better. In the first place, certain of the single-phase sub-stations supplied from the original Hanley 100 cycle station should be changed over to the 50 cycle system, and thus be supplied from the central power house without a double transformation. This might be done at first to such a degree as to bring the load on that district within the limit of the 600 k.v.a. motor-generators already working, and thus enable the steam plant in the orginal Hanley station to be shut down. The improvement could only be carried out gradually, as there were many motors to be changed; but when completed it would save over 3,000 tons of coal per annum. In time the whole distribution in Hanley must be changed to the 50 cycle system. The department ought gradually to change the whole of the direct-current consumers to the pressure of 480 volts, and so eliminate the 460 and 440 volt distribution. After those changes had been made there would remain only the principal generation at 6,600 volts, three phase, 50 cycles; and distribution at 50 cycles, three phase and one phase, and direct current distribution at 480 (and 240) volts. The longer extensions of mains are permitted to be made on the several systems the worse the position will become.

Though the several stations were not strictly comparable owing to the larger output and higher efficiency of the central power house, the coal consumption per unit at Burslem, Hanley, Longton and Stoke was

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very greatly higher than that at the central station. Had it been possible to generate all the energy at the latter in 1917-18 there would have been a saving of at least 5,700 tons of coal (£5,195), although the coal cost per ton delivered was lower at the local stations than at the central power house. He estimated that savings in coal, stores, wages and repairs, had all the energy been generated at the central station, and had there been no further capital expenditure necessary to accomplish that end, would have amounted to over £11,400 per annum.

The site of the central power station was not very fortunate for a large power station. The canal water apparently could only be used through the agency of cooling towers, and the amount of water which could be abstracted for making up the losses due to cooling was very strictly limited. The station was on the top of a hill, with the boilers at the highest part of the site. All the coal had to be carted at the considerable cost of 3s. 7d. per ton, which, however, might be somewhat reduced through the use of electric vehicles. The design of the station did not lend itself conveniently to extensions for large units of plant, and the facilities for storage of coal were quite inadequate. He did not consider the Corporation were justified in incurring any expenditure other than was absolutely necessary upon a station which would be outgrown in a few years. The problem now was to add just sufficient plant at the central station at the lowest possible cost. Steps must be taken at the same time to secure an adequate site elsewhere, with the best water supply which the locality would afford, and cooling facilities, so that when the war was over a station might be erected with large units of plant, and with all modern appliances for securing the greatest economy in coal. He thought inquiries ought to be made as to the availability of waste heat from the blast furnaces or local coke ovens, as those sources of otherwise wasted energy ought to be utilised, to the advantage of the suppliers and the public. The total load in 1917-1918 was 4,419 kw., and from statistics and particulars of new loads supplied he estimated a maximum load of 6,250 kw. in 1922-1923. The addition of a further 3,000 kw. unit would be sufficient, with slight occasional overload, to meet the demand during the next two or three years. There were five boilers, each evaporating 17,000 lb. (actual), or 85,000 lb. altogether. The present boiler capacity was insufficient to give adequate reserve, and must be supplemented. A full load of 6,250 kw. necessitated about 100,000 lb. of steam, and, allowing spare boilers for cleaning and reserve, it was necessary to add three boilers of 25,000 lb. each. In order to secure the highest economy in coal it was essential to have adequate cooling water. A full load of 6,250 kw. required not less than 700,000 gallons of water circulating per hour under the local conditions. The existing two towers were presumed to deal with 300,000 gallons in all per hour, and two new cooling towers, each of 200,000 gallons, were required. The possibility of using the canal water direct should be considered, but, failing the direct user of the canal, the question of providing a cooling pond with sprinklers might be considered.

The necessary changes at the local stations would involve a third 600 kw. converter and switchgear at Burslem, Longton and Stoke respectively. The estimated cost of these additions was £9,000. Only a very small extension of high tension cables would be required to carry out the scheme. The Corporation had already under consideration a proposal to lay a further cable from the central power house to the borders of the old Stoke area (Shelton), which was absolutely necessary, and should be laid at once. A short extension of this afterwards to the local Stoke station would suffice for the load distribution for the next few years. Some further development of the general high-tension cable system would also be required from time to time. For the present £5,000 would be sufficient for the additional high-tension cable. A proper protective system ought to be included for the high-tension cables.

The total cost of the extension and improvements (possibly reduced to £89,000) would, therefore, be £102,000, the capital charges on which would be covered by the saving effected, and there would be a net surplus to carry forward. Demands made upon the Corporation by the Ministry of Munitions from time to time to give a supply to various works had not been met, with the result that local works plant had been installed at a greater cost, representing a national waste. Stoke was 30 miles from any other large electrical undertaking, and was not likely, therefore, to be included within any new and larger electrical district which might be set up; at any rate, not for many years. The electrical distribution area of Stoke would be greatly increased in the near future, and the Corporation would be asked to undertake the supply of electricity within a radius of 10 or 15 miles from the boundary. The high-tension system was of the right kind, collieries were actually within the district, and the sole difficulty was the want of ample condensing water. The next development of generating plant after the second 3,000 kw. had been installed should not be at Hanley, but on a site where coal can be delivered to the power station without cartage, and with room for adequate storage, where ashes could be easily removed, and where water could be obtained for "make up" purposes at the towers. If the Corporation did not establish their electricity undertaking in such a manner as to supply the wants of industrial users within Stoke and in the area surrounding Stoke, then it was certain that another authority would be set up to carry out that necessary work. He strongly advised the Corporation to face the responsibility of a well-established and wide power supply, and he was confident that if properly carried out the development would add to the prosperity of the borough. The Corporation had the right to purchase the greater part of the tramways system in 1924. Other parts (constructed under the Light Railway Acts) were purchasable in 1932. It would be in the public interest if the Corporation would now negotiate with the company to settle by consent a date for the purchase of the whole system, to shut down the company's two small generating stations and to purchase energy from the Corporation.

Australian Trade in 1917.

The report on the trade of Australia during 1917 by H.M. Trade Commissioner (Mr. G. T. Milne) states that at the end of 1917 there were 17,508 motor cars in use in New South Wales alone, against 14,175 on December 31, 1916, while commercial vehicles and motor cycle registrations also showed substantial increases.

The most serious difficulties with which commercial interests have been concerned were those arising out of the scarcity of tonnage. The shipbuilding proposals of the Commonwealth Government have so far taken shape that a Supervisor of Ship Construction appointed by the Federal Government was actively engaged in the early part of 1918 in making arrangements for the immediate construction of several steamers. As far as possible, Australian materials and labour will be employed in the construction of the vessels, and the engines will be built locally.

Although expenditure on railway construction has had to be curtailed to some extent, about 941 miles of new lines were completed by the State Governments during the year ending June 30, 1917.

The new mileage added was greatest in Queensland and New South Wales. At the date mentioned, over 1,700 miles of new lines were also reported as being under construction, close on 800 miles of which are in New South Wales. The most important event in connection with railway construction during the year was the completion by the Commonwealth Government of the Transcontinental Railway, which joins Port Augusta, at the head of Spencer Gulf in South Australia, to Kalgoorlie, Western Australia. This line, which was begun in 1912 and which was completed in October, 1917, has cost, approximately, £7,000,000. The distance between Port Augusta and Kalgoorlie is 1,051 miles, and the time occupied in covering the distance is 33 hours, inclusive of stops. It will now be possible to travel by rail from Fremantle, Western Australia, to Brisbane, Queensland, but it should be observed that there are no fewer than five points at which changes in the gauge occur and where it is necessary to change from one train to another.

In the whole range of imports of metals and machinery the most striking decline was in rails, fishplates, bolts, points, crossings, &c. In 1913 the value of these articles was £1,282,355, while in 1916–17 it only amounted to about £73,000. Wire netting imports have almost ceased, and only about one-fourth of the quantity of iron and steel wire imported in 1913 entered the country in 1916–17 at about double the price officially recorded in the earlier year. For railway and constructional material, the local market is increasingly depended upon to meet the demand. With regard to plate and sheet and fencing wire, the position is one of greater difficulty, as these staples are not yet manufactured in the country. Importers have been obliged to get from the United States many items formerly obtained in the United Kingdom. With the exception of Belgium, none of the other allied countries has figured largely as sources of supply in the hardware and metal trades, and up till the present the export of Japanese heavy lines is largely confined to brass and copper bars, rods, sheet pipes and tubes. It is stated that steel wire ropes of Japanese manufacture for use in mines, lifts, &c., are about to be placed on the market. Complaints are numerous as to the unsatisfactory character of many Japanese goods, and to Japanese conditions of trading generally. Importers express their readiness to revert to the United Kingdom as their source of supply when conditions permit. The important market for agricultural machinery is largely catered for by Canadian and American manufacturers, and also in an increasing degree by the local manufacturer. In connection with dairying machinery and appliances, the market is an important one and likely to expand.

ELECTRICAL EQUIPMENT.

The market for electrical machinery and equipment of every kind is important and certain to grow rapidly. Various schemes for the production and transmission of electrical energy are under consideration at present, but are held up owing to the war. The United Kingdom's chief competitor in this trade is the United States, although Italy and Sweden also contribute. As regards appliances other than machinery, Japan has made rapid progress. Recently, a Japanese firm introduced a wire-covered cable with a label attached to the coil bearing the letters "C.M.A.," the obvious inference by the uninitiated being that the firm is a member of the Cable Makers' Association. As the result of representations made by Mr. Milne to the Department of Customs, it has been decided to regard the letters "C.M.A." or the word "Association," when unqualified, as indication that the manufacturer of the goods is associated with the British Cable Makers' Association, and that the goods have been manufactured in accordance with the specification of that Association. It has also been decided that statements such as "guaranteed equal in all respects to C.M.A. product of imilar grade" may be used on wires and cables manufactured by non-members of the Cable Makers' Association, provided that the goods are thereby correctly described. The latter part of this somewhat important decision appears to throw on the Customs Department the obligation of seeing that the goods are correctly described.

MINING MACHINERY, &C.

The decline in the imports of mining machinery is explained to some extent by the conditions of the industry and by the fact that much of the mining equipment throughout the country, other than electrical, is manufactured locally. The output of silver, as well as lead, from well-known mines, has increased. The output of zinc has declined during the war, but the causes of this are regarded as being temporary. Tin and

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copper also show some decline, but it is probable that, under normal conditions, the output of these metals may increase. The winding engines and pumping plant on some of the mines are of local manufacture, while, at Broken Hill, jigs, concentrating tables embodying the features of well-known tables of overseas origin, and tube mills, formerly made by Krupp, of Essen, are all made locally. Roll shells used in the reduction of zinc-lead ores formerly imported from the United Kingdom and Germany, are now also made in Melbourne and Sydney. American manufactures retain their supremacy in rock drills and coal-cutting machinery, and such competition as there is from the United Kingdom is not pronounced. Until recently the output of the steel works of the Broken Hill Pty. Co. (Newcastle, N.S.W.), on which about £2,500,000 have been expended, was largely confined to steel rails and structural material, but merchant bars are now being turned out, while a continuous rod mill imported from the United States has been erected for rolling wire rods. An additional blast furnace, which will double the output of the works, has been installed, as well as a steel foundry where all the heavy castings for the new plant can be made. The equipment for producing plate for ship building has been completed, and it is stated that steamers can be constructed in Australia of material manufactured in the Commonwealth.

A Newcastle engineering firm has recently designed and constructed an electrically driven three high mill for rolling merchant bars, and it is stated that the mill is running satisfactorily. At their works at Alexandria, near Sydney, the Australian Electric Steel Co. is installing their second electric furnace. In view of the demand for their products, this Company contemplates installing an electric steel furnace in Western Australia in order to supply material required for the mining industry. It is also proposed to erect an electric furnace in Melbourne. At the Alexandria works of the Company a furnace for the manufacture of ferro silicon, which in the past has had to be imported, is also being installed. At Alexandria steel ingots of a kind suitable for railway tyres are turned out, and although at present there is no tyre mill in Australia, forged weldless steel tyres are being made by a 500-ton combined steam and hydraulic press by a firm at Castlemaine, Victoria. The steel blooms or ingots are supplied by the Australian Electric Steel Co. and also by the Broken Hill Pty. Co. The Castlemaine firm has had orders from several of the State railways, including an order from the New South Wales Government Tramways for 1,500 tyres. The Australian Electric Steel Co. has supplied the mining companies at Broken Hill with a certain amount of plant, including chrome steel "roll shells," which were formerly imported from Germany and the United Kingdom.

The Colonial Ammunition Co., of Melbourne, have recently made considerable additions to their works, and are now placing on the market brass, copper, aluminium and nickel silver sheets. A company, with which copper-producing interests are identified, is installing plant at Port Kembla, New South Wales, for the manufacture of copper sheet and wire.

Patent Record.

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

October 10, 1918.

16,469 COBBOLD. Electrical speed-indicator.
16,482 SIMPLEX CONDUITS, LTD., & WATERHOUSE. Electric switches.
16,490 BOWEN & INSLEY. Tramway track.
16,491 B. T.-H. CO. (G. E. Co.) Controlling alternating electric currents.
16,522 EASTERN TELEGRAPH CO. & BARWELL. Electrical Relays.
16,536 O'NEILL. Bayonet-joint sockets for electric lamps.

October 11, 1918.

16,546 BRAND. Trolley guide for electric tramcars.
16,549 CRICHTON. Apparatus for electric welding.
16,575 BROOKES. Electric switch.
16,576 KEENAN. Securing electric circuit wires in concrete structures.
16,582 CROSS. (Hulfish.) Automatic telephone systems.
16,593 SHIPMAN. Trolley shoes.
16,603 REUBENSTONE. Registering attachments for telephones.
16,612 ETAB. L. ROSENGART. Portable electric lamps. (27/10/17, France.)

October 12, 1918.

16,631 ALLTREE. Ignition magnetos.
16,653 BERRY. Portable accumulators.
16,659 ELECTRICAL IMPROVEMENTS, LTD., & BEARD. Protective arrangements for distributing cables, &c.
16,669 THOMPSON & WOOD. Utilising waste heat in electrical machinery and apparatus.
16,673 MORGAN CRUCIBLE CO. & SPEIRS. Current-regulating devices for electrically heated crucible retorts, &c.
16,675 IGRANIC ELECTRIC CO. Measuring instruments.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Captain of the Week.—Capt. W. Hynam.

Next for Duty.—Capt. W. D. Bentley.

Monday, Nov. 18, to Saturday, Nov. 23.—Drills as usual.

Sunday, Nov. 24.—Commandant's parade at Waterloo Station, 9 a.m. for Inspection at Esher. Drill Order. Midday and tea rations to be carried.

Demobilisation Problems.

In the House of Commons on Tuesday the Minister of Reconstruction, Dr. Addison, made a statement on the plans of the Government for demobilisation and the re-establishment of industry on a peace basis, &c. He said the fundamental principle was that demobilisation, subject to military needs, must be governed by industrial requirements and broad social considerations. "Demobilisers" and pivotal men would be brought back at the earliest possible moment.

It was proposed that State assistance should be given in respect of apprentices whose apprenticeship had been interrupted by war service.

Arrangements were being made by the Shipping Controller which would render it possible to import as large a quantity of foreign ore as was imported prior to the war. It was proposed to release iron and steel forthwith, but it was intended to continue Orders fixing for a period a maximum price for steel. With regard to other metals, there was a sufficient supply available to render it possible to release some from control now and nearly all the rest within six months. With regard to wool, cotton, jute, leather, &c., the situation would soon be relieved by the reduction in military orders and by imports.

A number of advisory bodies, other than reporting committees, have been appointed by the Minister of Reconstruction to report on specific terms of reference and to advise on different aspects of the various problems which come before him. In the first place there is an Advisory Council, which is divided into five sections, viz., Finance, Transport and Common Services; Production and Commercial Organisation; Labour and Industrial Organisation; Rural Development and Social Development. There is an Advisory Council on the Disposal of Surplus Government property, and there are a number of special committees, including the Engineering Trades (New Industries) Committee, which has several branch committees, including those for wire machinery, machine tools, electrical apparatus, textile machinery, aircraft, scientific instruments, miscellaneous machinery and the motor industry. There are also committees to advise on the supply of raw materials, metals, &c.

Legal Intelligence.

Assessment of Engineering Works.

A case of importance to occupiers of manufacturing premises containing machinery was decided last week at Middlesex Quarter Sessions. Messrs. S. Smith & Sons (Motor Accessories), Ltd., appealed against the assessment of their works at Cricklewood, the respondents being the Assessment Committee of the parish of Willesden. The appeal was in respect of a rate made in April, 1917, and chargeable in two instalments, the assessments for the first instalment being £3,645 gross, estimated rental and ratable value £2,430; and for the second instalment £4,720 gross and £3,147 ratable value. The ground of objection was that, in arriving at the assessment, the machinery upon the premises had been rated and that the assessments were thereby excessive, and not in accordance with legal decisions. The valuers for the Assessment Committee claimed that by the decision in Kirby *v.* Hunslet (1905) they were entitled to value the engineering machinery as if it were ratable.

The Court decided against the Committee and reduced the ratable value for the first instalment of the rate from £2,430 to £1,437, and for the second instalment from £3,147 to £1,915.

Alien Enemy Patents.

The Controller-General of Patents (Mr. Temple Franks) was recently asked by Messrs. Howard S. Cooke & Company, Birmingham, for a licence to use patent No. 26,436 of 1907, granted to Robert Bosch (of Stuttgart), for improvements in sparking plugs.

Mr. COLEFAX, K.C. (for applicants) explained that two previous licences had been granted—the first to Mr. Suckling, and the second to a firm of Blumell Bros. A licence was not asked for on the same terms as to royalty. The plug was of a type which could be applied to all kinds of mechanical transport and to aeroplanes, and the main feature of improvement was that it gave a guarantee against leakage.

Mr. HUNTER GRAY, K.C., on behalf of Mr. Suckling, opposed, and urged that it was inadvisable to create a multiplicity of licensees, and the best policy was to grant licences only as the demand required.

Mr. TEMPLE FRANKS thought the licence ought to issue in that case, and he would report to the Board of Trade to that effect.

Re Siemens Bros. & Co.

Last week, Mr. Justice Astbury gave judgment in two actions, one brought by Messrs. W. L. M. Burns and C. E. Hambro against Siemens Bros. & Company, Ltd., and the other an action by the company against Mr. Hambro and Mr. Burns, both actions being mainly in connection with the rights of the shareholders in Siemens Brothers Dynamo Works, Limited. Both Mr. Burns and Mr. Hambro were debenture stock trustees and as part of their security they held 19,993 fully-paid shares of £10 each in the Dynamo Company out of a total of £20,000 of such shares, and the dispute which arose was between the mortgagor company, Siemens Bros. & Company, and the subsidiary company, the Dynamo Company, on the one hand, and the trustees, on the other, as to the rights of the latter to vote in respect of these shares.

Mr. Justice ASTBURY held that the trustees were entitled to have their names so entered on the register as to enable them to be in a position to exercise their admitted voting power in the event of one of them being unable to be present at any meeting. He made a declaration to that effect and ordered the defendant company to pay the costs.

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Commercial Topics.

Boiler Sales.

It is announced that no further permits for the sale by public auction of any boilers to which the Boilers (Control) Order, 1918, applies will be issued, and therefore no sales by auction of such boilers may be held.

* * * *

Excess Profits Decision.

The Board of Referees has, on the application of Erinoid, Ltd., increased the statutory percentage as respects "the business of the production from casein by pressure and chemical process of a horn-like material which is non-inflammable and non-conducting" to 7½ per cent. in the case of a business owned by a company or body corporate, and to 7½ per cent. plus 2 per cent. in the case of any other trade or business.

* * * *

Demobilisation of Munition Works.

The Minister of Munitions has appointed a Demobilisation Board to deal with all measures affecting the demobilisation of munition works and the liquidation of contracts, apart from the questions assigned to the Resettlement Board under the Minister of Labour. The Board will consist of the following members:—

Sir James Stevenson, Bart., chairman; Mr. H. H. Piggott, C.B.E. secretariat; Sir Stephenson Kent, K.C.B., labour; Mr. W. T. Layton, C.B.E., priority; Sir Arthur Duckham, K.C.B., liquidation of contracts (aircraft and engines); Sir Gilbert Garnsey, K.B.E., liquidation of contracts (all other contracts); Mr. Alexander Walker, disposal and sale of stores; Sir Keith Price, disposal of factories, &c.; and Major-General the Hon. Sir F. R. Bingham, K.C.M.G., military services.

The Secretary of the Ministry (Sir W. Graham Greene, K.C.B.), the Assistant Secretary (Mr. J. E. Masterton Smith, C.B.), and the Chairman of the Finance Committee will be *ex-officio* members of the Board. The Board will be assisted by the following expert advisers: Mr. S. Dannreuther, C.B., Sir Philip Henriques, K.B.E., Sir John Mann, K.B.E., and Mr. W. J. Larke, O.B.E. Financial Department representatives will also be attached to members of the Board.

* * * *

Electricity Supply Connections.

By an Order (dated Nov. 8) of the Minister of Munitions, no person shall, except under and in accordance with the terms of a permit issued under the authority of the Minister:—

(*a*) Connect or cause to be connected to any source or means of supply of electricity any place or any building, premises or plant or any part thereof not so connected at the date, or

(*b*) Supply or cause to be supplied any electricity to any place or any building, premises or plant or any part thereof not supplied with electricity at the date of the Order, or

(*c*) Use or cause to be used any electricity in or at any such place, building or premises or for the purpose of any such plant as hereinbefore mentioned.

Provided that in any case coming within the scope of the Household Fuel and Lighting Order, 1918, or the Household Fuel and Lighting (Scotland) Order, 1918, as defined by Clause 1 of these Orders respectively, where the previous assent of the Local Fuel Overseer is required and has been duly obtained to any fitting, equipment or supply under Clause 99 of the first mentioned Order or Clause 77 of the secondly mentioned Order, no permit shall be required for such fitting, equipment or supply or the use of such supply.

All applications with reference to this Order should be addressed to the Director of Electric Power Supply, Ministry of Munitions, 8, Northumberland avenue, London, W.C. 2. This Order may be cited as The Electricity (Restriction of New Supply) Order, 1918.

The permission required by the Order is in addition to and not in lieu of usual priority certificates and permit reference number.

* * * *

Control of Non-Ferrous Metals.

During the sittings of the Imperial War Conference in June the position of the non-ferrous metal industry was discussed, and it was resolved that, "in pursuance of the policy of freeing the Empire from dependence on German controlled organisations in respect of non-ferrous metals and ores, the Conference endorses the principle of the Non-Ferous Metal Industry Act of the United Kingdom, and recommends the Governments of the Empire to adopt effective measures, in so far as these may be necessary and have not already been taken, to carry out this policy."

The above resolution was passed after consideration of a memorandum which was prepared by the Board of Trade. In this memorandum some particulars were given of the extent to which the industry was controlled by German companies, their methods of procedure, &c. The position of the German interests was so strong that they were able to force the smelters of these metals in other countries into the International Lead and the International Spelter Convention, which regulated the world's prices: and by controlling the market the German interests were able in some cases to restrict the development of the smelting of the metals elsewhere than in Germany. The influence of the German metal organisations was very extensive in the case of zinc and lead (*e.g.*, they controlled by long-period contracts the output of Australian zinc concentrates, the raw material of spelter); and there were indications that endeavours were being made at the time of the outbreak of war to acquire a controlling influence over other metals, particularly copper and nickel. The present development of the non-ferrous metal industries is for the most part a modern growth, and the high development of scientific training and industrial research in Germany undoubtedly assisted that country in its efforts to obtain a preponderating influence in respect of non-ferrous metals; while in this, as in others of the newer branches of production, this country has fallen seriously behind both Germany and the United States. The control of the non-ferrous metal trade of the world by Germans or German-controlled interests, and the weak condition of the native industry, have been a cause of grave embarrassment to the Allied Governments during the war; and it is essential that this position, in view of its obvious dangers in peace as in war, should not be renewed. His Majesty's Government endorsed the view that German influence should be completely excluded from the non-ferrous metal industry of the United Kingdom for at least a period sufficiently long to allow the establishment of a strong industry in this country under British control. For this reason the Non-Ferrous Metal Industry Act was passed, and the main provisions of that Act are set out.

Electricity Supply.

LURGAN URBAN COUNCIL has decided to erect electric generating plant at the water works at Caster's Bay, Lough Neagh.

MORLEY TOWN COUNCIL has increased the maximum charge for electric current to 7d. per unit.

MAIDENHEAD CORPORATION has increased the charge for electric current for lighting by 1d. a unit and for power by 50 per cent. over pre-war rates.

It is announced that the ALUMINIUM CORPORATION have acquired the North Wales Power & Traction Company, of Snowdon, and are now working the concern.

The award of the Committee on Production granting to men of 18 and over in London electrical undertakings an increase of 3s. 6d., and to those under 18 1s. 9d. per week, is to be applied to the workmen of the NOTTINGHAM ELECTRICITY COMMITTEE.

WOKING ELECTRIC SUPPLY COMPANY has applied to the Board of Trade for permission to increase the maximum charge under their present provisional orders, viz., per quarter, for any amount up to 20 units 13s. 4d., and for each unit over 20 7d., to a flat rate of 8d. per unit.

In order to minimise as far as possible interruptions for the supply of current to tramways at WALSALL an additional feeder panel is to be installed and existing switches replaced by larger ones at an estimated cost of £410. A second 500 kw. rotary is also to be put in at an estimated cost of £3,370.

The City of London Retailers' Association has asked the Board of Trade for a relaxation of the lighting regulations for shops. The Association thinks that a trader should be permitted to use the light he is allowed where it is most advantageous to him, but at present no light is permitted in shop windows.

The Board of Trade recently decided that the application of the CHARING CROSS, WEST END & CITY ELECTRICITY SUPPLY COMPANY for power to increase the maximum prices chargeable under the City of London Electric Lighting Order, 1899, must be dealt with under the Statutory Undertakings (Temporary Increase of Charges) Act, 1918, as the facts of the case brought it within the class of undertaking entitled to relief under the Act. An order has now been made on the subject.

The Association of Electrical Power Engineers has applied to BOURNEMOUTH Council for an increase of salary to all technical engineers on the staff of the electric supply and tramways undertakings. The increase demanded is 20 per cent. of present salary, plus £90 per annum from March 31. The Incorporated Municipal Electrical Association is taking up the matter on behalf of the different municipalities.

ABERDEEN Wages Committee recommend that the wages of electrical workers over 18 years of age be increased by 3s. 6d. per week, and those under 18 by 1s. 9d. per week as from Oct. 1. The committee has refused an application by the Electrical Power Engineers' Association asking for an advance of 20 per cent. on the existing wages of the engineers of the electricity department, plus £90 per annum.

In our issue of the 1st inst. we stated that Messrs. Caird & Company, Ltd., of Greenock, had been authorised to erect an electric power station in their shipbuilding yard. This statement was inaccurate, but we learn that the local Dean of Guild Court has given Messrs. Caird & Company, Ltd. (now Messrs. Harland & Wolff, Ltd.) permission to erect a temporary sub station which will be supplied from the Greenock Corporation system.

The accounts of EAST HAM electricity fund for the year ended March 31 show gross capital expenditure £152,886 (increase £210), of which £75,756 has been repaid. Revenue was £29,177 (compared with £27,136 in previous year), total costs were £26,379 (£21,909), leaving gross profit £2,798 (£5,227). Capital and special charges were £10,372 (£10,764), deficit being £7,574 (£5,537). Total operating costs were 1·59d. (1·29d.) per unit sold. Maximum load was 1,722 (1,938) kw., and load-factor 2·99 (26·6) per cent. Units generated were 4,489,380 (4,518,260) and sold 3,962,904 (4,063,721).

The accounts of GRIMSBY ELECTRICITY DEPARTMENT for the year ended March 31 show gross capital expenditure £137,596 (increase £697), of which £70,564 is outstanding. Income was £28,999 (compared with £26,951 in previous year), and gross profit £9,961 (£10,742). Capital charges required £7,927 (£7,955), leaving net surplus, after deducting £873 for payments to employees with H.M. Forces, £1,104 (compared with £2,787, including payments to men on military service). Total costs were 1·392d. (1·228d.) per unit sold. Total connections are equal to 192,457 8 c.p. lamps. Units generated were 4,168,347 (4,149,192) and sold 3,281,279 (3,154,158). Maximum load was 1,540 (1,616) kw.

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Stepney (London) electricity supply accounts for the year ended March 31 show total capital expenditure £686,616 (increase £12,335), of which £474,232 is outstanding. Revenue was £146,103 (compared with £131,199 in previous year), and gross profit was £45,936 (£40,156). Interest on mortgage debenture required £18,737 (£19,567), instalments of principal £23,526 (£26,558), and the balance carried to appropriation account was £3,642. After providing for income tax, sums written off capital account for assets now non-existent, special expenditure, &c., the balance carried to reserve was £297. Costs per unit were 0·993d. (0·829d.) exclusive, and 1·415d. (1·232d.) inclusive of capital charges. Maximum supply into feeders was 9,757 kw. (9,490 kw.) Units generated were 29,659,586 (29,451,471), purchased in bulk 678,920 (3,358,911) and sold 24,880,717 (27,011,530).

At the meeting of the DERBY TOWN COUNCIL on Saturday, Ald. W. G. Wilkins, chairman of the Electricity Committee, referred to the progress of the proposal to link up East Midland towns. He explained that the towns affected were Derby, Nottingham, Leicester, Loughborough, Burton-on-Trent, Long Eaton, Ilkeston, Mansfield and Newark. They had combined for the purpose of engaging Sir John Snell and Mr. Worthington to report as to the most suitable area, and the best arrangements for securing the most economical supply of electricity in the district. The fee would be 1,000 guineas each, and another £2,000 would be expended in preparing the report. It was important that there should be as little delay as possible, because coalowners and others were preparing to supply the area on individualistic lines.

The action of the Electricity Committee in combining with the other authorities was approved.

Councillor Bruce Lindsay, convener of the EDINBURGH ELECTRIC LIGHTING COMMITTEE, entertained the members of his committee and officials at dinner on the 16th inst., when he expressed the hope that it would not be very long before a great many of the present restrictions were removed, and they would be able to approach the Board of Trade with some degree of confidence and get sanction to go ahead with their new station at Portobello. That project the Committee would endeavour to push forward to the utmost of their ability. During the past year 9,040,892 units were sold for lighting and 11,470,080 for power 304,075 public lighting and 130,357 traction, total, 20,945,404—an increase of 16·4 per cent. over the previous year. They were likely to extend the capacity of Dewar-place station owing almost wholly to representations made by the shipbuilding and ship repairing firms at Leith to the Admiralty. Leith and Edinburgh Councils put forward certain proposals, but the Leith scheme was rejected. The Edinburgh proposals were not adopted in entirety; but the extra supply was to come from the Dewar-place station, and it was for the Committee to get ahead with the proposed alterations.

A general meeting of the Midland division of the ELECTRICAL POWER ENGINEERS' ASSOCIATION was held at Birmingham on the 9th inst., when a large and representative gathering gave the president a hearty welcome on the occasion of his first meeting in Birmingham. Mr. Lunn, in the course of his address, reviewed the progress of the E.P.E.A., and indicated the probable course of action of the executive in the future. His statements regarding the policy of the Association were unanimously endorsed by the meeting.

At the recent meeting of the Divisional Executive Council of the Southern Division the following officers were elected for the ensuing year: *Chairman*, G. D. Bendix; *Hon. Secretary*, A. C. Bostel (3, Park-lane, Croydon); *Hon. Treasurer*, W. L. Leece; *Hon. Publicity Secretary*, T. W. Smith. Inquiries relating to divisional matters should be addressed to the hon. secretary, and information re membership, &c., may be obtained from the section hon. secretaries, as under:—

London Western Section, W. J. Wilcocks (8, Willow-avenue, Barnes, S.W. 13); London Central Section, E. N. Christmas (55, Calabria-road, N. 5); London Eastern Section, W. Sawford (74, St. Mary's-road, E. 10); London South Eastern Section, E. W. Martin (169, Well Hall-road, S.E. 9); South Coast Section, W. J. Gibbons (8, St. Andrew's-road, Portslade, Brighton); Portsmouth Section (pro tem.), P. L. Weir (112, Laburnum-grove, North End, Portsmouth); Bristol Section, F. F. Elliott (8, Glena-avenue, Knowle, Bristol).

Electric Traction.

The NEWPORT (MON) TRAMWAYS COMMITTEE has determined to establish an institute and mess-room for its tramway employees.

The fares on the system of the DUBLIN UNITED TRAMWAYS COMPANY have been again increased. On this occasion the increase is about 20 per cent., but in May last there was an increase of 50 per cent.

BLACKPOOL TRAMWAYS COMMITTEE has decided when the Fleetwood tramways are taken over at the end of the year to couple up the system with the Corporation lines. The committee will also seek powers to run 'buses to Bispham, Boulton and Marton.

The Committee on Production has awarded the men over 18 who are employed as car lifters, engineers' assistants and white-metal moulders at the engineering and car repair works of the BELFAST CORPORATION Tramways Department an advance of 3s. 6d. per full ordinary week, and boys, youths and apprentices under 18 years 1s. 9d. per week.

The EAST HAM tramway accounts for the year ended March 31 show total capital expenditure £196,683, of which £91,940 has been repaid or placed in sinking fund. Revenue was £71,237 (compared with £65,021 in previous year), and gross profit £7,321 (£7,813), and net result, after providing for interest and sinking fund, a deficit of £3,376 (£3,213). Revenue per car-mile was 11·85d. (10·04d.), and operating costs were 10·63d. (8·83d.). Passengers carried were 16,744,998 (18,618,654) and car-miles run 1,442,436 (1,554,164).

Imperial and Foreign Notes.

FLINDERS (VICTORIA) SHIRE COUNCIL has decided to borrow £3,600 for the erection of electric supply works.

MOSSEL BAY (CAPE PROVINCE) TOWN COUNCIL has formed a committee to inquire into the possibility of securing municipal electric lighting.

The Premier of BRITISH COLUMBIA has announced that the Government may convert to electric traction the North Vancouver section of the Pacific Great Eastern Railway after the war.

For the year ended June 30 last the earnings of the NEW SOUTH WALES TRAMWAYS were £1,992,641 (decrease £15,898), working expenses £1,603,260 (decrease £88,107), interest £348,546 (increase £13,185), number of passengers was 255,740,808 (decrease 39,562,902) and tram mileage 21,762,244 (decrease 3,589,748).

The daily output of the Risden (TASMANIA) works of the Electrolytic Zinc Company of Australia is 10 tons a day, but it is anticipated that this will in a short time be increased to 15 tons per day. In a few years Hobart will be treating annually from 80,000 to 100,000 tons of zinc concentrates from Broken Hill, giving an output of 35,000 to 40,000 tons.

The local CARBIDE WORKS have recently had a preliminary run. The electrodes used were of very poor quality, and did not prove as satisfactory as was anticipated. The factory has had to shut down pending the arrival of further electrodes. The company is erecting its own electrode factory, the machinery for which is in course of erection.

Mr. Jas. Gitsham, managing director of the C.M.C., Ltd., recently arrived in Tasmania to establish at Launceston works for the MANUFACTURE OF WHITE LEAD by the G.M.C. electrical method. It is stated that by this system galena is directly converted from PbS to $PbSO_4$. Mr. Gitsham claims that "one ton of galena can be put in and 24 cwt. of lead obtained, the increase in weight being due to the atmospheric oxygen, which combines the lead and the sulphur, thus giving the increased weight." A contract has been entered into with the Tasmanian Government for the supply of 400 H.P. of electrical energy to the company at ½d. per unit.

A co-operative society is to be formed at TRES ARROYOS, Province of Buenos Aires, Argentina, to undertake the erection and equipment of an electricity supply station.

The electric supply and tramway undertakings of the city of ASUNCION, Argentina, were recently purchased by the Cia. Americana de Luz y Traccion, which will extend the electricity works and convert the steam tramways to electric traction.

COPENHAGEN Municipal Corporation recently voted £173,300 for extensions of the municipal electricity works. The contract for the plant has been placed with a Swedish firm, which will supply a 10,000 kw. turbo-generator and three boilers.

The ARGENTINE BOARD OF NATIONAL SANITARY WORKS has been authorised to purchase from Messrs. Alsina y Cagnoni a 5-ton motor truck at $11,865 m/n (about £520). The same Board has also received authorisation to acquire at the same price from the "A.E.G." Electricity Company a motor truck of 5-6 tons capacity.

The ST. POLTEN-MARIAZELL (AUSTRIA) electric railway, which was recently equipped by the Austrian Siemens Schuckert Co., is over 56 miles long and the gauge is 30 in. The greatest gradient is 27 per cent.; Current is supplied at 6,000 volts (25 ~). The weight of the locomotives is 47 tons, and each is fitted with two 250 H.P. motors. The normal speed is 35 km. per hour, and the normal tractive effort of each locomotive 3,800 kg.

Miscellaneous.

We are glad to hear that the ever-welcome annual, "Winter's Pie," will be published on the 18th inst., and, judging by the list of eminent authors and artists who have contributed to its pages, it will come as a cheery gleam to those on active service, in hospitals and camps, or at home. "Winter's Pie" is published at 6, Great New-street, London, E.C., and is obtainable at all booksellers and bookstalls at 1s. 6d. net.

The Glasgow Branch of the Association of Engineering and Shipbuilding Draughtsmen recommend the association, as a national policy, to reject the Whitley scheme for the control of industry. The reasons for this attitude are that it gives the workers no real control over the industry, and that the formation of an Industrial Council will in no way lead to the desired goal—namely, the complete control of the various industries by the workers engaged therein.

The Mercantile Marine Service Association recently suggested to the Government the necessity for the installation of wireless apparatus on coasting vessels, but the Admiralty replied that there were objections to extending the Defence of the Realm Act to vessels below 1,600 tons. The Admiralty would, however, welcome any action which might be taken by shipowners to instal wireless telegraph apparatus in such of their vessels as were not covered by the Regulation quoted on board for which accommodation could be found for a wireless office and the necessary operators.

In a written reply to a recent question in the House of Commons, the Minister of Labour stated that NATIONAL JOINT INDUSTRIAL COUNCILS had been established in 17 industries, and each had held one or more full Council meetings. In a number of other industries the Ministry of Labour was giving assistance in the setting up of Councils. The Government had approved a scheme dealing with the application of the Whitley Report to the industrial establishments of the Government, and steps had been taken to place the scheme before the Trade Unions and Departments concerned.

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Tenders Invited and Accepted.

WARRINGTON ELECTRICITY AND TRAMWAYS COMMITTEE invites tenders for Underfeed Mechanical Stokers. Specifications from the Engineers, and tenders to the Chairman by noon Nov. 19.

WALSALL Corporation require tenders by Dec. 5 for supply and erection of 500kw. rotary converter equip ent. Specification from the Manager of the electricity department.

MANCHESTER Electricity Committee requires tenders by 10 a.m Nov. 29 for the supply and erection of three-phase 6,600-volt switchgear Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

The GREAT NORTH OF SCOTLAND RAILWAY COMPANY requires tenders by 10 a.m. Nov. 21 for 6 or 12 months' supply of telegraph materials, rubber goods, belting, castings, &c. Forms of tender from the Stores Superintendent, 80, Guild street, Aberdeen.

The SLIGO, LEITRIM & NORTHERN RAILWAY COMPANY require tenders by 10 a.m. Dec. 1 for 12 months' supply of stores, including electric telegraph materials, metals, leather belting, &c. Forms of tender from the Secretary, Enniskillen.

The TYNE IMPROVEMENT COMMISSIONERS require tenders by Nov. 21 for 6 months' supply of incandescent lamps, arc lamp carbons, castings, ironmongery, rubber goods, oils, &c. Forms of tender from the Manager and Secretary, Bewick-street, Newcastle-on-Tyne.

The UNION OF SOUTH AFRICA TENDER BOARD require tenders by 3 p.m. Dec. 18 for 800 yards underground telephone cable (paper insulated, lead sheathed, 306 twin conductors) and 800 yards ditto (204 twin conductors). Forms of tender, &c., from the Controller of Post Office Stores, Palace of Justice, Pretoria, or the District Stores Clerks, Capetown, Johannesburg, Durban, &c.

LEEK URBAN COUNCIL has placed an order for the supply of a 310 H.P. horizontal gas engine for the electricity works with the National Gas Engine Company, at £3,300.

WOLVERHAMPTON TOWN COUNCIL has accepted the following tenders: Chloride Electrical Storage Company, electric vehicle battery, £145; J. Spencer, Ltd., steam pipes, £210; Alley & McLellan, 24 in. sluice valve for water-pipe system, £63; Messrs. Gibbons & Company, turbine platform, railings, &c., £188, plus £32 for contingencies.

SALFORD TOWN COUNCIL has accepted the following tenders: Callender's Cable & Construction Company, 33,000 volt trifurcating box, &c., required in connection with bulk supply by Manchester Corporation, £394: Ed. Bennis & Company, six machine stokers, £195 each; British Electric Transformer Company, one 500 k.v.a. three-phase transformer.

BARROW-IN-FURNESS Council has accepted the following tenders: Babcock & Wilcox, chequerplates and ironwork for turbo-alternator foundations; F. Braby & Company, feed tank; J. Spencer, Ltd., w.i. pipes and fittings; British Insulated & Helsby Cables, cables; British Thomson-Houston Company, alterations and additions to e.h.t. switchgear for turbo-alternator; Ferranti, Ltd., three ironclad e.h.t. switch panels; General Electric Company, meters.

DERBY CORPORATION has accepted the following tenders: Dempster & Sons, electric capstan, £595; Babcock & Wilcox, economiser-stokers; &c., £4,747; G. & J. Weir, Ltd., turbine-driven feed pumps, £416. 10s.; British Thomson-Houston Company, switchgear, £948; E. Morley & Sons, boiler foundations, &c., £643; Aiton & Co., steam and water piping, &c., £1,974; Chain Belt Engineering Company, extension of coal bunkers and conveyors £6,000, ash conveyor £295, elevator and bunker, £1,550.

Appointments Vacant and Filled.

Applications are invited for the position of professor of physics in the University of Cape Town. Salary £800 per annum. Applications by Jan. 1 to the High Commissioner for the Union of South Africa (32, Victoria street, London, S.W.1), from whom particulars can be obtained.

POPLAR (LONDON) BOROUGH COUNCIL has appointed Mr. L. C. Templeman charge engineer at £150 per annum, rising to £185. Mr. H. W. Underhill, station electrician, has been placed in grade 5 at a salary of £162. 10s. per annum, rising to £185.

Mr. J. Townley, works superintendent at the Hylton-road electricity works of Sunderland Corporation, has been appointed, and has now taken up his duties as acting borough electrical engineer to the BARNSLEY CORPORATION ELECTRICITY DEPARTMENT.

Business Items.

Philip Arthur Newton and Leonard Arthur Newton (at present serving in H.M. Army), carrying on business as Newton & Son, patent agents, 6, Bream's-buildings, London, E.C. 4, have dissolved partnership. Debts by Mr. P. A. Newton.

Messrs. Watson & Sons (Electromedical), Ltd., have issued their Bulletin 18A, which deals with high-tension transformers and rotating rectifiers.

Mr. W. Holehouse, managing director of the Davenport Engineering Company, Ltd., has severed his connection with the company, and has commenced business at 21, Morley-street, Bradford, on his own account, to design and manufacture special cooling plant for large turbines.

Automatic & Electric Furnaces, Ltd., have recently issued Nos. 3 and 4 of their Heat Treatment Bulletins. No. 3 gives several examples of the articles now being hardened by their process, and No. 4 deals with the effect of tempering on water-quenched gauges, and contains instructions for using the Wild-Barfield furnace.

Companies' Meetings and Reports, &c.

The directors of the WEST AFRICAN TELEGRAPH COMPANY, LTD., have declared an interim dividend at the rate of 4 per cent. per annum for the half-year to June 30 last.

An interim dividend of 2½ per cent. (6d. per share) has been declared on the shares of the INDIAN ELECTRIC SUPPLY & TRACTION COMPANY, LTD., for the past half-year.

The directors of the ANGLO-PORTUGUESE TELEPHONE COMPANY have declared an interim dividend of 3 per cent., less tax, on account of the year 1918.

The CITY OF BUENOS AYRES TRAMWAYS COMPANY has declared a dividend of 1s 3d. per share (being at rate of 5 per cent. per annum), less tax, for the three months to Sept. 30.

The income of the MONTREAL TRAMWAYS COMPANY for the year ended June 30 was $5,526,796, against $7,725,499 in 1916-17, and $856,449 was brought forward. Charges aggregated $5,830,787, leaving profits of $552,458.

The directors of the WEST INDIA & PANAMA TELEGRAPH COMPANY announce the payment on the 28th inst. of the following interim dividends for the six months to June 30, 1918: 6s. per share on the first and second preference shares, and 6d. per share on the ordinary shares, tax free.

The directors of STOTHERT & PITT, LTD., have declared a dividend for the past year of 10 per cent. (2s. per share), tax free, on the ordinary shares. A sum of £5,000 has been placed to reserve; £2,579 in reduction of premises; £2,000 written off drawings and patents, £2,000 to a fund for pensioning old employees and £11,394 forward.

The directors of the NORTH METROPOLITAN ELECTRIC POWER SUPPLY COMPANY have convened an extraordinary general meeting for the 26 inst., for the purpose of considering and passing a resolution authorising the company to raise the remaining unissued portions of the capital (£259,980) by the issue of preference shares ranking *pari passu* with those existing.

The report of the CITY OF SAN PAULO IMPROVEMENTS AND FREEHOLD LAND COMPANY for the year ended Dec. 31 last states that at the end of the year 1,660 metres of tramway lines were laid and 785 metres of electric lighting mains. The Armour Company of Brazil is constructing a large packing factory close to one of the company's properties, which will employ several thousand workpeople, and negotiations are proceeding for the construction of railroad and tramway connections and sidings.

The report of the MANAOS TRAMWAYS & LIGHT COMPANY for the year ended April 30 last states that the gross earnings from all departments were £122,495, compared with £120,387, while operating expenses increased from £82,511 to £84,003. The net operating revenue increased from £37,876 to £38,492. After providing for debenture interest, sinking fund, interest on loan, London office expenses, &c., the balance is £10,564. The directors have placed to renewals reserve £5,000, leaving £5,564, or with £6,292 brought in £11,856, which it is proposed to carry forward. The directors consider it prudent to set aside this sum to provide for future renewals, which are practically impossible at present owing to the difficulty of obtaining the necessary materials.

Details of the proposed revision of the capital of the BRITISH WESTINGHOUSE ELECTRIC & MFG. COMPANY will be laid before shareholders on Tuesday next. The directors propose that the Company be empowered to form subsidiary undertakings at home and abroad. The capital will be increased to £6,395,000 by the creation and issue of 5,000,000 ordinary shares of £1 each, which, after an 8 per cent. non-cumulative dividend has been paid on the 685,000 preference shares of £2 each, will rank for 30 per cent. non-cumulative, before the deferred shares. After the latter have been paid, 7½ per cent. ordinary shareholders will receive the balance of profits. The Board's fees are to be fixed at £11,000 a year, excluding the managing director and local boards.

The disposable balance of the UNITED ELECTRIC TRAMWAYS OF CARACAS for the year ended June 30 (including £1,899 brought forward) was £19,194. The directors recommend a dividend for the year at the same rate as last year—namely, 7 per cent. (less tax)—and to carry forward £7,294. The gross receipts of the local company (the whole capital of which is owned by this company) were Bs1,557,644, against Bs1,425,756; operating expenses Bs766,225, against Bs753,524, net receipts being Bs791,419, against Bs672,231, which at exchange of 25·25 equals £31,343, against £26,623. After adding Bs539,809 brought in, providing for mortgage interest, setting aside Bs50,000 to reserve and renewal funds, and paying a dividend amounting to Bs483,869, the local company carry forward the same amount as last year.

For the past year the profit of the Cape Electric Tramways, Ltd., was £88,512, and after providing for debenture interest, redemption of debentures, and crediting amount brought forward, the net balance is £42,391. From this amount the reserve fund has been credited with £12,000, leaving £30,391, out of which the directors recommend a dividend of 5 per cent. on the ordinary share capital, leaving £5,830 to be carried forward. During the year 26,444,465 passengers were carried, the earnings being £264,137, against 23,752,016 passengers and £231,105 in 1916-17. The increase in the traffic receipts on both the Cape Town and Port Elizabeth systems has been more than maintained, and shows a substantial increase on the previous year. The high cost of supplies and the further rise in wages, have not permitted any reduction in the ratio of the working expenditure, but the profits earned on account of the heavier traffic show an increase of £8,420.

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CONTENTS.

Notes 605
Arrangements for the Week 607
Electric Furnaces in Metallurgy. Illustrated.—*Concluded* 608
Electrical Engineering as Taught in American Colleges. By Alexander Gray, M.Sc., Whit.Sch.—*Concluded* 610
Patent Law Amendment 612
The Effect of Power-Factor on Output of Retary Converters With Reactance Control. By R. G. Jakeman, B.Sc. Illustrated ... 614
The Dynamical Theory of Electric Engines. Illustrated 616
Patent Legislation 618
Review 618
Electric Welding for Shipbuilding 619
The Applications of Electricity in Ships and Shipbuilding. By J. F. Nielson 621
Allocation of Generating Plant by the Ministry of Munitions 622
London Electricians' Wages 622
Batti-Wallahs' Society 623
Hardware Exports 623
Legal Intelligence 623
Patent Record 624
Commercial Topics 625
Electricity Supply 625
Tenders Invited and Accepted 627
Companies' Meetings and Reports 627

Notes.

Demobilisation.

One of the greatest problems, and one of the most urgent, which is immediately before us is that of demobilisation of the Army, excepting such part as may be required to be kept on a permanent basis. It may, perhaps, be said that a certain proportion of the demobilisation, and even a large part, is not very urgent, and cannot, in fact, be carried out for some time to come. What may, however, be described as the smaller portion is extremely urgent. We all remember the importance that was attached to the first 100,000 which Kitchener demanded in the first days of the war. It may be said that the first 100,000 of demobilised men are of equal importance at the present moment for our industries. It will be impossible for us to begin seriously to get to work until certain classes of men are released. These are more particularly pivotal men, upon whom the employment of large numbers of less skilled men depend. A pamphlet has just come to hand, published by the Ministry of Reconstruction, in which the urgency of the problem is fully admitted, and the desire is expressed that the work should be carried out as rapidly and as equitably as possible. There are probably, however, large numbers of people who have no conception of what demobilisation really means, or the magnitude of the problem. With the best intentions in the world, some millions of men cannot be demobilised in a very short time. If there were no other difficulty, that of transport alone would be sufficient to set a limit. Nevertheless, it is clear that a great deal can be done, and done quickly, to relieve our industries at the present time. We think, for example, that, without being unfair to those who have served a considerable time, those men who were exempted until quite recently for business reasons might well be discharged immediately. More than usual consideration should also be given to those who left one-man businesses, and who have suffered special hardship through their country's demands. The pamphlet before us is clearly written, and will do much to clear up the position when placed in the hands of men in the ranks. There appears, however, to us to be one omission. There is no indication of what an employer should do who wishes to get back one of his employees with the least possible delay. There should surely be some machinery through which the employer could apply, apart altogether from the routine applications made by employees themselves.

The Allocation of Plant by the M.M.

During the past four years there have been extensions of plant at many electricity supply stations, but owing to the very large demand in other directions such extensions were necessarily restricted, and the matter was placed in the hands of the Director of Electric Supply at the Ministry of Munitions. It is common knowledge that dissatisfaction at the result has been expressed by some municipal undertakings, it being felt that company undertakings were favoured, more particularly the Power Company on the North-East Coast. Colour was, no doubt, given to this view by the fact that both engineers who have held the position of director have been associated with this company. This feeling of discontent culminated recently in a circular issued by the Council of the Incorporated Municipal Electrical Association to members of Parliament. In this circular the somewhat curious statement was made that the Association represents practically the whole of the electricity supply undertakings in Britain, and there was a request that impartiality should be shown in deciding future applications for plant. In our present issue we are able to publish some official figures relating to this subject, and for the first time it will become public knowledge what an enormous expansion there has been in our power stations during the war. From this statement it appears that the total plant at June 30, 1914, in stations extended since that date, was 851,756 kw., and this has been increased by authorising 969,525 kw., some of which is still in progress. This does not include 50,000 kw. sanctioned for Sheffield as soon as the linking-up scheme with Rotherham is signed. The important point, however, is the comparison between what has been done for municipalities and for companies respectively, more particularly for the North-East Coast. From these figures we think that there is very little ground for the complaint which has been made, though it is easy to understand that a feeling of dissatisfaction can arise when restrictions are necessarily in force and when it is not publicly known what is being done in other directions.

Dick, Kerr & Co.

At the annual general meeting of Messrs. Dick, Kerr & Co., Ltd., last week the Chairman disclosed a progressive policy similar to that followed by several other undertakings, and having for its object the strengthening of the Company's position so as to afford adequate manufacturing facilities for some years to come. With that aim in view there has been a consolidation with the organisations of Willans & Robinson and the United Electric Car Co., and an alliance has

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also been formed with Siemens Brothers & Co. Owing to the fact that there is very little competition between Messrs. Dick, Kerr & Co. and the last-named firm, the combination is likely to be very advantageous. As is well known, Messrs. Siemens Brothers manufacture all kinds of cable, telephones, instruments, dynamos and motors, while Messrs. Dick, Kerr & Co. have specialised in apparatus for railways and tramways, steam turbines and the larger classes of electrical machinery. Consequently, the one company is largely complementary to the other. To enable the largest class of electrical work to be manufactured, Messrs. Dick, Kerr & Co. have entered into an optional agreement with the Coventry Ordnance Works, Ltd., with a view to utilising these works, which are at present engaged on war equipment, but which will be very suitable for the heaviest work required in electrical engineering. From what has been said it will be gathered that Messrs. Dick, Kerr & Co. will be in a very strong position in the immediate future.

The Kelvin Lecture.

IN our present issue we are now able to give a short account of the Kelvin Lecture delivered by Mr. LLEWELLYN ATKINSON. The Lecture is lengthy, and under present restrictions we are only able to give a very brief sketch of the ground that it covers. The subject taken was the "Theory of Electric Engines," and this was considered on the lines of the familiar Carnot cycle in theory of the steam engine. A large number of cases were taken, either electrostatic or electromagnetic, and it was shown that the theoretical efficiency, neglecting such losses as those due to the resistance of conductors, was generally either one-half or unity. Whether this treatment of the subject will lead to useful practical results we must leave for future developments to demonstrate. It may well be, however, that if, as Mr. ATKINSON remarks, one-tenth of the energy which has been given to the development of the magneto in this country during the last four years had been given to the development of an electrostatic generator a useful result might very possibly have been obtained, and a machine which would have been much cheaper and simpler. We have seen an electrostatic generator which was designed for this very purpose, and which certainly gave interesting results; but, unfortunately, there are limitations to the quantity of electricity so generated which introduces difficulties. Possibly this may yet be eliminated. In any case, there is no question that it is often an advantage to go back to the fundamentals of a subject, to disregard the superstructure which has grown upon them, and to see whether our ideas are as clear as they should be on the theories we have assumed, or at least that we have often taken for granted without reinvestigation. We are apt to grow up with ideas which, although perfectly correct at the time we received them, are rendered invalid by later developments, and they then become a source of weakness instead of strength.

Electric Appliances at Sea.

IN his inaugural address before the Scottish Local Section of the Institution of Electrical Engineers, Mr. J. F. NIELSON recently gave an interesting summary of the applications of electricity at sea. The achievements of wireless telegraphy are common knowledge; electric motors are widely used for auxiliary machinery; electric ship propulsion, at least for battleships, appears to have a future. In addition, electric welding has made great strides during the war, while there are many special appliances, such as the gyro-compass, which are invaluable when conditions of cost are not insuperable. We feel sure, however, that the possible applications of electricity at sea are by no means exhausted, and we are somewhat surprised that in one field—electric cooking—greater progress has not been made. The growth of electric cooking naturally pre-supposes an electrical supply, and no doubt the cost is also a consideration. Anyone who has read an account of a storm at sea must have been impressed by the difficulty of continuing cooking in the ordinary way in view of the violent motion of the ship and the liability of the extinction of the galley fires by stray waves. To men facing such severe exposure it is a great handicap to be unable to obtain hot drink and food. We think it would be worth consideration whether electric cooking could not be more freely utilised as a supplementary process, as it would naturally not be subject to the same extreme difficulties in the event of rough weather.

Federation of British Industries.—The Federation has passed resolutions of homage and congratulation to the King, of appreciation to the forces, of thanks to Mr. Lloyd George, and of hearty appreciation to the staffs and workpeople of manufacturing and business establishments on the occasion of victory.

University College Engineering Society (London).—The University College Engineering Society (London) is holding two meetings, on November 22nd and November 29th. At the first of these a Paper will be read by Mr. E. N. Varian on "Agricultural Machines"; and at the second a Paper by Mr. H. S. Kleinberg on "Industrial Reconstruction."

Nobel Prizes.—The Swedish Academy has awarded the Nobel Prize for physics for the year 1917, in reserve from last year, to Prof. C. G. Barkla, of Edinburgh, for his discovery of characteristic Röntgen rays in elements. The prize in physics for 1918 and those in chemistry for 1917 and 1918 have been reserved.

Royal Institution.—The ninety-third illustrated Christmas Course of Juvenile Lectures will be delivered this year by Prof. D'Arcy Thompson, C.B., F.R.S., his title being "The Fish of the Sea." The subjects are as follow: Jelly-fishes, Tuesday, Dec. 31; Star-fishes, Thursday, Jan. 2; Cray-fishes, Saturday, Jan. 4; Cuttle-fishes, Tuesday, Jan. 7; The Herring-fishery, Thursday, Jan. 9; The Whale-fishery, Saturday, Jan. 11. The Lecture hour is 3 p.m.

Standardisation of Railway Equipment.—In the report of the Advisory Council of the Ministry of Reconstruction it is recommended that the standardisation of wheels, axles, wheel-centres, tyres, running gear, draw gear, buffing gear, bogies, brakes and under-frames be dealt with immediately by the Engineering Standards Committee, on which all interested, including private builders and makers of materials, should be represented, and that when such essential parts have been standardised the adoption of the standards should be gradually enforced. In view of the difficulties of standardising complete locomotives and other rolling stock under existing circumstances, they recommend that a committee be formed to investigate the existing conditions of structural gauges and clearances of the British railways and similar conditions.

The Transatlantic Cable Service.—In "The Times" of the 14th inst. Mr. H. J. Learoyd, London Correspondent of the Philadelphia "Public Ledger," suggested that, in the interests of Anglo-American information and mutual understanding, no time should now be lost in multiplying the Atlantic cable services, which have so utterly failed recently to meet even urgent demands. There was no probability that present existing facilities would ever again meet requirements.

In a communication in the following issue of "The Times" Mr. Charles Bright stated that it was only by a material multiplication of the existing cables that a more uniformly expeditious and cheaper service is practicable. The present lines were congested with traffic for certain periods, and as things stood, if the rates were reduced, the congestion would become worse confounded.

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Institution of Engineers and Shipbuilders in Scotland.—The report of the Council of the Institution of Engineers and Shipbuilders in Scotland for the session 1917-1918 summaries a considerable amount of useful work which is being done by various bodies and committees on which the Institution is represented. Special interest attaches to the work done at the N.P.L. in the William Froude National Tank, by the British Marine Engineering, Design and Construction Committee, the British Corporation Technical Committee, and the Ship Electrical Equipment Committee. We notice that, among other matters, shipbuilding in reinforced concrete, and the uses of electric welding in ship construction, and of electric casting for steel chain cables, are receiving special attention. The Sectional Committee of the Engineering Standards Association on the gauging of machine parts, as a preliminary to Anglo-American conferences, have supplied to America full details of the work completed in this country in regard to screw threads.

Institution of Electrical Engineers (Western Area).—The 25th ordinary general meeting and the second meeting of the session was held at the South Wales Mining Engineers' Institute on Monday, November 11th. Despite the armistice celebrations, the chairman (Mr. H. I. Rogers) had the pleasure of presiding over one of the largest attendances at a meeting held by this area. Mr. H. I. Rogers, in introducing the president, Mr. C. H. Wordingham, said they were met on a very happy occasion, as the old order of things had been reverted to, in addition to which they had their estimable president with them. The president received a hearty reception on rising to give his address. He congratulated the Western Area on their recent acquisition of new territory, and based a lengthy address on the work of the Institution. The work accomplished during the past session was reviewed, and his proposals for the remodelling of the Institution, having regard to the obtaining of a Royal Charter, were listened to with keen interest. He also made a special plea for the Benevolent Fund, and suggested that members when forwarding their subscriptions for the coming year should increase them by the sum of 1s., this sum to be ear-marked for the Benevolent Fund. If this were done the fund would benefit by a very substantial amount.

Industrial Reconstruction Council.—The fifth lecture of the series arranged by the Industrial Reconstruction Council will be held in the Saddlers' Hall, Cheapside, E.C.2, on Wednesday, November 27th. The chair will be taken at 4.30 by the Right Hon. J. H. Whitley, M.P., and a lecture on "Labour and Industrial Development" will be delivered by Mr. Ernest J. P. Benn, C.B.E., Chairman of the Council. Applications for tickets should be made well in advance to the Secretary, I.R.C., 2 and 4, Tudor-street, E.C.4.

In view of the success which has attended the fortnightly conferences and discussions now being held by the Council, and the universal demand for their continuance, a second series has been arranged for January, February and March of next year. They will be held on Tuesdays, as before, in the Hall of the Institute of Journalists, at 6 p.m. The first, under the title of "Reconstruction or Restoration?" will deal with the general principles which should guide us during the difficult transition period, and will be opened by Major H. J. Gillespie, D.S.O., on January 14th. The other meetings will discuss "The Workers' Interest in Costing," "The Place of the Merchant in British Industry," "Welfare Work," "Wages and Conditions of Employment in Relation to Future Industrial Prosperity," and "Industrial and Educational Reconstruction," the opening address in each case being delivered by Mr. A. Webster Jenkinson, F.C.A. (Controller of Factory Audit and Costs), Sir Charles McLeod (chairman of the Imperial Commercial Association), Miss Newcome (secretary of the Central Association of Welfare Workers), Captain James O'Grady, M.P. (secretary of the National Federation of General Workers), and Mr. F. W. Sanderson, M.A. (headmaster of Oundle School). No tickets will be issued, but all those who intend to be present are asked kindly to inform the Secretary, I.R.C., 2 and 4, Tudor-street, E.C. 4, who will be glad to send a full prospectus of the series on application.

Obituary.

The Hon. A. E. GATHORNE-HARDY.—The death of the Hon. A. E. Gathorne-Hardy, one of the Light Railway Commissioners, occurred on the 15th inst. at the age of 73.

D'ABADIE D'ARRAST.—The "Review of the River Plate" records the death of Mr. D'Abadie D'Arrast, who was intimately connected with the development of the city of Cordoba where he initiated the Electric Light & Power Company. He was also the promoter of the Cordoba Electric Tramway Company and of many other important public works there.

DEATHS ON ACTIVE SERVICE.—The following deaths are reported:—

Lieut. Douglas Stephen Corlett (Royal Fusiliers), aged 21, elder son of Mr. G. S. Corlett, electrical engineer, Wigan, has died of wounds in hospital at Rouen.

Major F. A. Robinson, M.C. (with bar), (Tank Batt.), formerly in the electric light department of the India Rubber Company, was killed in action on Nov. 4. He was the son of Commander F. W. Robinson, of the submarine department of the India Rubber Company.

Lieut. J. H. Clark (R.A.F.), formerly on the outside construction staff of the British Thomson-Houston Company, has been killed in a flying accident.

Pte. A. S. Webb (Leicester Regt.), formerly in the employ of Messrs. Willans & Robinson, has been killed in action.

The deaths of Pte. F. Garner (Royal Warwickshire Regt.), formerly employed by the B. T.-H. Company, and Pte. H. Horsley (Manchester Regt.), formerly an apprentice with the same company, are also reported.

Pte. G. A. Dickinson (E. Lancs Regt.), formerly employed by Messrs. Dick, Kerr & Company, has also died in action.

Personal.

Mr. F. L. Wright, late of Quead, Ltd. and Messrs. Tyler & Freeman has been appointed a director of Napier-Kimber, Ltd.

Dr. Martin O. Forster, F.R.S., D.Sc., has been appointed director of the Salter's Institute of Industrial Chemistry.

The town clerk of Ilkeston, Mr. F. S. James, has been appointed secretary of the Board of Trade Tramway Committee.

The Council of the University College of South Wales and Monmouthshire has conferred the title of Emeritus Professor of Experimental Philosophy on Dr. E. H. Griffiths on his retirement from the principalship of the College.

Arrangements for the Week.

FRIDAY, Nov. 22nd (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, Imperial Institute-road South Kensington, London, S.W. Paper on "Cohesion," by Dr. H. Chatley. Also the following Papers by Mr. A. Campbell, B.A.: "Note on the Linguistic Nomenclature of Scientific Writers"; "A Method of Comparing Tuning Forks"; "Low-Frequency Microphone Hummers"; and "A Simple Tuning Fork Generator for Sine-Wave Alternating Currents."

INSTITUTION OF ELECTRICAL ENGINEERS, STUDENTS' SECTION.

7 p.m. At King's College, Strand, London, W.C. Paper on "The Permeability of Faintly-Magnetic Materials," by Prof. E. Wilson.

SATURDAY, Nov. 23rd.

MANCHESTER ASSOCIATION OF ENGINEERS.

6.30 p.m. At the Grand Hotel, Manchester. Paper on "Conveyors in Relation to Engineering Works," by Mr. W. H. Atherton, M.Sc.

TUESDAY, Nov. 26th.

INSTITUTION OF ELECTRICAL ENGINEERS, NORTH-WESTERN CENTRE.

7 p.m. At the Engineers' Club, Manchester. Paper on "The Use of High Pressure and High Temperature Steam in Large Power-Stations," by Mr. J. H. Shaw.

JUNIOR INSTITUTION OF ENGINEERS, NORTH-EASTERN SECTION.

7.15 p.m. At the Mining Institute, Newcastle-on-Tyne. Paper on "Boilers, Coal and Gas Fired," by Messrs. E. F. Oakford and S. H. Moore.

WEDNESDAY, Nov. 27th.

INSTITUTION OF ELECTRICAL ENGINEERS, SOUTH MIDLAND CENTRE.

7 p.m. At the Birmingham University, Edmund-street, Birmingham. Paper on "High Pressure and High Temperature Steam in Large Power-Stations," by Mr. J. H. Shaw.

FRIDAY, Nov. 29th.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. 1. Social Evening.

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Electric Furnaces in Metallurgy.

THE HÉROULT FURNACE.

(*Concluded from page* 540.)

NATURE OF THE LOAD.

The load taken by a single electric furnace is necessarily fluctuating, and full power is taken for about half the time the furnace is in operation. This is due to the fact that more power is required during the melting period than during the subsequent refining. The character of the load is well shown by Fig. 8. This is reproduced from an actual record, which we publish through the courtesy of Sir Robert Hadfield. It refers to one of the battery of 6-ton furnaces in regular operation at the works of Messrs. Hadfields Ltd., Sheffield.

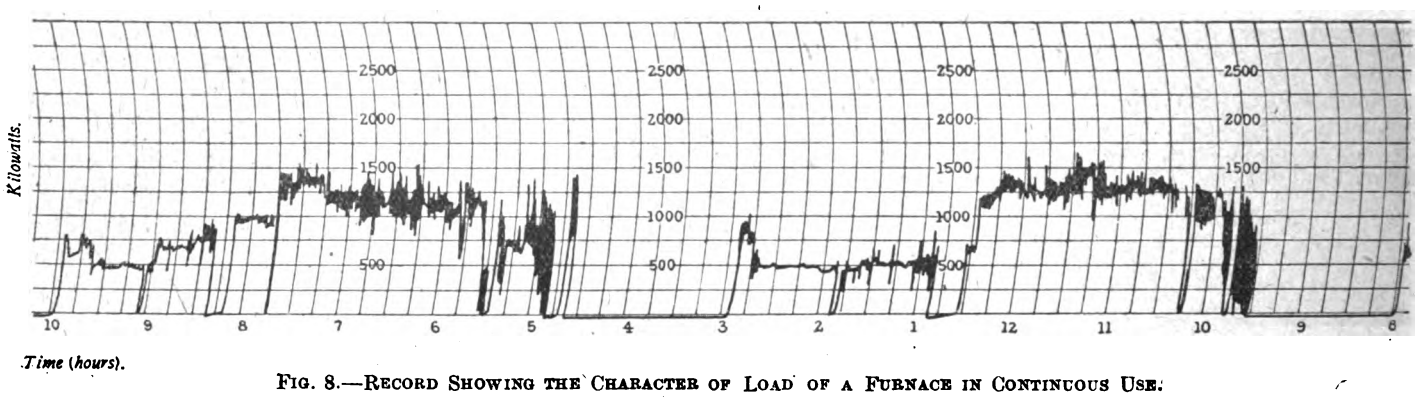

FIG. 8.—RECORD SHOWING THE CHARACTER OF LOAD OF A FURNACE IN CONTINUOUS USE.

With all furnaces above 2-tons capacity, the use of automatic regulators is recommended. With smaller sizes the additional capital expenditure involved is in most cases considered too high in proportion to the cost of the plant to justify their installation. These regulators are of the Thury type, which are now made in this country by the Watford Electric Manufacturing Co., Ltd. Regulation is effected by bringing into operation an electric motor, which adjusts the length of arc.

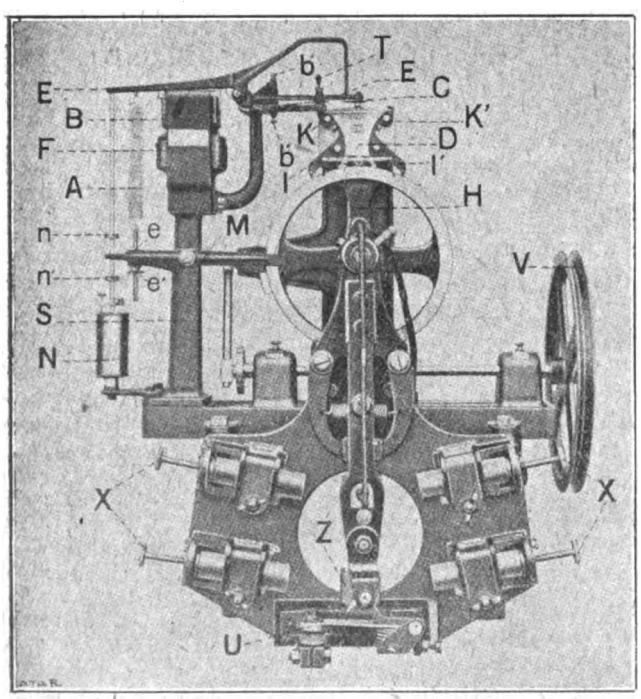

FIG. 9.—THURY REGULATOR FOR ELECTRIC FURNACES.

One of these regulators, as made by the Anglo-Swiss Construction Co., is shown in Fig. 9 and a diagram of connections is given in Fig. 10. As is well known, the Thury regulator depends upon an oscillating member which carries two pawls, *I*, *I'* (Fig. 9), and these are brought into action by a tappet gear. The latter is actuated by the solenoid *F*. One or other of these pawls will engage with the notched wheel *H* if the current in the solenoid rises above or falls below some pre-determined value, and will thus cause the arm *Z* to make contact with the terminals *X* to the right or to the left, as the case may be. The necessary oscillatory motion for the pawls is given by gearing which is driven by the wheel *V*.

In Fig. 10 the solenoid is shown at *B*. If one of the pawls is engaged the contacts *A*1 and *A*2 will make contact with the contacts 7A and 9, seen to the left of them, or if the other pawl is engaged contact will be made with Nos. 8 and 9 to the right. Every time a contact is made the armature of the electrode motor, of which the series field is fully excited, moves round and thus the electrode is adjusted by a step-by-step motion. The controller handle is left so that the controller is in the centre or "regulator" position, but if the regulator is not working, hand regulation can be effected by turning the controller in one direction or the other. Current supplied to the solenoid is derived from a current transformer and part of this is shunted by the load adjusting resistance marked *C*. Consequently

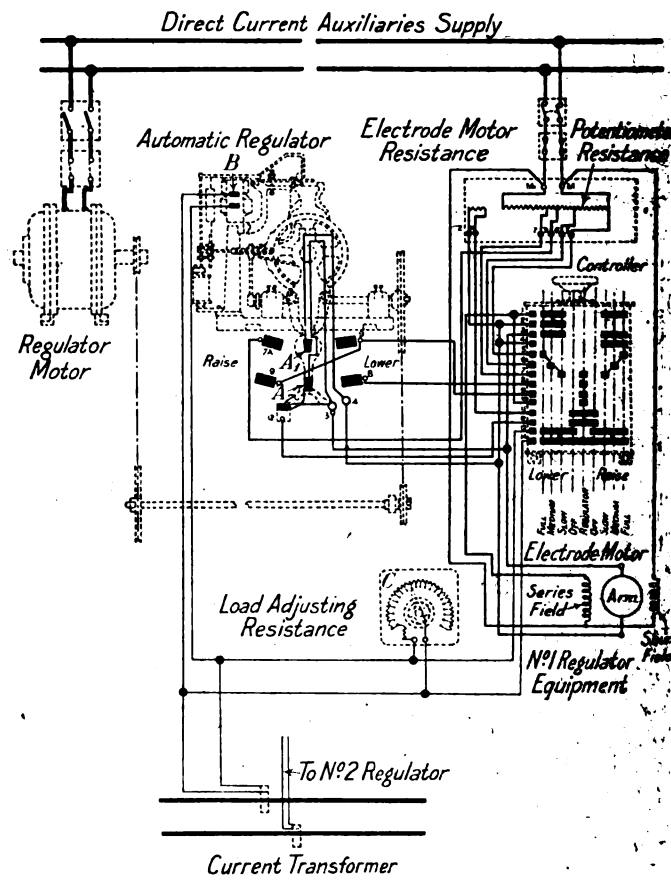

FIG. 10.—DIAGRAM OF CONNECTIONS FOR AUTOMATIC REGULATORS IN ELECTRIC FURNACE D.C. AUXILIARY SUPPLY.

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the load at which this comes into action can be varied by altering this resistance.

Fig. 11 shows the effect of automatic regulation on a ferro-alloy furnace. The saving of power shown, apart from the benefits obtained by steadier working of the furnace, is of great importance.

Even with automatic regulation, considerable fluctuations of load are often experienced, and it is usually important that these should be avoided so as to work at as high a load factor as possible. In order to secure this high load factor a master regulator may be employed, so that the load on a whole series of furnaces does not exceed a certain pre-determined value.

MASTER REGULATOR EQUIPMENT.

The master regulator equipment consists of a Thury regulator of the ordinary type, but fitted with a three-phase instead of a single-phase solenoid. Current is supplied to the solenoid from three current transformers on the mains, and the regulator can be set to work at any desired total current by means of a varying resistance placed in parallel with the solenoid. The regulator can operate any number of motors, one of which is used with each furnace to be controlled. Each of these motors controls three load-adjusting resistances. These load-adjusting resistances are in series with the load-adjusting resistances on the furnaces, which are in parallel with the solenoids of the furnace regluatois. Thus, if the total load on the main supply is too great, each of the motors is operated by the master regulator, and additional resistance is put into each circuit causing all the furnace regulators to operate the electrode-raising motors on the furnaces, and so reduce the total load on the battery of furnaces.

The object of the master regulator is to prevent a number of power users, all of which take fluctuating amounts of current, from overloading a power station. Its most obvious use is in the case of electric furnaces.

With an electric steel furnace melting scrap the ordinary cycle of operations is as follows :—

1. 30 minutes fluctuating load.
2. 2½ hours full load.
3. 15 minutes no load.
4. 1 hour four-fifths–two-thirds load
5. 15 minutes one-third load.
6. 30 minutes no load.

Thus each furnace is only taking full load for about half the period of operation.

Where several of these are supplied from one power station, there may occasionally be periods when all of them are taking their full power and putting a heavy load on the station. This period will probably be of only short duration, as a number of furnaces are not likely to be all at the same stage, and one or more of them will soon not use its maximum load.

The master regulator is used to prevent these short periods of overloading. The maximum load on each furnace is reduced during the period when the total demand of the furnaces would cause an overload; but as soon as the demand is reduced by one or more of the furnaces decreasing its requirements, the remaining furnaces are no longer interfered with.

For instance, if four furnaces, each of 1,500 k.v.a. transformer capacity, are operated from one station, and it is essential to keep the total load down to 5,000 kw., the master regulator would be most valuable. As long as the total load was below 5,000 kw., each furnace would get the full amount of power called for by the melter; but as soon as this amount was exceeded the master regulator would reduce the load at each furnace. Thus, if the total demand was 6,000 kw., the master regulator would reduce each furnace by 250 kw., so that each would receive 1,250 kw. If furnace "A" reduced its demand to 1,000 kw, while the other three each still demanded 1,500 kw., the master regulator would cut down the load on each furnace by 125 kw. The melter on furnace "A" would find then he was getting 125 kw. less than he wanted, and would increase his demand until he got it, slightly reducing the amount of power on the other three furnaces.

The master regulator is not intended to protect the station against sudden overloads caused by momentary short-circuits. To do this a very sensitive instrument would be required, and it would be constantly increasing and decreasing the loads on the furnaces, and causing a great deal of trouble. The regulator is purposely made sluggish, so that it only operates when the overload is maintained for some time. It is also not made to prevent out of balance on the phases, though this could be done by using three separate master regulators, each with a single-phase solenoid, instead of one with a three-phase solenoid. In cases when phase balance is of great importance the possibility of correction by master regulation is of considerable interest.

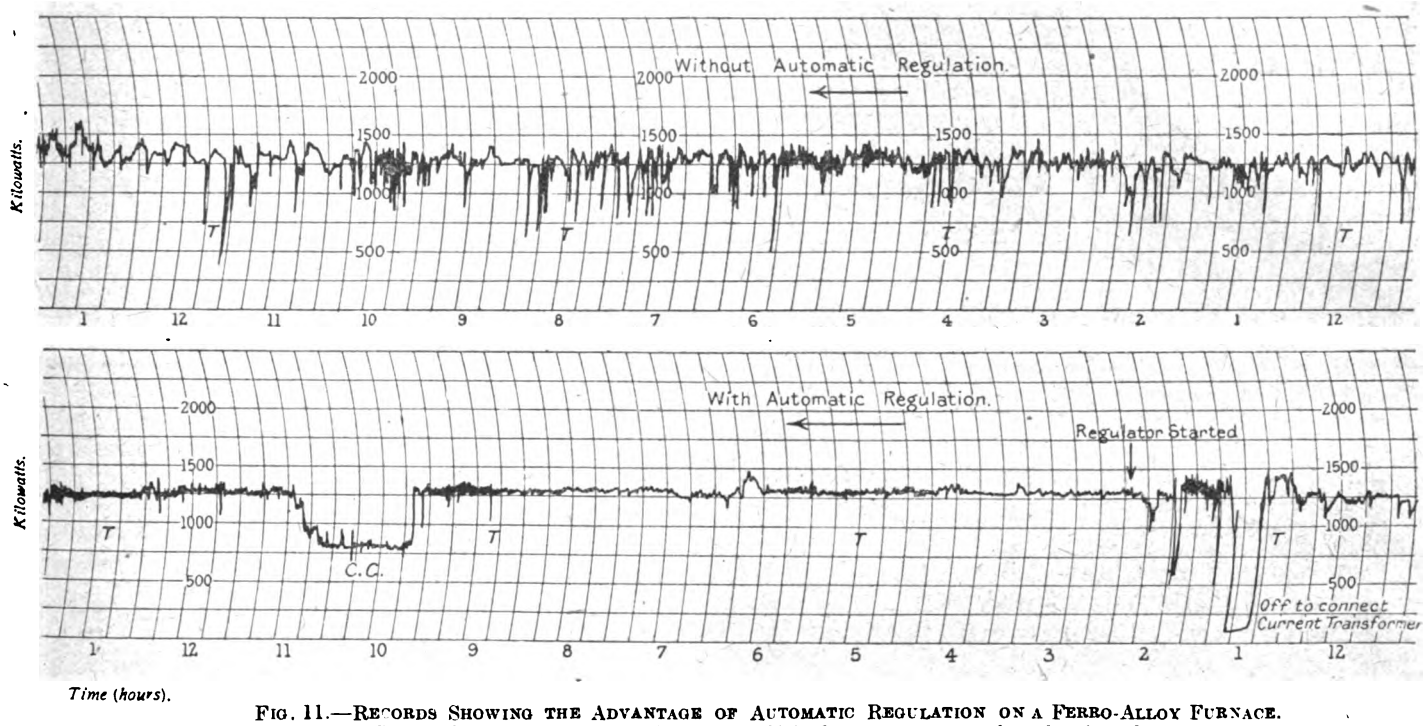

FIG. 11.—RECORDS SHOWING THE ADVANTAGE OF AUTOMATIC REGULATION ON A FERRO-ALLOY FURNACE. "CC"=carbon electrodes were changed. "T"=furnace was tapped at the time shown.

ELECTRODES.

Either amorphous carbon or graphite electrodes can be used. The conductivity of the latter is about four times that of amorphous electrodes, so that electrodes of only half the diameter may be used. The chief advantage of the graphite electrode is its small size, and the resulting ease of handling. On the other hand, from the metallurgical point of view, a large electrode is advantageous, as the arc is less localised and a larger area is directly heated. There are now four factories in England making amorphous electrodes, while the sole source of graphite is Niagara Falls. With furnaces of 2 tons capacity, or less, graphite electrodes are usually employed, as the amorphous electrode takes up rather a large proportion of the roof space, and the comparatively small tonnage required can usually be obtained. In normal times the question of relative cost will be more vital than it is at present, and unless graphite

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costs are greatly reduced this type of electrode will be unable to compete with the amorphous.

With regard to electrode holders, it may be said that water-coolers are placed around the electrodes on the roof, and the holders are also water-cooled. The holders are hinged, and a great deal of experimental work has been done to obtain a suitable material for their manufacture. Owing to the variations in diameter of amorphous carbon electrodes, it is difficult always to obtain a good contact, and it has been found that the holder now used gives more satisfactory results than any of the earlier types.

Costs

The cost at the present time is difficult to estimate exactly, and varies considerably at different works. The great advantage possessed by the electric furnace at the present time is that it can melt miscellaneous steel scrap alone without the addition of any pig iron, and make a large variety of steel of remarkable purity.

The main costs are as follows :—

(*a*) *Power.*—This varies from 650 to 800 kw.-hours per ton, according to the nature of the scrap, the material to be made and the efficiency of the stop.

(*b*) *Labour.*—One melter, one helper and one or two labourers are employed on the furnace itself.

(*c*) *Electrodes.*—The consumption of amorphous electrodes is usually from 30–40 lb per ton, and of graphite electrodes 12–16 lb. per ton.

(*d*) *Repairs.*—This is not an expensive item. The life of the roof varies with the size of the furnace and other conditions between 80–200 heats, and the banks are fettled with dolomite between the heats.

(*e*) *Other Charges.*—Additions, tools, overhead charges, ladle, &c., vary greatly according to the class of steel made and the shop conditions.

An interesting recent development is the use of an acid lining. Owing to the high quality of a large proportion of the turnings now available it is frequently unnecessary to refine, and in this case an acid lining presents many advantages. The expensive magnesite brick is avoided, the roof lasts longer, as it is not splashed with lime; and in the case of foundries, scrap castings, &c., covered with sand, can be re-melted without cutting the lining, as in the case of a basic furnace. The furnace can be converted into a basic furnace at any time by changing the lining, no other alterations being necessary.

The refining of hot metal has so far not been developed in this country to the same extent as on the Continent and in America; but a large plant is now being erected in Sheffield to refine open hearth steel electrically.

The future of electric steel in this country depends very largely on the cost at which electric energy can be obtained. In fact, this is of the most vital importance if the electric furnace is to be adopted for the manufacture of steels other than those of a special nature Electric furnaces require large quantities of energy, and it therefore follows that any part of the country which can offer electric power at really low rates will attract this new industry.

Electrical Engineering as Taught in American Colleges.

(*Concluded from p.* 593.)

By ALEXANDER GRAY, M.Sc., Whit.Sch.

The work of the computing room in the fourth year consists largely of the predetermination of the characteristics of machinery and the selection and arrangement of the electrical apparatus required for power generation, transmission and distribution. An induction motor problem is given below to which not less than eight computing periods, each of three hours, would be devoted.

Course E 21. Due on May 18th. Second Term, 1917-18.

INDUCTION MOTOR DESIGN.

Data : 75 H.P., 440 volts, three-phase, 60 cycle, 720 syn. revs. per min.

	Stator.
External diameter	33 in.
Internal diameter	26 in.
Frame length	6·5 in.
Centre ducts	None.
End ducts	Two, each 0·5 in.
Slots per pole	12.
Size of slot	0·36 in. by 1·6 in.
Cond. per slot	10.
Winding	YY.
Size of cond.	0·11 in. by 0·22 in.
Air-gap	0·035 in.

Requirements—

1. Re-design the stator for a motor rated at 100 H.P., 440 volts, three phase, 60 cycle, 720 syn. revs. per min., using the same punchings at for the 75 H.P. machine given above.
2. Design a squirrel-cage rotor to give a starting torque of 1·5 times full-load torque, with full applied voltage for the 100 H.P. machine.
3. Design a phase-wound rotor for the 100 H.P. machine; specify the external resistance required to give maximum starting torque, and also that for full-load torque with full-load current in the stator.
4. Fill out a design sheet similar to that on page 402 of Gray's design, and make freehand sketches showing the approximate proportions and the mechanical and electrical construction of the machines.
5. Draw the circle diagram for one of the motors, and tabulate a few characteristic values from it. Check the performance data at some load with those obtained from the equivalent electric diagram.

Option—

Extra credit will be given for an investigation of the performance of the machine as induction generator.

Initiative, resourcefulness and *originality*, as well as a *clear and forceful* presentation of the *results* in the report will be given considerable weight in the mark.

Reference : Gray's "Elect. Mach. Design," Chapters XXVII.–XXXIX.

The work of the senior laboratory is of a more advanced nature than that of the third year. At Cornell University it has been found satisfactory to give the student a large number of suggestive questions, around which he can write a report. Such a set of questions, along with the laboratory instructions, are given below for an experiment on the alternator, which experiment will require one hour of study in class before the experiment is performed, two afternoons of work in the laboratory, and a minimum of 10 hours for the write up. Many of the students will prepare what is almost a treatise on the subject.

EXPERIMENT No. 16.—TESTS ON ALTERNATORS.

Object :

(*a*) To predetermine the efficiency of an alternator from the total losses, including the load losses, and draw the efficiency curves for 100 per cent., and also for 60 per cent. power factor.

(*b*) To predetermine the regulation from no-load and short-circuit tests, draw the regulation curves for 100, 80 and 20 per cent., also zero power factor, and compare the 100 per cent. power factor curve with test curve.

The following order of procedure is generally followed in practice :—

1. Make no-load saturation and core loss test.
2. Find the stray power loss.
3. Make the short-circuit test, and at the same time measure load losses.
4. Draw the no-load saturation curve, also the optimistic and pessimistic curves for full-load current and zero power factor.
5. Make the full-load saturation test at approximately zero power, using a synchronous motor for load.
6. Take data for regulation curve at 100 per cent. power factor up to 25 per cent. overload, keeping exciting current constant.

NOTE.—When shutting down, keep exciting current constant and note that short-circuit current is practically independent of frequency. What is the explanation ?

The following curves must appear in the report :—

A. No-load saturation.
Short circuit.
Synchronous reactance.
Optimistic.
Pessimistic.
Experimental, zero power factor full-load saturation.
Computed 80 per cent. power factor full-load saturation both leading and lagging.
Computed 20 per cent. power factor full-load saturation both leading and lagging.

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B. Regulation by calculation at 100, 80 and 20 per cent., and zero power factor both lagging and leading. Take synchronous reactance from actual zero power factor saturation curve.

C. Losses against full-load current at 100 and 60 per cent. power factor lagging.

D. Efficiency against kilovolt-amperes at 100 and 60 per cent. power factor lagging. Give necessary theory and vector diagrams.

Course E 28. EXPERIMENT No. 16. 1917-18.

QUESTION SHEET ON ALTERNATORS.

References: Karapetoff, Arts. 558-560, 572-574, 577, 578, 581-583.

A. Answers should be known before recitation hour.

1. What are the three important points in the performance of an alternator with respect to which guarantees are usually made in contracts of sale ?

2. What are the losses in an alternator ? How is each of these losses determined experimentally ? How is efficiency obtained from losses ?

3. An alternator is rated in kilovolt-amperes and the efficiency is guaranteed at 85 per cent. power factor. What do you take for the alternator output ?

4. What factors affect the regulation of an alternator ?

5. How are these factors affected by a change in power factor with a given kilovolt-ampere output ?

6. Which of these factors has the greatest effect at unity power factor ? Which at zero power factor ? Explain by vectors.

7. What is meant by " optimistic " and " pessimistic " limits of regulation of an alternator ?

8. What attachment would have to be made to the alternator to make it self exciting ?

9. How would the excitation vary with the current remaining constant, power factor varying ?

10. Why is it not possible to test a 10,000 k.v.a. alternator by input output method ?

11. If it could be done, would it be more accurate than by method of losses ?

B. To be taken up in recitation.

1. Give the general theory of the optimistic method of predetermining regulation.

2. Give the general theory of the pessimistic method.

3. What is meant by synchronous reactance ?

4. Are there any methods which give more nearly correct values than either of the above ?

5. Why does the synchronous reactance obtained from load test at zero power factor differ from the synchronous reactance from short circuit ?

6. What is meant by armature reaction ? How does it affect regulation ?

7. What is meant by stray load loss ? How obtained ?

8. What excitation loss do you use to meet guarantee in question A3 ?

9. Why has the rotating field construction superseded the rotating armature type except for small low voltage machines ?

C. Answers to the following must be known.

1. Describe in detail the method of obtaining armature copper loss from the short-circuit run.

2. Is this greater or less than the I^2R loss ? Why ?

3. In computing copper loss from the short-circuit run, should the iron loss be taken into consideration ?

4. Having obtained the regulation curve for zero power factor, how do you obtain the regulation for any other power factor ?

5. How does the predetermined regulation for 100 per cent. power factor differ from the experimental regulation ? Give reasons.

6. In purchasing an alternator, what points in guarantee would you be most insistent upon having fulfilled ?

7. Note that regulation at 20 per cent. power factor load is little better than at zero power-factor load.

8. Alternating-current generators were formerly designed with 6 and 8 per cent. inherent regulation at 100 per cent. power factor. To-day very little attention is paid to regulation, and regulations of 15 to 20 per cent. are common. What factors have led to this change ?

9. Why is such poor regulation satisfactory in practice ?

D. Other questions of interest :—

1. Why are delta windings used so little as compared to star-connected windings ?

2. Why are reactances sometimes used in leads from alternating-current generators to 'bus bars ?

3. Why are reactances sometimes used in feeders from 'bus bars to load ?

4. Do synchronous motors constitute a more or less favourable load for alternating-current generators than induction motors of corresponding ratings.

5. If a turbo-generator is guaranteed to meet a rise of 50 deg. by thermometer, but on test shows a rise of 45 deg. by thermometer on the coil ends, 90 deg. rise by thermo-couple at the hottest part of the coil within the core, and 60 deg. by thermometer on the outside surface of the core, would you accept the generator in spite of its failure to meet the guarantee by thermometer ?

6. How should temperature rise be specified in contracts for large turbo-alternators ?

7. When two generators are operating in parallel, what holds them together ? Why is it that two generators connected in series will not stay in synchronism unless mechanically connected ?

8. A plant was installed with engine, generator and boiler capacity to operate at 75 per cent. power factor load. Power factor is raised to 100 per cent. by synchronous motors, but the kilovolt-ampere output is unchanged. Will the plant operate satisfactorily ?

9. Would the instantaneous short-circuit current be the same for a given field excitation as was obtained in the short-circuit run ?

Penalties.—A very elaborate system of prerequisite subjects is enforced, so that, for example, a student is not permitted to enter the second year physics course until he has passed the physics and mathematics of the first year, nor is he permitted to take the electrical engineering course of the third year unless he has passed the physics, mechanics and electrical engineering of the second year. Students who have failed in one or more subjects cannot, therefore, graduate on time, and considerable care is necessary in the planning of their work, so that class advisers are appointed, who see that the students do not get into difficulties. Each student has his study card checked up by the class adviser, and is not allowed to take more or less work than is stated thereon. If a student finds that his work is becoming too heavy, and that he wants to drop part so as to do the remainder successfully, he has to consult with his class adviser as to what part may be dropped. No student is allowed to take less than 17 credit hours per term or more than 20 unless special permission is granted by the Petition Committee. The pass mark in most colleges is 60 per cent., this being the average mark obtained from the class examinations and from the mark obtained in the daily recitations and in the computing room. Three times during each term the whole class record is sent over to the department office, and those whose work in one or two subjects would indicate that they are not progressing satisfactorily, are called before a Delinquency Committee and asked to state the reasons why the work is unsatisfactory and what they expect to do to get it in shape again. By this means loafing and unsystematic study is discouraged. If the student obtains a class mark in any subject between 40 and 60 he is given a conditional mark and allowed to proceed with his work; but he must pass what is called a make-up examination within one year after obtaining the condition, and if he fails in this trial he has to repeat the work over in class. Any student who obtains a mark below 40 is not allowed to proceed with that subject. At the end of the term the records of those students who have obtained conditions or failures in one or more subjects is brought up before the Doubtful Case Committee. If a student has obtained a condition in more than one-third of his work he is put on probation, and if his record is very bad, so that the Committee feels that he cannot proceed and do justice to his work and to his teacher, he is asked to leave college for the remainder of the year and come back and repeat all of his unsatisfactory work. In this way he graduates one year later than the rest of the men in the class.

Regular attendance is required at all meetings of the class, the roll being taken by having a seat assigned to each student, and the names of the students who should be in the vacant seats are noted by the janitor or by an instructor. The attendance record is displayed, so that the student may verify his record. If the student is absent without excuse from more than 10 per cent. of the meetings of the class he is dropped from the course, and excuses can be obtained only when a doctor's certificate is shown. If a student has a considerable amount of sickness, and has done creditable work until taken sick, he is given a mark of " incomplete," and allowed to make up his unfinished work when he can find time.

The laboratory reports have to be handed in for correction within one week of the date on which the experiment was performed. If this report is unsatisfactory it is handed back for correction, for which another week is allowed. A report which is one week late has five points deducted from the grade, and a report which is more than two weeks late is given a grade of zero.

The reasons why a student may be put on probation have already been stated. No student on probation can represent the university either individually or with any student organisation either at home or abroad, nor can he take part in any

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student activity or hold any class office, nor be a member of any athletic team or student organisation. A student is removed from probation only by the completion of one whole term of satisfactory work.

These many restrictions will appear rather strange to teachers in England, but have been found necessary in order to maintain a high order of scholarship, especially when the classes are large. Before the war the engineering colleges of America were graduating about 4,000 students each year, and, in spite of the restrictions mentioned, only about 40 per cent. of the men who enter the university graduate in the four years. The greatest elimination takes place in the second year, when many students find that they cannot stand the pace, while others decide that they have entered the wrong profession. One of the problems of the American colleges is to maintain a high average of scholarship by enforcing discipline and still take care of the development of the few students of unusual ability who do not, as a rule, thrive well under ironclad rules.

Student Organisation.—It is impossible to discuss the many student activities, but the student organisation cannot be overlooked. In America the undergraduate body is organised according to the year in which they expect to graduate; thus the class of 1920 contains all arts, science, medical and law students who expect to graduate in June of that year. Such a method of organisation is better than one in which the students are grouped together according to the college to which they belong, because the engineering student meets young arts, medical and law students at the class functions, and begins to appreciate that all lawyers are not crooks, that medical men are not infallible, and that arts students may be live men even although they are studying dead languages. Since the engineering colleges are generally the stronger numerically, and since they take their full share in athletics and in other student activities, there is no tendency on the part of even the faculty of the college of arts to consider the engineering student as an educated plumber. Many of these students do a considerable amount of work in the arts college and elective subjects, such as psychology, public speaking, English literature, history and economics, are very popular.

The type of instruction just described is typical of that given at practically all of the engineering schools; but there are signs that changes may be expected, particularly along the line of closer correlation with industry and with the purpose of eliminating unsuitable students earlier than in the second year, and also testing and grading students for initiative and judgment, as well as for their ability to pass examinations. Much information on these subjects will be found in the "Transactions" and "Proceedings" of the Society for the Promotion of Engineering Education, and it is hoped that a better understanding of the discussions of this society will have been made possible by the information contained in this article.

Patent Law Amendment.

REPORT OF THE COMMITTEE OF THE INSTITUTION OF ELECTRICAL ENGINEERS.*

In what follows we give a summary of a report drawn up by a Committee of the Institution of Electrical Engineers on patent law amendment. The Committee was constituted as follows: Mr. W. M. Mordey (chairman), the President (ex officio), and Messrs. A. E. Cachemaille, S. Z. de Ferranti, J. Hunter Gray, John Gray, H. H. Harrison, S. Morse, D. Murray, A. P. Trotter.

The Committee was formed primarily to consider the 1917 Bill, which is to be re-introduced this session in some form, to amend the Patents and Designs Act, 1907; but was broadly instructed to report on patent law amendment. Full consideration has been given to the proceedings at the meeting of members on February 28th, called to discuss the Bill, and to certain recommendations received from the Committee of the Newcastle Local Section.

Introductory Statement.—It is common ground that invention, as the basis of industrial progress, must be encouraged, and, if the reward offered by the State takes the form of a monopoly for a term of years, such a monopoly must encourage capitalists to assist in developing commercially the inventions in which they are invited to take an interest. Without capital, few inventions can be developed or even made. The progress of invention during the past 25 years in this country has been much less than it would have been if proper encouragement had been given by legislation and otherwise. At no time in the history of this country so much as at the present has there been so urgent a need or so great an opportunity for placing invention in the most favourable condition to help industry, and it is with this conviction that the Committee have carefully considered the proposed Bill. They are of opinion that every effort should be made to reduce, if not to remove, the number of weapons available to people here and abroad for attacking patentees who own real inventions, and in many cases have spent much time and money on them.

Patents Moratorium.—Shortly after its formation the Committee considered it advisable at once to press on the Board of Trade the need for dealing adequately with patents as affected by the war. There was much force in the suggestion made by Dr. de Ferranti that a short separate Bill was desirable to provide for an automatic moratorium or prolongation of patents to meet war conditions. The Committee are of opinion that an extension for a period equal to the total duration of the war should be granted in the case of patents which were in force when the war broke out and are still in force when peace comes; that in the case of patents which have expired by lapse of time during the war the extension should be for a period equal to that from the commencement of the war to the end of the ordinary life of such patents; and that for patents, other than war patents, which have been taken out since war commenced, the extension should be for a period equal to that between the date of application and the end of the war.

Advantage was taken of an opportunity presented by the London Chamber of Commerce of making a representation on this matter to the Board of Trade. The deputation obtained a hearing for the recommendation by the representative of the Institution of a short Moratorium Bill for Patents. Sir Albert Stanley, in reply, was opposed to any extension of the life of patents, contending that such action would amount to making patentees a specially favoured class, who alone were not to suffer by the war. And, in any case, he was not in favour of a separate Bill. But in recently stating in the House of Commons that the Patents and Designs Bill is to be re-introduced this session he announced that it would contain clauses dealing with the life of patents, the working of which had been prevented during the war.

The Committee still think it would have been better to deal with this matter in a separate Bill. Clause 7 of the Bill, which amends Section 18 of the Act, does not deal with the real difficulty, since the position still is that the extension can only be granted in the case of inventions of especial merit as before. The Bill perpetuates the evils of the present procedure, which are such that the number of petitions for extension presented annually is under 10, and in no year have more than three patents been extended. Something very different is needed to meet the war difficulty. No scheme of extension will be effective unless it is simple and inexpensive, and the renewal fees for such extended period should be low, for two reasons: (*a*) The renewal fees will have already been paid, generally on unproductive patents, and (*b*) renewal fees involve no appreciable expense to the Patent Office. It is therefore suggested that these fees should not be more than £1 per annum.

COMPULSORY LICENSES AND WORKING OF PATENTED INVENTIONS.

Clauses 1 and 2.—These clauses are intended to replace sections 24 and 27 of the Act. Section 24 provided for the granting of compulsory licences under certain specified circumstances, and section 27 dealt with the working of patented inventions. The latter section was introduced into the Act to compel foreign owners of British patents to work them in this country. It is doubtful if it achieved its purpose in any single case, but it became a powerful lever with which foreigners could, and did, harass British patentees for some years, as it was obviously to the interests of a foreigner to revoke patents belonging to a British subject so that he might freely flood the market with imported articles. The Committee are of opinion that section 24 of the 1907 Act, with certain alterations, would be amply sufficient and much to be preferred to clauses 1 and 2 of the Bill. Letters patent properly granted require that the invention should be new, should disclose sufficient invention, and should be properly and sufficiently described. If these requirements are complied with, it is illogical that the letters patent should be revocable on the ground of non-working, except with the consent of the owner. The only justification for revoking a patent is that it is invalid. The possibility of revocation on the ground of non-working is an incentive to blackmailers, and greatly detracts from the value of a patent as a security for financial support.

Even if there were no other complete remedy, which is not the case, revocation should not be possible. It would penalise British patentees for the faults of foreigners. The same considerations apply to designs.

The so-called "abuse of monopoly rights" has been during the last 20 years almost, if not entirely, confined to foreigners, especially Germans, who obtained British patents and did not work them in this country, but held them for the sole purpose of stopping competition, while they imported the patented articles. Obviously nothing could suit them

* Abstract.

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better than the right to revoke British patents which interfere with their importation. The history of section 27 of the 1907 Act is strong evidence of this, as practically most of the applicants under this section were foreigners or persons who desired only to import the patented article. This matter can be properly dealt with without revocation.

(In the Report a brief synopsis of this section of the Act is given.)

The course which the Committee would best like to see is that section 27 of the 1907 Act should be repealed, and that section 24 of that Act should be altered by enacting (1) that the petition should be made to the Comptroller of Patents, with appeal to the Court, who would deal with it. (2) That the provision enabling the patent to be revoked should be cancelled. This, it is believed, would be most in the interests of invention and of industry.

Articles for Food or Medical Purposes.

Clause 11 (*Section* 38*a*).—This clause makes it impossible to patent articles intended for food or medicinal or surgical purposes, or capable of being used for the production of food or medicine or surgical appliances.

The processes of making foods, drugs, medicines can, however, be patented. To illustrate the drastic effect of such provisions it is only necessary to mention the following examples of a few of the articles which would be unpatentable under the section :—

1. All new machinery capable of being used in bakeries or for food production.
2. Surgical instruments and appliances of all kinds.
3. Electric motors capable of being used for driving dentists' drills, &c.
4. X-ray tubes and other X-ray apparatus.
5. Machines and apparatus useful in the manufacture of drugs and medicines.

The provisions of the section will prevent inventors and capitalists from developing industries which are admittedly in great need of stimulation and encouragement, and will tend to prevent many new developments which otherwise would take place after the war. It is difficult to induce manufacturers to take up unpatented inventions This country is notoriously behind-hand, not only with inventions relating to drugs and the like, and surgical and therapeutic appliances, but also in their development and manufacture. Practically all the supplies of modern articles used in surgery came from Germany and America. There is no reason why this industrial development and manufacture should not be carried on in this country. Our position in medical and surgical science justifies all the industrial support that can be given to it. The framers of the section, in considering its effect from a humanitarian point of view, appear to have overlooked the fact that the encouragement of invention greatly helps progress.

This Committee consider that the section should be eliminated from the Bill, and suggest that the real objects of the section, so far as it relates to drugs and medicines, will be more readily accomplished by altering the present Acts relating to Foods and Drugs. In the United States of America and the British colonies, and several other parts of the world, no patent restrictions exist on the articles involved such as are proposed in the section.

Terms of Patent and Extension of Provisional Term.

The Committee consider clauses 5, 8, 9 and 15 of the Bill embody improvements. However, the Committee would prefer that the term of patents be 17 years, as in the U.S.A. (instead of 15 years, now proposed). They recommend that at least the term should definitely be made 16 years. The Committee regret that the period within which a complete specification may be left, after an application accompanied by a provisional specification has been filed, has not been extended. Section 5 of the Act of 1907 reduced this period from nine months to six months. With many inventions, especially those relating to complicated machines and apparatus, the present period of six months provisional protection is entirely inadequate to allow of an experimental machine or apparatus being made or tested. The Committee strongly urge that there should be a reversion to the old period of nine months, with the possibility of obtaining at least three months' extension of this term on payment of a nominal fee, instead of one month only, as at present. In the United States the law gives the inventor what amounts to provisional protection for two years, as the invention may have been in public use, or on sale, in the United States for two years prior to the date of application for the patent without in any way affecting its validity.

Suggested Extension of Term for Acceptance of Complete Specification

The Committee also urge that the time within which after filing the complete specification the same may be accepted should be extended. Such an extension will be necessary if the provisional term is extended to nine months, as suggested above. If the complete specification is filed six months after filing the provisional specification, there may prove to be only two months within which the result of a search can be communicated to the applicant. If he resides abroad, or is temporarily absent from this country, this period of two months is usually insufficient, and for the more distant colonies quite insufficient for him to study the whole matter and consider what amendment of his specification or claims may be necessary, and generally complete the prosecution of his application.

The Committee strongly recommend that the time within which the complete specification must be accepted should be extended as a minimum to 18 months after the date of application, with the possibility of extending this term as at present by three months on payment of a fee which the Committee think should be much less than at present. The restrictive procedure here as regards extensions compares very unfavourably with that in other industrial countries.

Patent to Bind the Crown.

Section 29 *of the Act.*—The Committee regret that no substantial alteration is made in this section by the proposed Bill. Experience has shown that the administration of the proviso of the section has in effect practically nullified the operation of a patent against Government departments, and accordingly inventors have been greatly discouraged in their endeavour to produce inventions of national importance. It has been found practically impossible for patentees to obtain compensation for the use by or on behalf of Government departments of their patented inventions. In many cases patentees have been asked to supply, and have supplied, working drawings, only to find that the latter have been distributed freely to their competitors, who have obtained most, if not all, of the Government orders for the patented article. The patentee has had no effective remedy, and frequently, after voluminous and prolonged correspondence with the department in question, has had to abandon all hope of obtaining any compensation. There is no method under the present legislation whereby the patentee can compel the determination of the matters in dispute between himself and a Government department with regard to his patent. Inventors and patentees object to the Treasury being practically in the position of purchaser, having the right to dictate the amount which shall be paid for the use of inventions. The Committee strongly recommend that the terms upon which an invention may be used by the Crown shall, in default of agreement, be decided by the High Court.

Cancellation of Registration of Designs.

Clause 14.—The Committee point out that the amendment proposed in clause 14 of the Bill will necessitate section 56 of the Act itself being amended. Clause 14 proposes that *at any time* after the registration of a design a petition may be presented to the Comptroller for cancellation of the registration. Section 56 of the Act, however, provides that registered designs shall not be open to inspection for a period of at least two years after the date of registration, except by certain privileged persons, and then only in the presence of an officer and on payment of a fee, and no copy of the design may be taken by the person making the inspection. These restrictions, the Committee believe, would very largely nullify the usefulness of the amendment proposed in Section 14.

Patents of Addition.—The Committee are of opinion that the proviso proposed to be added to section 19 (3) of the Act should be as follows :—

> "Provided that if the patent for the original invention is revoked or lapses for any reason, then the patent of addition shall, if the patentee so applies in writing to the Comptroller, become an independent patent," &c. (to end of proviso).

The Committee feel that this alteration is more fair to patentees than that the matter should be in the discretion of the Comptroller or the Court, as proposed in the Bill.

Patents Fees and Profits of Patent Office.

The Bill makes no change in the present official fees. The 1907 Act, by section 65 and schedule 1, allows maximum official fees of £155 on a full term patent, but provides that lower fees may be prescribed by the Board of Trade with the approval of the Treasury.

At present the prescribed fees on a full term patent are :—

On filing provisional specification	£1	
Or filing complete specification	3	
Or on filing a complete specification	£4	£4
On sealing of patent		1
Total (four years' life)		£5
Annual renewal fees begin with £5 at the end of the fourth year, rise £1 a year to £14 at the end of the 14th year. Total renewal fees		95
Total fees for full term patent		£100

In the opinion of the Committee, these fees are much too high, and compare unfavourably with those in many other industrial countries, as is shown by Table I.

Table I.—*Official Fees and Terms of Patents in the Principal Countries.*

Country.	Fees on application and grant.	Term covered.	Renewal fees.	Total fees.	Total term.
		Years.			Years.
U.S.A.	£7 0 0	17	None	£7	17
Canada	4 0 0	6	£8 6 0	12	18
Sweden	1 2 6	1	40 17 6	42	15
Italy	0 8 0	1	53 0 0	53·4	15
Switzerland	1 12 0	1	53 8 0	55	15
France	4 0 0	1	56 0 0	60	15
Norway	2 5 0	1	62 5 0	65	15
Belgium	0 8 0	1	81 12 0	82	20
U.K.	5 0 0	4	95 0 0	100	14
Denmark	2 5 0	1	129 15 0	132	15
Austria	2 18 4	1	162 1 8	165	15
Russia	4 15 0	1	223 5 0	228	15
Germany	2 10 0	1	262 10 0	265	15

The Committee believe that low patent fees would lead to a great development in invention, and that the country would benefit thereby.

It is probable that the favourable position occupied by the United States as regards inventions is largely due to the fact that patenting is cheap in that country—where patents are granted for their full term of

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17 years at a cost in official fees of only £7 ($35). There are about 70,000 patent applications per annum in the United States, as compared with about 27,000 here. And it is to be noted that, in spite of the smallness of the fees, the U.S. Patent Office is not only self-supporting, but yields an average surplus of more than £40,000 per annum. Although the Committee prefer the British system of a short term patents renewable after four years by the payment of annual fees, and consider the present fees of £5 to cover the first four years of the life of a patent are reasonable, they feel very strongly that the renewal fees are much too high. It is submitted that the present system, by which large profits are made out of patent fees, is wrong; that patents should be granted at the lowest possible cost consistent with the Patent Office being self-supporting; that the State should tax patents only through the income tax of patentees, thus taxing only successful inventors; that the encouragement of invention by lowering the cost of patents would almost certainly lead to a far greater return in income tax than the loss of revenue consequent on lower official fees.

In the Report a statement is included of the Patent Office finances for 1907–1916, showing an annual surplus of £116,344

Suggested Reduction of Renewal Fees.—The Committee recommend that in view of the existing large average surplus of £116,344, the cost of patents should be very substantially reduced. This recommendation is in accord with the principle set forth in Parliament by the Chancellor of the Exchequer, Sir Michael Hicks Beach, in 1890—that while patentees should bear the cost of the Patent Office, he did not think the country ought to look to the patent system as a permanent source of income. It appears to the Committee that the best way to cheapen patents would be to reduce the renewal fees, leaving the system in all other respects unaltered. A reduction of the renewal fees by one-half is strongly recommended. This would make the cost of a full term patent:—

To grant and sealing (as at present)	£5	0	0
Renewal fees	47	10	0
	£52	10	0

Even in the very improbable event of no increase taking place in the number of patents applied for, completed and kept up, such a reduction—on the basis of the average of the 10 years 1907–16—would still leave a surplus of £29,896. Should the effect of the reduction now recommended be to produce a considerable surplus, it is suggested that such surplus should be used for a further reduction of the renewal fees. It is thought probable that in this way it might soon become possible to again reduce the upkeep fees by one-half, in which case the full term fees would be:—

To grant of patent	£5	0	0
Renewal fees	23	15	0
Total	£28	15	0

which would still be four times as much as the total fees on a 17 years' patent in the U.S.

PROPOSED NEW TRIBUNAL.

The Committee also state their views upon the legal procedure by which all disputes involving scientific questions are determined. Recommendations on this matter have already been made by the Federation of British Industries, an association which, it is understood, represents capital of some £2,500,000,000 sterling. The Committee feel that it is due to the industries of the country that there should exist in the High Court of Justice a division specially constituted to deal with litigation involving scientific and technical questions. During recent years the application of science to industry has become so increasingly complex that such a division is more than ever essential. If industry is to flourish to the fullest extent there must exist machinery for adjudicating effectively upon actions involving technical matters, and the Committee urge in the strongest manner possible that such machinery should be provided. It is probable that more money and more serious issues are involved in patent and other technical questions than in all other actions put together. It is in the opinion of the Committee obvious that no adequate experience can be gained or proper consideration given by a tribunal which does not give its whole attention to technical disputes.

The Effect of Power-Factor on Output of Rotary Converters with Reactance Control.

By R. G. JAKEMAN, B.Sc.

Summary.—This article is intended to be supplementary to the author's previous article.* It deals with the effect of the power-factor on the size of the converter.

When installing rotary converters with reactance control a leading current is often required to relieve the generators and cables. In this article it will be shown, however, that if a large leading current is specified the converter becomes unduly expensive.

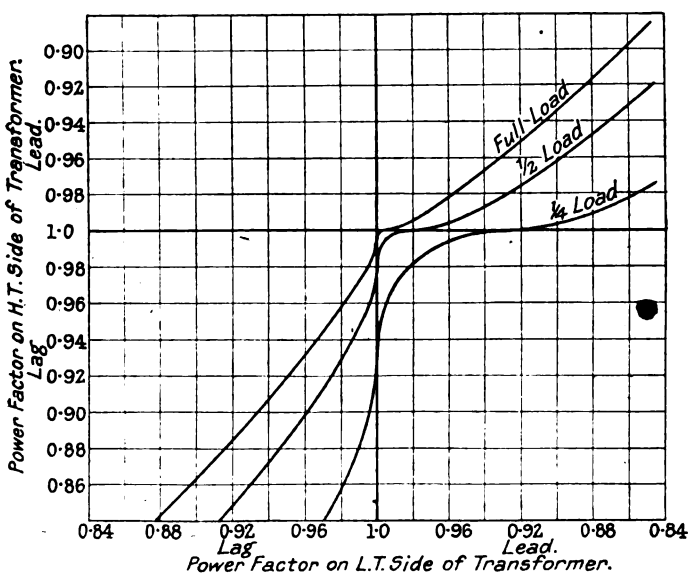

FIG. 1(A).—RELATION OF POWER-FACTORS ON H.T. AND L.T. SIDES OF TRANSFORMER.

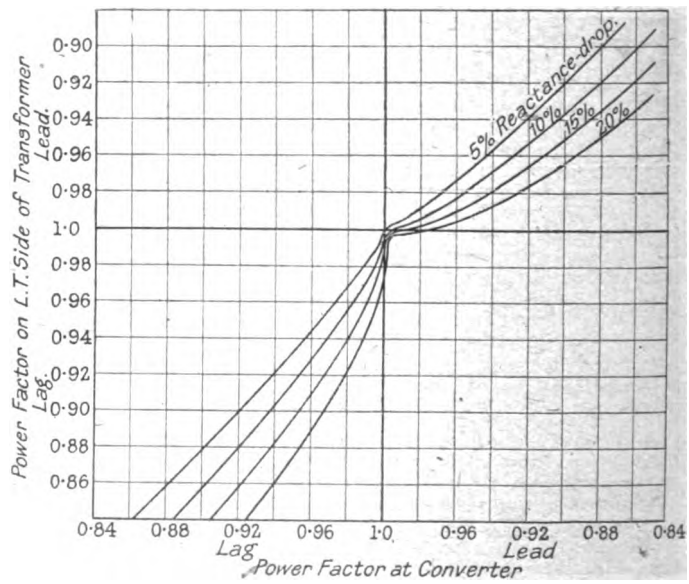

FIG. 1(B).—RELATION OF POWER-FACTORS ON L.T. SIDE OF TRANSFORMER AND AT CONVERTER.

It will also be seen that the voltage-variation required should always be specified within as narrow limits as possible, because a slight increase in the range of voltage necessitates a large increase in the wattless current. For this reason the actual maximum and minimum pressures required for any length of time should be determined and these should be specified as the limits of the normal range. Any pressures above or below this range, which may only be required for short periods, should be treated in the same way as overloads.

The wire on the field coils and the regulator would be made large enough to deal with them, but they could not be obtained for long at the normal temperature rise.

It was shown in my previous article* that the power-factor

* THE ELECTRICIAN, Vol. LXXX., p. 191.

* *Loc. cit.*

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in the armature of the converter is very different from that of the high-tension supply. For example, if the full-load power-factor of the high-tension supply is 0·95 leading, and the transformer has a reactance-drop of 15 per cent., it is clear from Figs. 1 (*a*) and 1 (*b*)* that the power-factor in the armature of the converter is 0·86 leading, on account of the magnetising current and reactance of the transformer.

Let us take as an example a shunt-wound converter with a voltage variation of 10 per cent. Choosing a reactance-drop

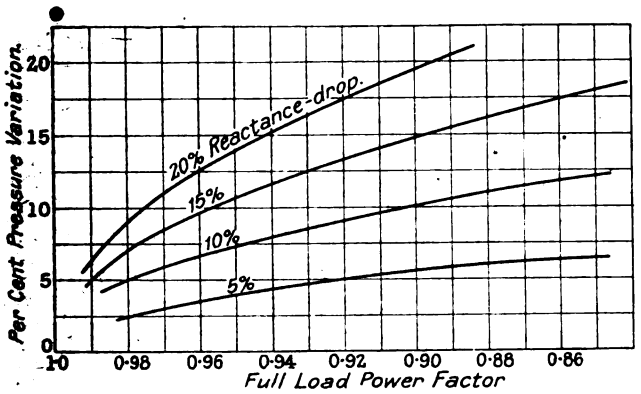

FIG. 2(A).—REACTANCE REQUIRED FOR SHUNT CONVERTER WITH FULL-LOAD POWER-FACTORS EQUAL AT MAXIMUM AND MINIMUM PRESSURES.

of 15 per cent. we see from Fig. 2(*a*)† that the full-load power-factor at maximum and minimum pressures is 0·955 leading and lagging respectively, if these power-factors are specified to be equal. This means that at the maximum pressure the power-factor in the armature is 0·87 leading, and the effect of this low power-factor is two-fold. In the first place, the armature copper loss is considerably higher than it would be at unity power-factor, and also the leading wattless current must be counter-balanced by extra ampere-turns on the field.

Consider a six-phase converter rated at 1,000 kw. at unity

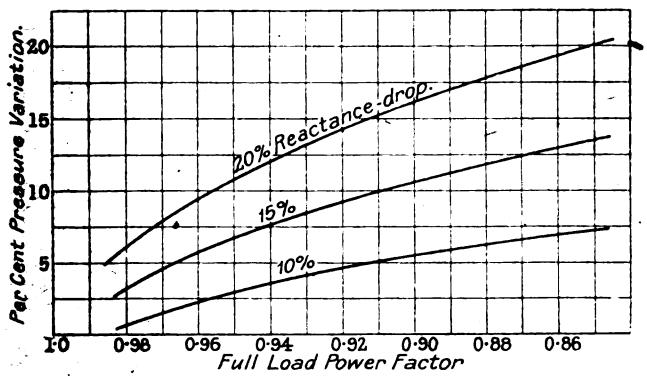

FIG. 2(B).—REACTANCE REQUIRED FOR COMPOUND CONVERTER WITH WATTLESS CURRENTS EQUAL AT NO-LOAD AND FULL-LOAD.

power-factor in the armature, in which the losses are as high as the temperature rise will allow and which contains as much copper as possible. The particulars are as follows :—

Voltage 400–440.
Full-load current 2,280 amperes.
Number of poles 12.
Number of armature conductors 1,080.
Resistance of armature 0·05 ohm.
Ampere-turns per pole-pair on field 18,000.

The armature copper loss at unity power-factor is 0·27 times the loss as a direct-current machine,‡ or 7 kw. In our case, however, as was shown above, the power-factor in the armature is 0·87, so that the copper loss is 0·55 times the loss as a direct-current machine (or twice what it was at unity power-factor), and therefore the current must be reduced to 1,610 amperes in order to obtain the same loss as before. The armature reaction caused by the wattless current is 5,000 ampere-turns per pole-pair on this new basis, so that out of the 18,000 ampere-turns permissible only 13,000 are available for producing flux. The voltage must, therefore, be reduced to approximately 375 volts, in order that the field ampere-turns may not exceed the maximum permissible value. We see then that the output

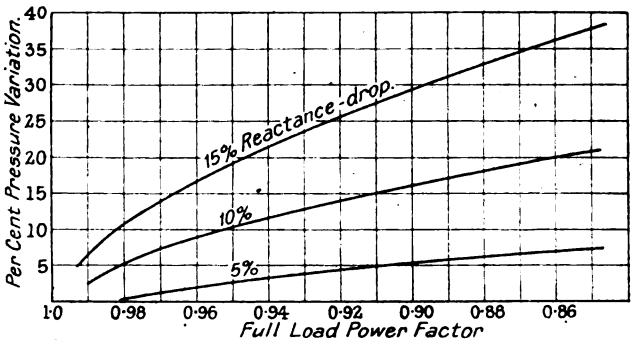

FIG. 2(C).—REACTANCE REQUIRED FOR COMPOUND CONVERTER WITH UNITY POWER-FACTOR AT THREE-QUARTER LOAD.

of the machine has been reduced to 600 kw.* from 1,000 kw., owing to the altered power-factor.

Hence, in order to keep the power-factor equal at maximum and minimum pressures, for the voltage variation we are considering, a converter capable of giving 1,000 kw. under the best conditions can only give 600 kw., though, of

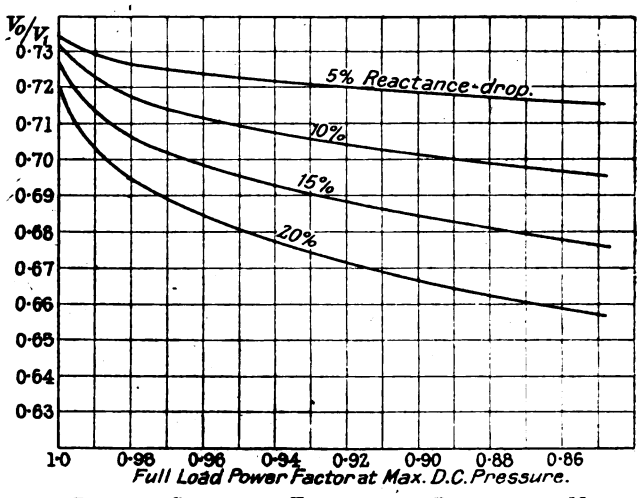

FIG. 3.—RATIO OF SECONDARY TRANSFORMER PRESSURE TO MAXIMUM D.C. PRESSURE FOR FOUR OR SIX-PHASE CONVERTERS.

course, with the latter output the size of the commutator and slip-rings can be reduced on account of the lower current.

In order to decrease the size of the converter, therefore, it is evident that the leading power-factor must be kept as near unity as possible ; but this can only be done at the cost of a larger lagging wattless current from the line at the minimum pressure.

Let us take as an example the case where it is specified that the power-factor shall be unity on the high-tension side at the maximum pressure, and the pressure variation and reactance-drop are the same as before. Then the power-factor in the armature will be 0·97 leading and the armature copper loss 0·32 times the loss as a direct-current machine. The current

* Figs. 1(*a*) and 1(*b*) are the centre portions, to a larger scale, of Figs. 9(*a*) and (*b*) in the previous article.

† Figs. 2(*a*), (*b*) and (*c*), and Fig. 3 may in some cases be found more convenient than Figs. 5(*a*) (*b*) and (*c*), and Fig. 10 respectively in the previous article, and may be used as alternatives.

‡ Miles Walker, "Specification and Design of Dynamo-electric Machinery," p. 544.

* This figure is somewhat low, because the reduced flux decreases the iron loss, so that the armature copper loss could be increased a little for the same temperature rise. Moreover, the reduced density in the teeth allows a wider slot, so that more copper could be put in the armature ; but this on the other hand would make the machine more expensive.

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must, therefore, not exceed 2,090 amperes. The armature reaction is 2,800 ampere-turns, leaving 15,200 ampere-turns for producing flux, which corresponds to 400 volts, so that the output is 840 kw.

In the first case, in order to obtain 600 kw., a converter capable of giving 1,000 kw. was necessary, a reduction of 40 per cent. In the second case, a converter capable of giving 1,000 kw. would now give 840 kw., so that to obtain the same output of 600 kw. a converter capable of 720 kw. would be necessary, a reduction of 17 per cent.

The size of the transformer is also affected, for in the first case, assuming 95 per cent. efficiency, the output of the transformer is $\frac{600}{0{\cdot}95\times0{\cdot}87}=725$ k.v.a., while in the second case the output is $\frac{600}{0{\cdot}95\times0{\cdot}97}=650$ k.v.a. This also shows a slight reduction in size. The combined efficiency will be slightly better in the second case.

The power-factor at the minimum pressure in the second case may be found from Fig. 4. It has been found above from Fig. 2 (*a*), that if the power-factor is equal at maximum and minimum pressures, its value will be 0·955. Choosing the curve marked 0·95 in Fig. 4, find the power-factor required at the maximum pressure (which is unity in our case) on the left-hand ordinate, and follow along the horizontal (the base-line in our case) to meet the curve. The abscissa then gives the power-factor at the minimum pressure. In our case we find 0·835 on the curve marked 0·95, so that for 0·955 the value of

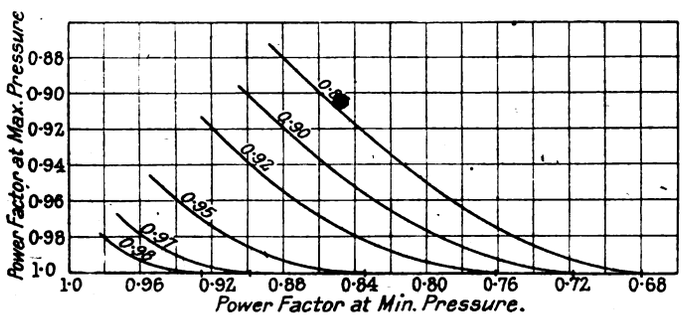

FIG. 4.—UNEQUAL FULL-LOAD POWER-FACTORS AT MAXIMUM AND MINIMUM PRESSURES.

the power-factor at minimum pressure is about 0·845 lagging on the high-tension side. This corresponds to 0·94 lagging in the armature, so that a current of 1,900 amperes is permissible which is about the same figure as for the maximum pressure.

The following is a summary of the above figures :—

	Case 1.	Case 2.
Power-factor on high-tension side at maximum pressure...	0·955 leading.	Unity.
,, ,, minimum pressure .	0·955 lagging.	0·845 lagging
Output of converter	600 kw.	600 kw.
Output of transformer	725 k.v.a.	650 k.v.a.
Size of converter in terms of output at unity power-factor	1,000 kw.	720 kw.

It will be seen, therefore, that it is expensive to obtain a leading power-factor, whilst on the other hand, a large lagging wattless current is usually very objectionable, so that the solution of the problem depends on the capabilities or demands of the station in the matter of wattless current.

If the converter is over-compound wound the large lagging wattless current only occurs at light loads, and may therefore be permissible; in fact, it is often specified that the power-factor shall be unity at three-quarters of full load. To find the wattless current at no-load, it is only necessary to divide the difference between the transformer pressure and the no-load pressure of the converter by the reactance of transformer and armature. Suppose the no-load direct-current pressure is 400 volts. Then the corresponding alternating-current pressure is 284 volts. Let the transformer pressure be 312 volts. Then if the reactance-drop is 15 per cent., *i.e.*, 47 volts, and the full-load current is 1,200 amperes, the value of the reactance is 0·0039 ohm. The reactance of the armature is usually about one-third of this, or 0·0013 ohm, making a total of 0·0052 ohm. We therefore have to drop 312—284=28 volts in this total reactance, which requires a wattless current of 540 amperes.

A variation in the high-tension voltage is often specified, and this has to be allowed for in using Fig. 2(*a*). Suppose the direct-current variation is 490 to 510, and the high-tension variation 6,000 to 6,300, and we have to obtain any direct-current voltage within the range at any high-tension voltage. It is evident that as we have to obtain 490 to 510 direct-current volts at 6,300 high-tension volts, if the volts were dropped to 6,000 without altering anything else, we should obtain 465 to 485 direct-current volts. But we have also to obtain 510 direct-current volts with 6,000 high-tension volts. Hence our case is exactly the same as if the high-tension volts were constant at 6,000 volts, and we required a direct-current variation of 465 to 510 volts. Therefore by multiplying the percentage variation in direct-current voltage by the percentage variation in high-tension voltage, we obtain the correct figure to use in Fig. 2 (*a*). The power factor at maximum and minimum pressures must then be interpreted as the power-factor at maximum direct-current pressure with minimum high-tension pressure, and that at minimum direct-current pressure with maximum high-tension pressure.

Erratum.—Line 16, col. 1, page 195, Vol. LXXX. of THE ELECTRICIAN, should read "cos φ is the full-load power-factor on the low-tension side of the transformer at the maximum direct-current pressure."

The Dynamical Theory of Electric Engines.

The 10th Kelvin lecture, before the Institution of Electrical Engineers, which was delivered by Mr. L. B. Atkinson, was so comprehensive, and our space is so limited, that we can only give a brief sketch of its contents. Mr. Atkinson referred to the desirability of bearing in mind some of the fundamental truths which were presented to the world by Kelvin, and he quoted at some length from an article by Kelvin in Nichol's "Cyclopædia" on the mechanical values of electrification and magnetism. This treatment provides a theory of generators and motors which has not been developed.

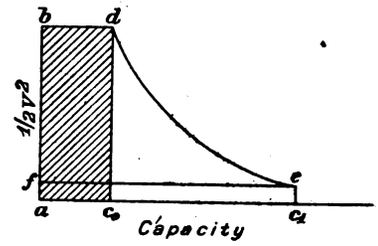

FIG. 1.

In the case of electrified conductors, the total energy is equal to half the sum of the products of the quantity on each conductor into its potential. The seat of energy is the dielectric, and if F is the electrostatic force and K a constant depending on the dielectric, the energy W per cubic centimetre of dielectric is given by

$$W=F^2K/8\pi,$$

electrostatic units being used. Taking 30,000 volts (about 100 e.s. units) per centimetre as the maximum for air, then for air the maximum energy is 400 ergs per cubic centimetre, K being unity. In the case of mica K is 3 and the gradient may reach 1,000,000 volts per centimetre, so that W becomes $1{\cdot}3\times10^6$ ergs per cubic centimetre, or about 1 ft.-lb. per cubic inch.

By definition, the capacity of a system is $c=Q/V$, so that the energy may be expressed in the three following ways :—

$$W=\tfrac{1}{2}\Sigma(QV)=\tfrac{1}{2}\Sigma(Q^2/c)=\tfrac{1}{2}\Sigma(V^2c).$$

Mr. Atkinson then described what takes place when conductors are charged by induction and by contact. Generally speaking,

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electrification of an insulated conductor from a charged conductor results in a diminution of the electric energy, for the total charge remains the same while the capacity is increased. The diminution of the energy may be wasted as heat or may be recovered as mechanical work. If this loss is to be avoided, the charging must be effected without altering the capacity, the capacity being subsequently increased while the conductors are in contact.

Passing to magnetism, the magnetic energy in a system is given by

$$\frac{1}{8\pi}\int\int\int \mu H^2 dx\, dy\, dz, \text{ or } \frac{1}{8\pi}\int\int\int \frac{B^2}{\mu}\, dx\, dy\, dz.$$

With low magnetising forces, such as $H=5$, the energy stored in iron is about 2,000 times that in air. If at any place where the magnetising force is constant we allow a piece of iron to replace a given volume of air, a certain amount of energy is converted into mechanical work, this being the difference between the energy in the iron and the air. This amount of work divided by the distance the iron has moved to replace the air gives the average force experienced by the iron in moving to the point in question. On this principle the attractive force of solenoids and electromagnets may be worked out in many instances.

Motion in the different parts of any such system involve changes in the energy contained in the system. There are definite relations between the mechanical work done and the changes in the energy, and thus a complete dynamical theory of electric engines may be derived. The efficiency of such an engine is the ratio in a completed cycle of the energy converted into mechanical work to the total energy supplied.

Electric engines may be divided into the three groups: (1) Electrostatic, (2) magnetic, (3) electromagnetic.

In electrostatic engines a change in capacity may be brought about by (1) moving charged conductors in a medium of uniform specific inductive capacity, or by (2) keeping the conductors fixed relatively

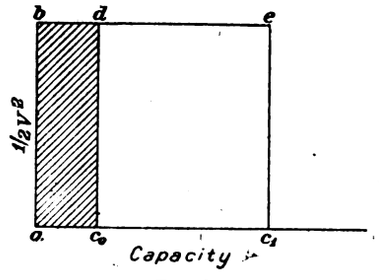

FIG. 2.

to one another and varying the specific inductive capacity of the medium. In both these cases there may be the further two cases, in which (*a*) the charge remains constant, and (*b*) the conductors are maintained with a constant P.D. between them.

These principles may now be applied to consider the efficiency of electric engines of the several types. A simple electrostatic engine will consist of two plates; the cycle will be as follows: The plates at a distance are charged, allowed to approach, doing work, discharged and moved apart doing no work. The P.D.s are V_0 and V_1, the capacity C_0 and C_1, the energy of the system W_0, W_1, at the beginning and end of the working stroke, and the mechanical work done W_m.

Case (*a*).—The plates are charged.

The energy $$W_0=\tfrac{1}{2}V_0^2C_0. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The plates move to a position where C_0 becomes C_1. The energy becomes

$$W_1=\tfrac{1}{2}V_1^2C_1. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The mechanical work done is

$$W_m=W_1-W_0=\tfrac{1}{2}(V_0^2C_0-V_1^2C_1). \quad . \quad . \quad . \quad . \quad . \quad (3)$$

But the quantity of charge Q is constant, so VC is constant, hence $V_1^2=V_0^2C_0^2/C_1^2$, so (3) becomes

$$W_m=\tfrac{1}{2}(V_0^2C_0-V_0^2C_0^2/C_1)=\tfrac{1}{2}V_0^2C_0\{1-C_0/C_1\}.$$

The plates are now discharged and moved back to the original position, no work being done, and the cycle is complete.

The efficiency

$$E=\frac{W_m}{W_0}=\frac{V_0^2C_0\{1-C_0/C_1\}}{V_0^2C_0}, \text{ or } 1-\frac{C_0}{C_1}.$$

This is a quantity which approaches unity as the ratio of the initial capacity to the final capacity increases, it being, however, remarked that the work done depends on the magnitude of C_0, so that in practice the ratio must be increased by increasing C_1, not by diminishing C_0.

Such a case may be shown graphically in the same way as the *pv* diagram of an ideal heat engine.

Case (*a*) is seen in Fig. 1. Here the ordinates are equal to half the squares of the P.D., and the abscissæ are the capacity, so that the product or area is $\frac{1}{2}V^2C$, or the electrostatic energy. The shaded area represents the energy originally put in electrically. If the capacity now increases, the square of the potential follows the line *dec*, and finally the energy left and lost in discharging the plates will be *ec*, *af*. The energy converted into mechanical work is given by the area enclosed between c_0d, *ec*, and the curved line.

Case (*b*) is shown in Fig. 2. Here the plates move, but remain connected to a source of constant P.D. The energy of the initial charge is given by the area $abdc_0$; the mechanical work done at constant potential is dec_1c_0, and this is also the energy added to the system. On discharging the plates the total energy $abec_1$ is all lost as heat.

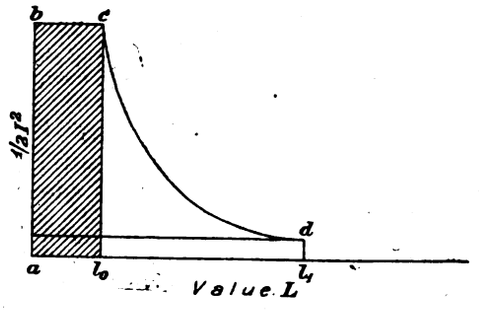

FIG. 3.

Mr. Atkinson discussed electromagnetic engines at some length. Here the resistance of the circuits is assumed to be zero, so that a current once established persists. Movement of a circuit in respect to another causes the induction to vary. The electro-kinetic momentum remains constant. Engines of this class may consist of one circuit and variable coefficient of self-induction, or of two or more circuits with variable coefficient of mutual induction.

As an illustration, a solenoid is considered with an iron core which moves in or out. If an E.M.F. is applied until a current, I_0, is reached, the stored energy is $W=\frac{1}{2}L_0I_0^2$. Suppose the E.M.F. then to be removed and the coil short-circuited; the current will remain steady. Then let the core move in. The energy is then, $W_1=\frac{1}{2}L_1I_1^2$, the current having changed to I_1 and the electro-kinetic momentum LI being constant. On breaking the circuit, W_1 is dissipated in heat, and the core may be moved out without any work being done, thus completing the cycle.

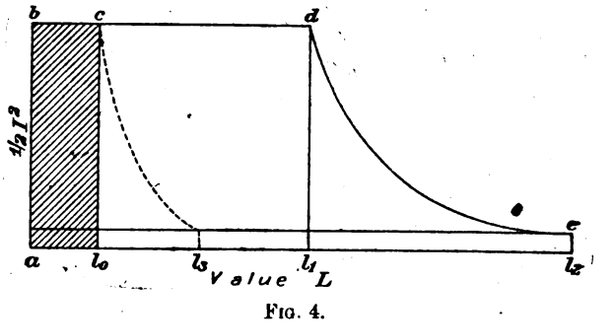

FIG. 4.

Fig. 3 shows the case where the core moves at such a speed that I^2 diminishes as L increases, so that the energy is constant. Here the work put in is equal at each instant to the work done mechanically. In Fig. 4 the initial current is started, the plunger moves at constant current; then the supply is disconnected and the coil short-circuited, and the core moves to its limiting position, when the circuit is opened and the remaining energy is lost as heat.

Lack of space does not permit us to refer to the more complicated cases, or to the section dealing with electric generators. The ideal efficiencies were given in all cases, and are generally either $\frac{1}{2}$ or 1.

In conclusion, Mr. Atkinson expressed the hope that the lecture would stimulate thought and invention. There was good reason why rotating machinery should be driven by rotating motors, but there was no good reason why the brake air pumps on an electric train should not be driven by direct reciprocating motors. It was possible that an efficient electrostatic generator might be developed if the problem were properly considered. There were wide fields for new experiments, and it was possible that the energy aspect which Kelvin developed might prove fruitful of new departures.

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Patent Legislation.

In another column we publish an important Report on Patent Law Amendment which has been drawn up by a Committee of the Institution of Electrical Engineers. It will be remembered that a public meeting was held in this connection by the Institution in February last, at which many points were discussed by the members. It was then known that a Committee was at work on the subject. Since that date their work has been completed, and, subject to a few verbal alterations, it has been adopted by a conference of representatives of some 30 leading scientific and technical societies convened by the Institution of Mechanical Engineers. A deputation from this conference waited on the President of the Board of Trade on the 10th ult., when the Report formed the basis of the representations made by the deputation. As our readers are aware, this action does not appear to have been quite as effective as could have been hoped.

Turning to the Report, it may be said that this deals very comprehensively with a number of important questions, but we cannot refer to more than a few of them in the present article. One of the points of greatest interest at the moment is no doubt the question of a moratorium. It is interesting to note that Sir ALBERT STANLEY, in response to a deputation from the London Chamber of Commerce, expressed a view opposed to any extension of the life of patents generally for causes connected with the war, and contended that any such action would amount to making patentees a specially favoured class who alone were not to suffer by the war. To some extent Sir ALBERT seems now to have altered his views, for he stated recently in the House of Commons that the new Patents and Designs Bill will contain clauses dealing with the life of patents where the working had been prevented during the war. Undoubtedly this is a move in the right direction, but as a working proposition it is futile and unworkable. How is the prevention of working by the war to be proved? Any number of patents have been put on one side simply because the time was inauspicious, and because such inventions could not be further considered until after the war. Many other patents have been worked to a very minor extent. Take, for example, patents dealing with street lighting. In all probability these have been worked to a small extent during the war. On that account are the patentees to receive no relief? Moreover, we all know the cost of submitting proofs in such cases. Many patentees will probably feel that they have lost enough money already without incurring further expenditure which may turn out to be profitless. Then, again, how can thousands of patents be considered without interminable delay? The idea of a specially favoured class is altogether preposterous. The position is simply this, that patentees have been paying the Government year by year for something which was necessarily useless to them, or at least useless to a large extent. The common-sense way of dealing with such a subject is to give an extension irrespective of claims, by means of a patent moratorium.

Another question which has given rise to a good deal of discussion is that of the compulsory working of patents. This was thought to be an excellent measure at the time it was introduced, but it has given rise to certain evils on which we have commented more than once. If a patent was not worked it was liable to be revoked. The Committee point out that there are other remedies than revocation which could be applied. The attitude is adopted that no remedy should be capable of being applied except in favour of someone who himself is ready and willing to do what he alleges and proves that the patentee has failed to do—namely, to give substantial benefit to the public.

Undoubtedly, one of the greatest objections to the present procedure is the shortness of time allowed for the acceptance of the complete specification after the provisional specification has been filed. A provisional specification is generally filed as a result of work in the laboratory stage, which is necessarily very imcomplete in character. The work has been sufficient to show that there is good ground for believing that the invention will be successful. The next stage is to produce the invention on a commercial or semi-commercial scale, so as to prove outright that it is of value and to obtain the conditions with sufficient closeness to enable the complete specification to be filed. Everyone who has carried out work of this character knows quite well that it is practically impossible to carry through such work in the short period of six months that is now allowed. Then, further, the complete specification must be accepted within 12 months of the date of application, which means that if the examiner takes some time in raising objections the patentee may have a very short time in which to consider these objections. In the United States one year is allowed for filing an amendment to each official action of the patent office examiner. Although we think there has been a good deal of abuse of this provision, we think equally that the period allowed in this country is altogether unfair to patentees. There should certainly be an amendment in this regulation.

Another direction in which there is undoubtedly a very strong feeling is that the fees charged by the Patent Office are far higher than they should be. It is altogether unjustifiable that an institution which is nominally for the good of patentees, and ultimately for the good of the public, should be run for profit. As is shown by the present Report, the renewal fees could very well be halved and yet a surplus would be shown in the revenue. In all probability this would lead to a considerable increase in the number of renewal fees, and it is not unlikely that these fees might then be halved once more. There should be some attempt to look upon inventors as a meritorious class of the community, instead of treating them, to a large extent, as though they were parasites to be discouraged.

Review.

Modern Engineering Measuring Tools. By ERNEST PULL. (London: Crosby Lockwood & Son.) Pp. viii.+115. 4s. 6d. net.

This compact addition to the author's works on engineering tools, &c., is intended to provide a summary of precision tools used in modern workshops. In these days measuring tools play a very important part of machine shop practice. After a preliminary chapter on units of measurement the author proceeds to explain the use of the micrometer and the vernier, and other separate chapters are given to gauges, measuring macihnes and miscellaneous measuring tools. The work is completed by a series of tables on mensuration, surfaces and capacity, metric conversion factors, wire gauges and screw threads, &c. The information is presented in a practical form and is fully illustrated. In some of the sketches the lettering and figures are rather small and difficult to read. In explaining vernier scales, &c., clear and neat diagrams are very important, and we think this point might receive further attention in a subsequent edition.

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Electric Welding for Shipbuilding.

LLOYD'S CHIEF SHIP SURVEYOR'S VIEWS.

Great interest was aroused on Tyneside last Friday evening by the lecture delivered, to a crowded audience of members of the North-East Coast Institution of Engineers and Shipbuilders, on "Electric Welding for Shipbuilding Purposes," by Mr. W. S. Abell, M.Eng., Chief Ship Surveyor of Lloyds' Register. The address was followed by a demonstration of electric welding, apparatus and operator being provided by Sir Geo. Hunter, of the shipbuilding and engineering firm of Messrs. Swan, Hunter & Wigham Richardson, Ltd., Wallsend. Mr. Edwin L. Orde presided.

Mr. ABELL stated that the practicability of uniting iron and steel plates by means of electric welding appeared to have been demonstrated about 25 years ago, but it was some considerable time after that before it was suggested that that process might be suitable for use in repairing hulls and boilers.

Since 1911, the use of welding for effecting minor repairs had been very greatly extended, and in 1917 about 154 cases occurred, of which 140 were to the boilers and the remainder to the hull. Of the latter, six repairs were made to the stern-post, three to the rudder and five were miscellaneous, including one case in which a previously executed weld had proved to be defective.

In view of the favourable nature of the experience gained, it was suggested about 18 months ago that the time had arrived when a further step in advance might be made, and the process of electric welding adopted throughout the entire structure of a vessel. Before, however, such a course could be approved it was thought desirable that all the evidence bearing upon the question should be examined, with a view to ascertaining the capability of electrically welded joints to withstand structural stresses. Numerous experiments had been made to find the strength of electric welds in various combinations of plating, but these had nearly always been confined to the determination of the ultimate strength of the welded joints and, in a few instances, to their ability to resist bending. In these circumstances it was considered essential that, before any substantial progress could be made, reliable data should be obtained embracing an examination of as many as possible of the properties of electrically welded joints. The information available regarding the ultimate strength of such joints did not touch at all upon several of the principal problems to be solved before the adoption of electric welding could be sanctioned in ship construction. In particular, information was lacking concerning the elastic properties of welding and welded material and its ability to resist the alternating stresses to which vessels were subject. As was well known, the stress at which a material broke down under conditions of repeated stress, particularly if of an alternating nature from a maximum tension to a maximum compression, was very much lower than the ultimate strength as measured in the ordinary way, and the behaviour of welded joints under such conditions was a question of considerable importance in its relation to shipbuilding.

In devising tests on material of that kind it was not possible to reproduce exactly the conditions which would be experienced in actual practice, and the object aimed at was, therefore, to arrange a series of experiments which would demonstrate the average reliability of the welds under various conditions of loading. Another source of possible difficulties was that there was not, at least at present, any known method of testing the soundness of a weld after completion. In engineering structures it was nearly always possible, by examination of the finished work and by suitable mechanical tests, to determine whether the workmanship and material were satisfactory and reliable, and the fact that tests were not possible with welding rendered it all the more necessary that the preliminary experiments should be as thorough as possible. It was found necessary to design several methods of investigating the problems involved. It was decided that the experiments should include a determination by different methods of the modulus of elasticity and the elastic limit of the welding and welded material, together with the incidental information regarding the ultimate strength and elongation of the welded joints. A series of alternating stress tests with different forms of specimens tested under various conditions was also devised, together with a number of minor tests, including bending and impact. Complete chemical and microscopic analyses of the welding and welded material were made to ascertain the changes in chemical composition and crystalline structure produced during the welding process.

As a proportion of the stress in a ship which would be borne by the welded joints was largely dependent upon the relative values of the modulus of elasticity of the weld and that of the adjacent plating, it was thought desirable to examine that relationship in specimens as large as practicable, and test pieces were prepared of the maximum size that could be tested in a 300-ton testing machine, that being the largest power available. The length of the specimens was 6 ft. clear between the holders, while the breadth varied from 48 in. to 22 in., according to the thickness of the plates. Loads, increased gradually, were applied and the extensions under these known loads were carefully measured, by the strain meter designed by Dr. Montgomerie, at the weld and at various points on the solid plate adjacent to and well clear of the weld. The general conclusion to be drawn from the tests was that there was little or no difference between the modulus of elasticity of the weld and that of the plating. Other tests appeared to confirm that conclusion. In all the tests it must be recognised that the measurements were taken on specimens containing only a relatively small amount of the deposited material forming the weld. To obtain further information regarding the properties of that deposited material, small test pieces were prepared entirely composed thereof, and the modulus of elasticity thus determined was found to be 11,700 tons per square inch, as compared with about 13,000 tons for mild steel and 12,000 tons for wrought iron.

Afterwards the large butt-welded specimens were tested to destruction to ascertain the ultimate strength of the welded joints and, as the most common form of joint in shipbuilding was the ordinary overlap, a complete set of tests was carried out on joints of that form, while a few riveted overlaps were added to complete the series of comparative results. All these specimens were made as large as could be tested in a 300-ton machine. From the results it would appear that the tensile strength of a treble-riveted overlap was about 65 to 70 per cent., that of the unperforated plate; that of the welded overlaps from 70 to 80 per cent., and that of the butt welds from 90 to 95 per cent.

Two methods of carrying out alternating stresses were employed, in the first of which the specimens tested were in the form of round bars, whilst in the second they were in the form of flat plates. The apparatus used in the former case was a modification of that used by Wohler in his well-known experiments. The fracture in the case of the welded bars always took place at the weld. From the results of the tests it might be inferred that the welded bars would withstand a very large number of repetitions of alternating stress (say 5,000,000) with a range of 6 tons per square inch tension to 6 tons compression; the corresponding figure in the case of the unwelded bars was about 10 tons per square inch. In the case of the flat plates it would appear that the stress at which the butt-welded specimens were able to endure a large number of alternations was about 70 per cent. of that borne by the similar plain plate; the corresponding figure for the comparative endurance of lap welds and riveted laps was about 60 per cent.

The chemical composition of the material of the electrode was, obviously, a matter of primary importance in securing a satisfactory weld, and special care should be devoted to the selection of the material in order that the elastic properties of the structure might be preserved as far as possible. For special types of work the use of various alloys had been proposed, but for structural work it would probably be found that the most favourable results were secured by the use of an electrode with a composition similar to that of mild steel. If the composition of the weld were examined it would be observed that the carbon, silicon and manganese were almost oxidised away from the filling-in material during the process of welding, whilst the sulphur and phosphorus remained nearly the same, the deposited material being practically pure iron. One of the chief causes of the unsatisfactory welds sometimes obtained was the oxidation of the original and filling-in material. The possibility of trouble arising from that source was, to a certain extent, lessened by the presence of the silicon and manganese which, especially the latter, were powerful reducing agents. In America, advantage was taken of that fact in the manufacture of the bare wire electrodes, which were the common type in that country, by using a steel which contained an increased percentage of manganese. In this country bare wire electrodes were not common, most makers using a coating of some kind, the object in each case being to protect the molten electrode from oxidation. These coatings might be divided into two classes, those which volatilised at the temperature of welding and those which formed a liquid slag which finally solidified on the surface of the weld.

The advances which had been made in the last 20 years in the micrographic examination of the structure of metals and, particularly, of the iron carbon alloys afforded a very valuable means of investigating the conditions existing at the junction of the original

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and the added metal and of determining in some degree of soundness of the weld. To secure a satisfactory weld it was essential that there should be a good diffusion of the fused metal into the work without any abrupt line of demarcation. It was also desirable that the temperature should not be excessive and that the effect of heating should be localised as much as possible, to avoid undue disturbance to the structure of the original material.

In the spring of last year a series of tests was conducted at Washington to determine the relative efficiency of riveting, caulking and electric welding, using ordinary mild steel electrodes without any covering. The test specimens were, in all cases, about 36 in. in length by 9 in. in breadth and ¼ in. in thickness. The results obtained showed that the strength of a single-riveted joint re-inforced by edge welding was nearly equivalent to that of an ordinary double-riveted lap.

An examination of the results of these experiments showed that the tensile strength of welded joints was greater than that of riveted joints, and such joints might, therefore, be accepted as fully equivalent to the latter. The results of the elasticity tests showed that, in general, the combination of welded and unwelded material behaved practically homogeneously up to at least the elastic limit, a feature of considerable importance in relation to structural stresses. It was only when the result of the alternating stress experiments were considered that the question of the limits of application became a serious problem. These tests showed generally that welded material would not withstand a very large number, say, several millions, of alternations, if the applied stress was greater than about $\pm 6\frac{1}{2}$ tons per square inch. The capability to resist alternating stresses was, of course, of the very greatest importance in shipbuilding materials, and would appear, for the present at least, to limit the application of welding to vessels in which the stress was not exceeded. The calculated stresses in ship structures were, in the case of large vessels, rather in excess of that figure, although, from such information as was available on the subject, it would appear that the stress actually experienced by the material in a ship was considerably less than that calculated under the usually assumed conditions. It was well, however, to proceed cautiously in the application of a novel method of construction like electric welding, and it would probably be wise to limit its application meantime to vessels of a length of not more than about 300 ft.

In designing the structural arrangements of a vessel the joints of which it was proposed to weld electrically, the time spent in arranging the various details of the structure would be well repaid. The first point to which attention might be drawn was the desirability of limiting the amount of overhead welding required to be done. It was not possible entirely to eliminate this feature, but, with care, its extent might be considerably reduced. One method of achieving that was shown on the lantern screen, illustrating a way of arranging the seams and butts in bottom shell plating. The butt straps were fitted on the outside and lightly welded to one of the plates before erection. After the plates had been placed in position, the principal strength weld was made downwards and the only overhead welding in the joint was on the remaining edge of the strap. Another slide showed how the same object might be attained in the case of the attachment of the centre keelson to the foundation plates of a single-bottom vessel. The seams of the side plating should be jogged with a good clearance between the joggle and the edge of the adjacent plate, the strength weld being applied to the upper edge of the seam, and a light run on the lower. Consideration of the methods of attaching two members at right angles to each other immediately raised the question as to whether connecting bars and the flanges of beams and frames might be omitted. As a rule, these angle bars and flanges had no inherent merit, and were merely fitted for lack of a better method of attachment, but their convenience for purposes of erection was such that their use was likely to be retained in the meantime, except in a few instances where temporary lugs might be fitted to secure the members until the welding was completed. In such cases, the welding might take the form of a complete run on each side, or an arrangement of tack welding might, in some cases, be adopted in which the welds were fitted in short lengths spaced three times the length of the weld from centre to centre. The actual amount of welded material which should be deposited varied, of course, with the thickness of the plating and could only be determined by actual trial in each case. It would generally be found necessary to complete the welds in more than one run. It was also advisable that as much welding as possible should be done on the ground before the various members were erected in place, as the operators had then a much better opportunity of securing satisfactory results. The maximum spacing of the service bolt required during the process of erection was a matter which could only be decided after some experience had been gained with vessels of different sizes. It was essential that the spacing should be sufficiently close to enable the surfaces to be properly drawn together, since the welding did not possess any drawing power at all, and any neglect to have the surfaces well closed must be very prejudicial to the success of the structure. It was probable that the most economical arrangement would be found to be a combination of riveting and welding, but the whole problem was one in which there would be gradual development as experience was gained and new methods of erection devised.

Since, as previously stated, there did not exist any means at present of testing the soundness of a weld after it had been completed, it was necessary that the operators employed should be reliable and well trained in the manipulation of a system of welding used. In welding, however, as in many other engineering processes, very much could be done to avoid variations in workmanship by the introduction of suitable mechanical devices to assist the workman by improving the means of control over the work. Electrodes were nowadays manufactured with a high degree of uniformity and, in most sets of welding plant, provision was made to enable the density of the electric current to be varied with the size of the electrode. It was important that the instructions issued regarding the size of the electrode and the corresponding current should be carefully followed and that care should be exercised to see that the metal was properly deposited. In the meantime, it was very necessary that the work should be closely supervised during the process of welding and, if that were done, the possibility of serious failure was remote.

The improvements in electric welding had opened up considerable possibilities of its extended application in shipbuilding. For reasons he had given, it was improbable that, until some practical experience on a fairly large scale had been obtained, welding would be applied to the structural members of a vessel exceeding 300 ft. in length, but, even for smaller vessels, there was ample scope for the introduction of that system of construction. Work had already been commenced on a coasting vessel, about 150 ft. long, by Messrs. Cammell, Laird, and both Lloyd's and he had to thank Sir George Carter and the firm for the great help given to them in carrying out their experiments. Proposals had been discussed for the building of a number of other welded vessels, ranging from 86-ft. drifters to standard ships 300 ft. long. In addition, numerous propositions relating to the use of welding in the construction of bulkheads, casings, deck-houses and similar items not subject to the principal structural stresses had been considered and many adopted. The extent to which welding would be adopted in the future would, in the long run, be governed by its relative cost as compared with the present methods of construction, account being also taken of the saving in weight and consequent increase in deadweight capacity due to the elimination of many of the structural elements which would no longer be necessary. On the whole, it would appear to be safe to say that for vessels of moderate dimensions the use of electric welding would become increasingly common with possibilities of extension to vessels of larger size as experience was gained and further research led to a nearer approach to perfection in the process of welding. If they could have some experience in different directions and if the result of the application to small vessels should prove to be satisfactory, he thought there was no question that they should be justified in extending the process to larger vessels, and, at the same time, by the time that stage was reached, they should probably have learnt many details in the application of welding and in the design of details necessary for that purpose.

Electric Melting of Brass.—We notice in the "Journal du Four Electrique" some notes on electric brass furnaces, the advantages of which are summarised as follows: Hand labour a minimum, because the capacity can be raised to 3–4 tons and the application of the heat does not involve manual labour. No crucible and maintenance running costs, except the renewal of electrodes, which requires determination by long experience. Loss in zinc probably little different from that in small covered crucibles, as the furnace is a closed one. Insignificant oxidation. No dross requiring treatment. It is convenient to recall that if combustibles are replaced by electric power the furnace will require about the same number of kilowatts per 100 kg. of metal turned out, as the kilogrammes of coke consumed by an ordinary furnace for the same output. Theoretically the electric furnace is the ideal, but its practical development is contingent on a sufficiently low price for energy.

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The Applications of Electricity in Ships and Shipbuilding.*

By J. F. NIELSON.

It is upon the multifarious applications of electrical science that the Navy largely depends for its existence to-day.

Electricity plays an important part in the lighting, heating, ventilation, internal and external means of communication, operation and control of every possible means of defence and offence of a modern battleship, cruiser and even torpedo boat destroyer. It is likewise an element of great importance in the mercantile marine. In this address it is proposed to deal mainly with the following topics :—

1. The growth in the application of electric power to shipbuilding yards during the last 30 years.

2. Some recent applications of electrical science to the equipment, navigation and propulsion of ships.

Thirty years ago electricity was generated almost, if not entirely, for lighting of workshops, wharfs and ships under construction, and even then only on a very small scale. To-day the demand for power is in the neighbourhood of 85 per cent. of the total consumption of electrical energy for all purposes. In a shipyard with which he (Mr. Nielson) was acquainted the total capacity of the generators installed in 1888 was under 80 kw. : to-day the available generating and transforming plant has increased to over 7,300 kw. The largest motor 25 years ago was one of 8 B.H.P. ; to-day motors of 600 B.H.P. will soon be in operation. Last year over thirteen million units of electrical energy were consumed for all purposes. The steam engine has almost entirely disappeared, its place being taken by the rotary converter and electric motor.

In lifting machinery there have been improvements, both in increased facilities for operation and in the speeding up of the transport of material. The slow and cumbersome sheer legs, the overhead travelling crane operated by heavy, slowly-revolving shafting, and the steam winch have all disappeared and been replaced by the electric cantilever crane, the fast running overhead traveller and the electric winch. The largest motors in most shipyards are now coupled to air compressors. During the last few months orders have been placed in this country for not less than 95,000 H.P. in motors for driving air compressors alone.

The application of electric welding to ship construction and repair is being extended. There are now in service some small barges in which riveted joints are entirely, or almost entirely, absent ; yet it seems improbable that the present methods of riveting and caulking, which are the result of long experience, will be immediately superseded by any other system. However, tests undertaken by the Committee of Lloyd's Register of Shipping have been so far satisfactory as to indicate that, under certain very definite restrictions, electric welding may be applied to ships constructed under their supervision. Electric arc welding as an adjunct to the riveting of water and oil-tight work appears to have great possibilities. The welded joint would seem to have the further advantage over the riveted and caulked joint in that it will remain water and oil tight up to its breaking point. It has wide applications in workshops, in building up oil and water tanks, in welding pipe flanges, filling in new teeth in gear wheels, reinforcing worn-down keys and bearings in shafts, and all such repair work in steel and iron. Indeed, its most useful application at the present time appears to be in effecting repairs.

The most interesting topic in connection with the electrical equipment of ships is undoubtedly that of propulsion. Whereas electric propulsion had its beginning in this country, we have allowed its development to be carried on by others. In particular, the United States of America have installed or built for installation on board ships of the U.S. Navy thousands of electrical horse-power in the form of turbo-generators. One electrical manufacturing firm alone has on order complete equipments of turbo-electric propulsion for no less than seven battleships and four battle-cruisers of an aggregate shaft horse-power not far short of one million. Among the arguments used in favour of electric propulsion for battleships are that it gives practically complete duplication, for with two turbines and two motors, one or other of them could break down and still leave a means of propulsion ; that electrically-propelled ships fitted with motors having pole-changing connections can be run at cruising speeds under conditions designed to give as good economy as at full power ; and, further, owing to the large speed reduction permissible between turbine and motor, the former can be run at high velocity, an essential requirement for high economy in steam consumption. Speed can be maintained with much greater accuracy than with any other system ; the arrangement of the machinery is much more flexible, as the position of turbines and motors is not fixed in relation to one another. The rapidity of operation when manœuvring is much greater ; electric propulsion does not require separate turbines for going astern, reversal of motion being accomplished by reversing the motors instead of bringing into use a turbine which, when the ship is going ahead, is all the time running idle. The double transformation of energy may involve a loss of 10 per cent., equally divided between the conversion from mechanical to electrical energy, and the reconverting of such electrical back into mechanical energy. The electrical should, therefore, possess a compensating higher steam economy, which can only be obtained by a very high velocity in the turbo-generators and the supply to it of a very highly superheated steam. It would seem, however, the mechanically geared system has little to fear in the much larger field of the mercantile marine.

The advantages of electrically-operated steering gear are becoming more and more widely recognised. As an auxiliary to the steam-driven gear, and as a substitute for the ponderous and slow-moving hand gear, electric steering has become standard practice in the British Navy. The "Ormonde," the latest addition to the Orient Company's fleet, is fitted with two sets of steering gear, but electrical—an excellent testimony, surely, to the reliability of the electrical drive. The system, which appears to have practically superseded all others, is that which comprises a continuously running constant speed motor, coupled to a variable delivery pump, which in turn operates an hydraulic variable speed gear. This same power transmission gear is admirably adapted for application to boat hoists, cranes, gun turret and armoured hood turning, and all such machinery where a positively driven mechanism capable of being started, stopped, reversed and controlled over an infinite range of speed is required. This gear can also be made to act as a gradual but positive brake. A most valuable feature, which should appeal strongly to the shipowner, is the deck space saved ; and, in fact, the motor and its starter can be kept under dry cover, and thus be less liable to break down than if exposed on a forecastle head to a sea breaking over them, as must necessarily be the case in the ordinary direct-geared electric winch.

Next, perhaps, to wireless telegraphy, there is no piece of modern scientific apparatus installed on board ship of greater interest than the gyro-compass. This instrument has not a "tendency," but a *determination*, to point "true north," and that with far greater force behind it than the magnetic compass, no matter how delicately poised on its pivot, ever has to point to the magnetic pole ; it is free from the influences which may powerfully seduce an ordinary needle from its allegiance to the magnetic pole. Owing to its necessarily costly construction, it will hardly come into common use in the mercantile marine, except perhaps in liners of the highest class. Electric power in the form of alternating current maintains the gyro wheel in motion. The gyro wheel operates in a vacuum, and forms the rotor of a three-phase induction motor, which, in the case of the Sperry instrument, absorbs 0·204 k.v.a., runs at 8,600 revs. per min., and, being of squirrel-cage type, has no slip-rings.

The future holds out great possibilities of ever-increasing usefulness for electric power on board ship. There is still room for investigation with a view to perfecting and standardising electrical equipment. Wireless telegraphy and submarine sound signalling apparatus have played a most important part in minimising the loss of life at sea from the barbarous acts of our enemies, and they will assuredly continue with increasing efficiency in the days of peace to bring succour to ships in distress and to warn them of impending danger. With the exception of the small outfits installed in submarines and in a few large passenger liners, electric cooking has made little headway in our navy and mercantile marine. The great improvements which have, however, been made on land installations should stimulate development of such appliances at sea.

* Abstract of inaugural address delivered by Mr. J. F. Nielson before the Scottish Local Section of the Institution of Electrical Engineers on November 12th.

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Allocation of Generating Plant by the Ministry of Munitions.

Our readers are well aware that much dissatisfaction has been expressed by certain municipalities at the way in which plant has been allocated by the Ministry of Munitions to electricity supply stations, and quite recently a resolution was passed by the Council of the Incorporated Municipal Electrical Association, and circulated to Members of Parliament, suggesting that the company undertakings had been unduly favoured. The following official statement is, therefore, of more than usual interest and goes to show that this accusation is without foundation.

	Municipal.		Company.
Total number of undertakings operating	327	...	230
Number of undertakings who have installed or have been authorised to instal more plant	56	...	20
Plant capacity of undertakings referred to above, at June 30, 1914	500,071 kw.	...	351,685 kw.
Additional plant installed or sanctioned (July 1, 1914, to Oct. 31, 1918)	645,072 kw.	...	324,453 kw.
Proportion of additional plant sanctioned by present director of electric power supply	219,565 kw.	...	85,000 kw.
Number of schemes sanctioned by him	32	...	10

(NOTE.—In an attached Schedule, the foregoing figures are shown in detail.)

The units sold by the 76 undertakings concerned were as follows:—

Year.	Municipalities (56).		Companies (20).
1917	1,384,185,750	...	1,160,337,146
1914	802,333,100	...	691,116,312
Increase in 3 years	581,852,650		469,220,834

Certain statements have appeared in the Press during the past few weeks, evidently based on inaccurate information, alleging that the Sheffield district is denied electrical expansion, while the North-East Coast undertakings are permitted to develop. The following figures bring out the facts:—

	Sheffield Corp.	Rotherham Corp.		N.E. Coast power companies.
Plant capacity of power stations, 1914	23,225 kw.	5,150 kw.	...	86,200 kw.
Installed or ordered since	*73,000 kw.	65,350 kw.	...	114,200 kw.
	138,350 kw.			
Total plant capacity installed or on order	96,225 kw.	70,500 kw.	...	200,400 kw.
	166,725 kw.			
Increase on 1914	580 per cent.		...	232 per cent.
Area of supply	60 sq. miles		...	1,400 sq. miles
Units sold—1917	186,220,901 kw.		...	563,365,976 kw.
1914	31,474,377 kw.		...	344,544,247 kw.
Increase in 3 years	154,746,524 kw.			218,821,729 kw.

Sheffield and Rotherham combined have installed or ordered during the war about one-seventh of the extensions of all the local authorities and companies combined.

The Ministry of Munitions commandeered for, or allocated out of their own plant, to Sheffield no less than 37,000 kw. of the additional 73,000 kw. which Sheffield have installed or ordered during the war. Some of this plant was commandeered by the then director of electric power supply (Col. McLellan) from that which his firm had previously ordered on behalf of various clients. He also placed at the disposal of the Rotherham Corporation, entirely free of charge, a complete set of drawings, specifications, &c., of the Melbourne power house (designed by his firm for the Victorian Government) to enable the Rotherham Corporation to save months of delay which would otherwise have been inevitable, with serious consequences to the district.

At the present moment Sheffield has 28,000 kw. and Rotherham 50,000 kw. of generating plant under construction with boilers to steam the whole, which plant should be available for operation between January and June, 1919.

In our next issue details will be given of the allocations to the principal undertaking, based on the schedule mentioned above.

(To be concluded.)

* This excludes a further 50,000 kw. provisionally sanctioned for Sheffield.

London Electricians' Wages.

The Committee on Production has given its award on the claims of the employees of the electricity supply undertakings in the London area for "the application of the award of the Committee on Production of July 24 last for the engineering and foundry trades," and also for new card rates and altered working conditions. The parties to the reference were the Incorporated Municipal Electrical Association, representing certain local authorities, the Conference of Chief Officials of the London Electric Supply Companies, six suburban electric supply companies (represented by Mr. K. Scott-Moncrieff), the Incorporated Association of Electric Power Companies and the Conference of Local Authorities on Wages on the one hand, and the Electrical Trades Union, the National Union of General Workers and the National Amalgamated Union of Enginemen, Firemen, Mechanics, Motormen and Electrical Workers on the other.

The award of the Committee of Sept. 6 dealt with the first part of the claim, and the present award on working conditions and basic rates represents an agreement arrived at after several conferences between the parties.

The "working conditions" lay down that eight hours shall constitute a shift and seven shifts a week's work. Overtime is to be paid for at certain rates and the men concerned shall receive 14 days' holiday with pay after 12 months' service. Double time shall be paid for work on Christmas Day. Good Friday and Statutory Bank Holidays shall be paid for at ordinary rates. The hours of labour remain as at present. Men and women shall be paid equal rates for equal work. All charge hands shall receive a minimum of 1d. per hour extra. Where existing rates are better than those provided for under this award, no change shall be made.

Assistants under 21 years or generating-station switchboards and in sub-stations shall be paid for learning period 10s. per week first six months (probationary); 15s. per week second six and 20s. per week third six months; afterwards, 75 per cent. of minimum rate for next 12 months, followed by an additional 5 per cent. on the rate per annum up to the age of 21. The number of probationers (learners) training on switchboards shall not exceed the number of sub-stations on the system, together with three generating stations.

The following shall be the basic rates: Electrical fitter, electrician, electrical wireman, 10½d. per hour; jointer, 9½d. per hour; plumber jointer, 1s. per hour; armature winder, 10½d. per hour; mains foreman, 60s. per week; cable gangers, 10d. per hour; public lighting foreman, 10d. per hour; public lighting leading hand, 9½d. per hour; public lighting attendant, 8d. per hour; arc lamp trimmer, 8½d. per hour; installation inspector, 55s. per week; meter inspector and tester (skilled), 10½d. per hour; meter repairer (mechanician), 11d. per hour; meter fixer, 8½d. per hour; meter reader, 8d. per hour; overhead linesman (skilled), 9½d. per hour; storekeeper (responsible for stock ledgers), 56s. per week; storekeeper, 40s. per week; assistant storekeeper, 8d. per hour; tool storekeeper (skilled), 50s. per week; battery fitter, 10½d. per hour; battery attendant, 9d. per hour; leading hands (conduit system), 8½d. per hour; cable hands, 7½d. per hour; fitter's, wireman's, electrician's and jointer's mate, 8d. per hour; telephone electrician, 10½d. per hour; telephone linesman, 9½d. per hour; telephone operator, 30s. per week; boiler cleaner, 8½d. per hour; labourers (general, indoor), 7d. per hour; labourers (general, outdoor), 7½d. per hour; cleaner, 7d. per hour; ash hopper and ash conveyor men, 8½d. per hour; coal handling apart from trimmer, coal weigher (not weighbridge clerk), and shunters and tippers, 8d. per hour.

Switchboard attendant up to 5,000 kw. installed, 50s. per week, and assistant, 35s. per week; above 5,000 kw. installed, 60s. per week; assistant, 40s. per week; fitter driver, 11d. per hour; driver, 9½d. per hour; assistant driver, turbine, pump and water softening plant attendants, 8½d. per hour; Greaser and auxiliary plant attendant, 8d. per hour; leading stoker, 10½d. per hour; stoker, 9d. per hour and trimmer, 8d. per hour.

Rotary sub-station inspector, 5s. per week above highest rate paid to attendants at sub-stations under inspection. Sub-station charge engineer or sub-station attendant: Under 1,000 kw. installed, 40s. per week; under 3,000 kw. installed, 50s. per week; and under 3,000 kw. and over, 60s. per week; subject to additional 5s. per week being paid when any or all of the following conditions apply: (*a*) Sub-stations which are supplied from two or more generating stations in which attendants in charge have to synchronise or parallel such generating stations; (*b*) Sub-stations where the attendants in charge are responsible for the area supplied from sub-stations and have to isolate sections of the network external to sub-stations in case any mishap occurs. Assistant sub-station attendants: Under 3,000 kw. installed, 35s. per week; over 3,000 kw. installed, 40s. per week.

Static sub-station attendants: All sizes under 2,000 kw., 40s. per week; over 2,000 kw., 45s. per week.

It was stated at the hearing on behalf of the electricity undertakings that a very large proportion of their officials belonged to another trade union known as the Electrical Power Engineers' Association. In the case of the shift or charge engineers, it was stated that 174 out of 196 belonged to the latter union. It appears that the Electrical Power Engineers' Association are considering the submission of a claim with respect to the rates of their members. The suggestion was made to the Electrical Trades Union that representatives of the two organisations should meet with a view to arriving at a line of demarcation in regard to their respective membership, but this proposal was not agreed to by the Electrical Trades Union. The Committee have very carefully con-

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sidered the matter, and "in view of the fact that a great proportion of these officials belong to an organisation which was not represented at the hearing, they feel a serious difficulty in attempting to determine the rates of pay of the officials. The Committee have accordingly come to the conclusion, and they so find, that in the absence of a substantial representation of the section of the employees affected by this part of the claim, no alteration shall at present be made in the existing rates."

Pending the setting up of District Boards under the proposed Joint Industrial Council for the Electric Supply Industry, it is proposed that if any questions arise with regard to the intent and application of any award of the Committee on Production, rates for additional grades, re-grading and general questions, the parties shall confer after requisite notice has been given and endeavour to arrive at a mutual settlement. Failing such settlement, any matters of difference to be referred to the Committee on Production.

Batti-Wallahs' Society.

MR. LL. B. ATKINSON SUPPORTS GERMAN BOYCOTT SCHEME.

At the usual monthly luncheon of the Batti-Wallahs' Society on Monday, Mr. Llewellyn B. Atkinson (secretary of the Cable Makers' Association) was the principal speaker, having been invited to attend and state his views as to German methods of business and the attitude which should be taken up in this country towards German firms and representatives.

Mr. ATKINSON said one reason for his having been asked to make some remarks on that occasion was that he had been one of those members who, early in the war, memorialised the Council of the Institution of Electrical Engineers to clear its books of the names of alien enemy members, which was subsequently done. His reason for declining to take the view that members should be accepted or retained solely on their technical and scientific qualifications, regardless of nationality, was that no scientific men in Germany had raised his voice against the outrage committed by Germans in going through Belgium and the other outrages and breaches of the agreements into which Germany had entered. He objected to the Germans' methods of warfare—including the use of poison gases and the torpedoing of vessels without warning—not so much as methods of warfare, as on the ground that they were breaches of undertakings into which the Germans had entered and that at the time of their adoption they secured an unfair advantage. He hoped it would be a long time before we would re-open the business we had with Germany. He had been for some years in Germany, and had witnesssed the growth of bitter hatred against this country, and an unveiled intention to take away all we had as soon as possible and in the near future. The Germans during the war had been guilty of inhumanity and bestiality which in our country would argue mental unbalance, and for four years they carried on murders and outrages on women on a wholesale and organised scale. Through Germany's action in declaring war we should have for the rest of our time a 7s. income tax, and our money was only worth half what it was. He was not going to forgive all these things. For 40 years the Prussians, who were swine, had educated the people of Germany to be swine, and it would take them another 40 years to educate another generation who were not swine. When they had done that it would be time enough for us to greet them again as comrades in business enterprise.

Hardware Exports.

Mr. Geo. W. Goodchild, 56–8, Eagle-street, W.C. 1, has sent us particulars of his scheme for the reorganisation of the hardware trade and for developing the export of tools and cutlery.

The proposal is to form an export association amongst the trade under the leadership of a firm of merchants, having the necessary experience of international trade, markets and finance without being manufacturers. The Association would send out at the earliest possible moment "Ambassadors" to all parts of the world: men having a sound knowledge of the trade as well as of the land and the people among whom they are to work. These men would take with them complete sets of samples of the firms represented in the Association for the establishment of permanent sample exhibitions in all industrial and trade centres of their respective territories. There would be a general agent for a country who would have its own sub-agents in districts. The general agent would serve as the manufacturers' direct and personal representative, as the rail-head for the receipt and distribution of all goods of the Association going into the territory, and as the intelligence officer, collecting and supervising all information received from his outposts, and forwarding same to headquarters with his remarks thereon.

The London headquarters would form the link between the general agent abroad and the manufacturer at home. It would initiate and organise the execution of all work and utilise the experience gained in one corner of the world for the common benefit of all the members throughout the globe. It would have a staff of experts versed in all languages spoken in any territory, where the Association contemplated doing business. Their duty would be to translate all the members' printed matter into the language, weights, measures, and the currency of the man whose good-will the manufacturer was anxious to cultivate. The head office would undertake the financial responsibility for all sales of the Association and act as banker thereof.

Legal Intelligence.

Batteries Contract Dispute.

Last week Mr. Justice Sankey heard the action brought by the United Kingdom Lighting Trust, Ltd., against Mr. S. Davis Nicholls for damages for an alleged breach of contract and warranty over the sale by defendant to plaintiffs of 12,000 "Master" batteries for pocket electric lamps at 10s. 6d. a dozen. Defendant denied liability and breach of warranty.

Mr. GREER, K.C. (for plaintiffs), explained that the goods were bought by plaintiffs as "Master" batteries, and were part of a large shipment from the United States. It was necessary that the batteries should give current at 4 volts, and there was a guarantee to that effect extending up to Dec. 24, 1917. Plaintiffs paid £525 for the goods, and their case was that they were not reasonably fit for the purpose for which they were purchased, were not of merchantable quality, and they said that, out of 12,000 delivered to them, no less than 11,031 did not give the proper illumination. Plaintiffs, as defendant knew, had bought for re-sale in smaller quantities, and as they had sold at 13s. a dozen the profit on the re-sales was 2s. 6d. a dozen. Plaintiffs claimed that loss of profit as part of the damages, and they claimed there was a warranty that the batteries should give sufficient current for the illumination of pocket electric lamps, and that any current of less pressure than 4 volts was not sufficient. Those pocket electric lamps were in very general use during the latter part of the war, and the trade became a very big one. Plaintiffs' contention was that, in the circumstances, they were entitled to recover back the price they had paid defendant, and damages for defendants' failure to deliver batteries in accordance with the contract. They said that there was an implied condition that the goods should be reasonably fit for operating those pocket lamps, and it was also a condition that they should be merchantable as batteries for pocket lamps. They also said that, in any case, there was an express guarantee in the contract; and as the batteries were practically worthless, their damages would be the same whether they relied on the condition which entitled them to return the goods, or upon the guarantee in respect of which their rights might be only the right of recovering damages. Immediately after plaintiffs had sent the batteries out they began to be returned by their customers. Of 540 sent out early, 474 came back with the complaint that they were useless, and that many of them were dead and would not give any light.

A number of witnesses were called, including Mr. Collett, who said he entered into the contract and he bought that large quantity at 10s. 6d. a dozen with the idea of re-selling in smaller quantities. Evidence was also given by Mr. J. Every and other witnesses as to the results of tests of the batteries, which showed that many were dead and others only gave about 3·6 volts.

For the defence Mr. PHILLIPS said that those batteries were guaranteed for four months. The fact that defendant was not willing to guarantee beyond Dec. 24, 1917, indicated that the four months' guarantee would be running out at or about that time, and therefore a larger percentage of faults were to be expected than with batteries that had a full four months to run. The batteries were sent out by defendant to plaintiffs in the original cases in which they were received; they were not touched in any way and they had the guarantee upon them, and defendant was perfectly willing to replace faulty batteries. When the batteries came back in the cases defendant reported to the people from whom he had bought them (Messrs. Farrant), and certain tests were made in December. It was then found that a very large number yielded over 4 volts, and it was deemed desirable that plaintiffs should be informed of that, so that they might come and be represented at the tests. Plaintiffs did not see fit to attend, and a much more exhaustive examination was made in January, after the guarantee had run out. At that examination very much better results were obtained than were recorded by plaintiffs.

Mr. Justice SANKEY: Is not the point in the case whose test was right?

Mr. PHILLIPS: I think it is. The question is what voltage would justify plaintiffs in rejecting the lot, and I submit that they cannot reject some and retain others. If he wants to claim his money back he must reject the lot: he is not entitled to keep some if he wants the contract rescinded. Counsel said he was not in a position to say that none were wrong, but he said the guarantee was that if the batteries were wrong and were returned others in their places would be sent. That was what the guarantee was in the trade. It was not that the money would be returned, but that good batteries would be sent instead.

Mr. Justice SANKEY: Is it compulsory upon them under the guarantee then, if there are bad ones, to receive others in their place?

Mr. PHILLIPS: It is not expressed in the words of the guarantee, but I say that is the effect of the guarantee when taken in connection with an article of that sort. The guarantee implied that the battery would give certain light for a certain period, and under the circumstances certain faults were always expected. Even if one got those batteries delivered at the beginning of the guarantee there would be some that would be faulty.

Mr. Justice SANKEY: And you cannot get damages for them?

Mr. PHILLIPS: No, because it is contemplated there would be some faulty, and the effect of the guarantee was that these must be replaced by proper batteries of sufficient strength.

Evidence was given by Mr. DARLINGTON SIMPSON, who said he knew that this parcel of 12,000 batteries was part of a shipment from the United States, and part of 25,000 sold to Mr. Nicholls. Those Master batteries came to various people on this side, and at the time in question the rights of sale were in the River Plate Commercial Company. When complaints were made the goods were returned to the warehouse of Messrs. Sheldon, and he went down and carried out certain tests. The result was that 60 per cent. gave 4 volts and over. He considered all

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under 4 volts as dead, and were useless to sell. He went again in January and opened five cases out of nine, and found that 60 per cent. were 4 volts and over.

Replying to the Judge: There would be 1,000 per case, and he tested, therefore, about 400 out of 9,000, taking them haphazard. He thought that the result suggested by plaintiffs that none reached 4 volts was due to a faulty testing instrument.

DEFENDANT, a gas mantle manufacturer at Bolton, gave evidence, and said he purchased these "Master" batteries from Farrant & Company, and ultimately sold them to plaintiffs. When the complaints were received the batteries were returned to Messrs. Sheldon's warehouse. The cases were sold direct to the trade in case lots. The test showed that 50 per cent. of them were right.

After other evidence had been called, Mr. Phillips submitted that plaintiffs knew they were buying batteries with a very short guarantee compared with the customary one, and a high proportion of faulty ones was to be expected. The claim for loss of profit could not be maintained, as plaintiffs could have gone into the market and bought others and thus made their profit.

Mr. Justice SANKEY said he accepted the evidence for plaintiffs as to the tests. He was of opinion that plaintiffs' tests were accurate, but that those carried out by defendant were perfunctory, and only covered a very small proportion of the goods. No notes were taken of defendant's tests, but, on the other hand, he had full and precise information about plaintiffs' tests. He thought plaintiffs' tests were accurate and defendants' tests were inadequate and inaccurate, and that their theory as to the boxes not having been unpacked was a mistaken one. He was satisfied that the goods were not of merchantable quality, and were not reasonably fit as batteries for those pocket electric lamps. Plaintiffs were entitled to have their money back, and there must be judgment for them for the amount claimed—viz., £482. 12s. 2d.—with costs.

Liability for Accident Due to Restricted Lighting.

Last week a Divisional Court (Justices Lush and Bailhache) heard an appeal from a decision of the Deputy Judge of the Lambeth County Court in an action brought by a cab driver named Baldock against Westminster Council for damages for alleged negligence in failing to have a street refuge at Cockspur-street properly lighted and in not supplying a proper lamp for the refuge, and in failing to place a red lamp or other warning there. The refuge was erected and the lighting of the standard (on which there was an electric lamp) was done under statutory powers. Owing to the war the light had been diminished from the normal power, and at the time of the injury suffered by plaintiff all the lights in the street were considerably diminished. On March 20, 1917, plaintiff's taxicab, which was being driven along Cockspur-street, was driven into the posts of a refuge where the light had gone out. The jury found that there was negligence on the part of defendants in omitting to maintain a danger lamp, and they also found that there was no conclusive evidence as to what caused the lamp to go out. The Deputy County Court Judge entered judgment for defendants, on the ground that there was no evidence that the particular lamp had gone out before or on the night of the accident, or that defendants knew that it had gone out or was likely to go out. He held it would be unreasonable to say that defendants were bound to provide against the contingency that a particular lamp might go out.

Plaintiff appealed, and after legal arguments the Court allowed the appeal, and judgment entered for plaintiff. Mr. Justice Lush said that sec. 130 of the Metropolis Management Act, 1855, provided for the lighting of streets by the lighting authority, and for the maintenance of a sufficient number of lights and for the keeping of them lighted during such times as might be necessary or proper. The question what was a reasonable degree of lighting was one for the highway authority, and it would not be competent for a jury to come to the conclusion that it was not what the authority but what the jury thought was reasonable. But in that case defendants had adopted the view that the refuge must be lighted, and they had undertaken to light it and did light it. The question, therefore, was whether there was any evidence which would justify the jury in saying that in the circumstances the authority had not taken reasonable care in discharging their duty in lighting the refuge. The Judge held that there was no evidence to justify the jury in taking that view. He said, however, in effect that if the particular lamp or the particular refuge had gone out before, then it would have been competent for the jury to say that defendants were negligent in not providing a substitute or alternative lighting. It did not seem vital to say whether that lamp had gone out previously. There was sufficient evidence that other lamps had gone out, and defendants were aware that, owing to the pressure, the lamps had become irregular, and that there was great risk at any moment of the lights ceasing. That being so, it was a mere question of fact or degree for the jury whether the lighting was reasonable, and it could not be said that there was no evidence to go to the jury that the lighting was insufficient and not reasonable.

☞ According to the "Telegraph and Telephone Journal," there were 172,674 TELEPHONE SUBSCRIBERS in DENMARK in March, 1918, against 153,820 in 1917. This is probably equivalent to upwards of 190,000 telephone stations. 88,672 belonged to the Copenhagen Telephone Company, 49,102 to the Jutland, 12,004 to the Funen, and 11,802 to the South Jutland Companies. Copenhagen had 60,611 subscribers, Aarhus 5,097, Odense 3,801 and Aalborg 3,429.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 SPECIFICATIONS.

112,415 REMY ELECTRIC CO. Regulation of dynamo-electric machines. (19/12/16.)
114,828 BROC. Couplings or connecting devices for electric circuits. (14/3/17.)
120,064 BAGGULEY & LACEY. Electric lamp holders or attachments. (24/9/17.)
120,066 TAYLOR. Apparatus and method for the localisation of faults in electrical conductors. (5/10/17.)
120,070 BONNELLA. Electric lamp fittings. (15/10/17.)
120,073 MACLUSKY. Gas, electric and like fires. (17/10/17.)
120,074 DONOVAN & DONOVAN. Boxes and switches of electrical fuses. (18/10/17.)
120,075 MILNE. Means for securing electrical fittings to conduit outlet boxes, patrasses and the like. (19/10/17.)
120,092 PARA. Electric light apparatus. (26/10/17.)
120,108 BENNETT. Electric heating and cooking apparatus. (7/11/17.)
120,119 STIRLING TELEPHONE & ELECTRIC CO., BELL & DAVEY. Electrical relays for use in cancelling arrangements for electrical signalling systems and other purposes. (14/11/17.)
120,135 HEURTLEY. Telegraphy. (6/12/17.)
120,167 SMITH. Magneto-electric machines. (10/4/18.)
120,172 CHAPMAN. Alarm clocks. (24/4/18.)
120,175 AUTOMATIC TELEPHONE MFG. CO. & TOMLINS. Apparatus for correcting electric impulses, particularly applicable to telephone automatic systems. (6/5/18.)
120,176 MAYSHIMA. Magnetic heating apparatus. (21/5/18.)
120,187 PICKERSGILL, PITT & HALIGH. Trolley heads for electric traction. (18/7/18.)
120,191 COMPAGNIE GENERALE DE MAGNETOS. Ignition circuits of magnetos. (29/9/17.)
120,197 AUTOMATIC TELEPHONE MFG. CO. Automatic telephone systems. (13/10/17.)
120,203 REMY ELECTRIC CO. Ignition apparatus. (19/9/17.)

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

October 14, 1918.

16,696 SIEMENS BROS. DYNAMO WORKS & WILLCOCKS. Electric fuse holders.
16,702 BAKER & SIMS. Flexible joint for cables, &c.
16,704 COLSON. Incandescent lamp holders.
16,735 EDISON SWAN ELECTRIC CO. & HIATT. Wireless telegraph valves.
16,736 WEST & CO. & PICKETT. Lifting magnets.
16,737 WEST & CO., BOSSOM & BREEZE. Alternating current motor starters.
16,739 SHEDLOCK. Manufacturing alloys of metal and electrodes therefor.
16,762 GERRARD & NEWBERY. Electrodes.

October 15, 1918.

16,778 REILLY. Electric lamp lock.
16,784 WOODBURN. Electric welding apparatus.
16,806 B. T.-H. CO. (G. E. CO.) Electric welding machines.
16,819 JAMES. (Stanley). Electric controllers.
16,850 CANDLOT. Electro-magnetically controlling jigging conveyors.

October 16, 1918.

16,909 WALKER. Searchlight apparatus.
16,910 PARSONS. Blading for turbines.
16,911 BREEDEN, URQUHART & LUCAS. Electric starting motors for engines.
16,918 B. T.-H. CO. (G. E. CO.) Electric motor control.

October 17, 1918.

16,974 B. T.-H. CO. & WEDMORE. Protective devices for alternating-current distribution systems.
16,996 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. & FLETCHER. Alternating current dynamos.
16,979 SOLOMON. Electric ignition.
16,995 TURNBULL. Electric ignition apparatus for engines.
16,999 IGRANIC ELECTRIC CO. (Cutler Hammer Mfg. Co.) Thermionic amplifiers.
17,000 IGRANIC ELECTRIC CO. (Cutler Hammer Mfg. Co.) Electrical discharge devices.
17,002 OLDHAM. Electric lamps.

October 18, 1918.

17,038 UPWARD. Portable electric lamp.
17,053 B. T.-H. CO. (G. E. CO.) Electric welding machines.
17,054 LATOUR. Radio telegraphy and telephony. (18/10/11, France.)
17,058 PINEAU & GERVILLE-REACH. Searchlights, &c. (18/10/17, France.)

October 19, 1918.

17,084 STRINGER & VANDEN WYNGAERT. Electric safety signal for motor vehicles.
17,120 LATOUR. Auotmatic alarm device for vacuum tube relays. (4/10/17, France.)
17,122 TUDOR ACCUMULATOR CO. (Soc. de l'Accumulateur Tudor.) Stoppers for containers of electric accumulators.

October 21, 1918.

17,149 EDMONDSON. Locking ring for incandescent lamps.
17,174 COCKADAY. Radiotelegraphy. (17/10/17, U.S.)
17,189 ROBERTS. Anchor devices for cables used in power cultivation of land.

October 22, 1918.

17,211 BRITISH INSULATED & HELSBY CABLES. Extrusion of metal.
17,222 PAGNON. Clip or fastening for electrical connections.
17,231 PRICE. Accumulator boxes.
17,242 DAVIS. Attachment of telegraph wires to insulators of telegraph poles, &c., of aerial wires.
17,245 BOLLIGER. High-tension continuous-current machine. (22/10/17, Switzerland.)
17,258 OLDHAM. Galvanic batteries.
17,259 OLDHAM. Electric signalling, &c., lamps.
17,267 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Axial flow steam engines.

October 23, 1918.

17,277 BRADLEY. Electrical treatment of gases. (21/6/16, U.S.)
17,316 B. T.-H. CO. & CARTER. High speed electric, &c., locomotives.
17,319 YOUNG. Machine for generation of electric currents, also applicable as a motor.
17,338 CAVE. Alkaline accumulators.
17,341 BRUSH ELECTRICAL ENGINEERING CO. & CHILTON. Combined turbines and electric generators, &c.
17,342 BRUSH ELECTRICAL ENGINEERING CO. & CHILTON. Turbine and electrical generator plants.

October 24, 1918.

17,373 DICKINSON. Means of effecting electric synchronised control.
17,398 HOLSLAG. Alternating.
17,404 PERL. Electric switches.

October 25, 1918.

17,420 GLOYNE. Electric aeroplane bicycle, &c.
17,442 EDISON SWAN ELECTRIC CO. & SHERGOLD. Electric make and break switches.
17,454 B. T.-H. CO. (G. E. CO.) Producing a high vacuum.
17,466 OLDHAM. Gas exits for galvanic batteries.

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Commercial Topics.

Capital Issue Restrictions.

It is notified that, notwithstanding the armistice, no relaxation can at present be permitted in the restrictions on capital issues, and the approval of the Treasury must still be obtained for issues of shares, debentures or other securities.

* * * *

Second-Hand Tools.

The Minister of Munitions announces that in future second-hand machine tools, wood working machinery and treadle lathes may be bought and sold without the sanction of the Ministry and without restrictions as regards price. The suspension of regulations does not apply to new tools.

* * * *

Companies' Annual Returns.

On Nov. 1 the Board of Trade prescribed a new form for companies' annual returns to the Registrar of Companies. In the new form, the nationality, the present and any former Christian names or surnames of the present directors, and any persons who have been directors since the registration of the company are to be given.

* * * *

Steel Exports.

The Minister of Munitions has notified that all deliveries of steel for export shall continue to be made at prices fixed by the Minister. Information as to the export prices will be obtainable on application to the Ministry of Munitions (Controller of Iron and Steel Production), Whitehall-place, S.W. 1.

* * * *

Steel and Iron Restrictions Removed.

The Ministry of Munitions has announced that until further notice iron and steel makers may accept and execute orders for iron and steel ranking for priority below class B, subject only to conditions shortly to be issued, as regards prices, and to the Order as to priority dated March 8, 1917.

* * * *

Designation of U.S.A. Goods.

The Executive Committee of the Merchants' Association of New York recently decided that the designation "Made in U.S.A." in plain type form should be used by all of its members on all goods manufactured by them in the United States of America, and that the use of all other markings to identify the country of origin of such goods be discontinued.

* * * *

Industrial Accidents.

As showing the value of good lighting in connection with the reduction of accidents, the records of the Travellers' Insurance Company of the United States give the following interesting results: Of 91,000 industrial accidents recorded in 1910, 23·8 per cent. were due directly or indirectly to poor lighting. It should be noted that this record refers only to the accidents investigated by this one insurance company. For the same period an estimate is made that puts the total industrial accidents of the United States at 500,000 and, on the basis of the Travellers' Insurance Company's percentages, about 125,000 of these accidents were chargeable to the lack of proper illumination eight years ago. Since that time insurance companies have studied lighting conditions in factories in order to classify the risk, and, as proper lighting resulted in lower premiums, it was not long before factory managers and their engineers worked out better methods of illumination. The result of this is that during the last two or three years the improvements in lighting have caused a reduction of at least 30 per cent. in accidents which are chargeable to the lack of proper illumination.

* * * *

Regulation of Wages.

A Bill for the temporary regulation of wages was introduced into the House of Commons last week by the Minister of Labour. The Bill imposes on employers the obligation to pay prescribed rates of wages for six months after the passing of the Act, under penalty of a fine not exceeding £5 for each day during which an offence is committed. The Minister of Labour may set up an interim arbitration court, consisting of employers, representatives of the workers and independent persons, to decide such questions as the status of the workman, the standard rate of wages, &c., and the finding of the court may be made binding on the parties concerned. The Arbitration Act of 1889, however, does not apply to any reference under the provisions of this Act. Proceedings under the Act are to be taken before munitions tribunals of the second class, as in the case of offences under the Munitions of War Acts, 1915 to 1917, and the provisions of those Acts are to apply accordingly. Proceedings against an employer may be instituted by or on behalf of a trade union. The Bill, which also repeals certain sections of the Munitions of War Acts relating to the settlement of labour difficulties and the prohibition of strikes and lock-outs, has passed through all its stages in the House of Commons.

* * * *

British Mineral Resources.

In a report by Sir L. Phillips, the late Controller of the Department for the Development of Mineral Resources in the United Kingdom, the following recommendations are made:—

That the Government should concern itself more actively than hitherto in the mining and mineral industries at home and in the Crown Colonies and Dependencies

That for this purpose it is necessary to organise a Mines Department on suitable lines for the United Kingdom.

That in order to secure the full benefit of the Department, at least three small qualified bodies acting as Committees or Commissioners should be appointed, and they might be conveniently styled: (*a*) The Imperial Mineral Resources Bureau—forming a link with the self-governing Dominions; (*b*) The Mines and Minerals Commission to watch and foster the interests of the Empire in the output and trade in mineral and metallic products; (*c*) Commissioners authorised to take action in cases of improper exploitation of properties, or unreasonable or prohibitive conditions imposed by landowners for royalties and wayleaves.

That a fund to be administered by the Mines Department should be provided for undertaking experimental work in approved directions.

In the report Sir Lionel Phillips states that the British Isles have probably been endowed with greater mineral wealth than any area of equal size on the globe. Vast reserves of coal remain, and beds so far untapped await exploration. Considerable but diminishing quantities of high grade and enormous bodies of lower grade iron ore are available. Limestone, clays, igneous rocks, chalk, sandstone, salt, slates (unrivalled in quality) and various silica sands for moulding, furnace work and glass making, and barytes are abundant. The tin mining industry of Cornwall has been steadily declining, but the great rise in the value of tin has stimulated interest in derelict properties, and the possibility of reviving past activity is attracting the attention of capital.

* * * *

Export of Samples.

The War Trade Department has issued an announcement that samples of prohibited goods (with certain exceptions) may now be exported without Privy Council Licence. A list is given of goods which are entirely excluded from this privilege, including iridium, molybdenum and molybdenite, osmium, palladium, platinum, rhodium, ruthenium, selenium, steel (containing tungsten, molybdenum, chrome, cobalt, nickel or vanadium), tantalum, tungsten, tungsten alloys, tungsten lamp filaments, and vanadium. A list is also given of certain goods of which samples may only be exported by *sample post* without licence. These include aluminium, ferro cerium, ferro-chrome, ferro-manganese, ferro-molybdenum, ferro-titanium, ferro vanadium, magnetos and parts, mica, nickel, radium, rubber and rubber goods and tin.

* * * *

Coal Conservation.

Last week Sir J. D. Rees asked the President of the Board of Trade whether he was aware of the opinion held by borough councils and others to the effect that the recommendations of the reports of the Coal Conservation Sub-committee to the Ministry of Reconstruction and the Electric Power Committee to the Board of Trade should be translated into effective legislation at the earliest possible moment; and, seeing that it was of the utmost importance that the Government should provide industry with the means indicated in these reports of absorbing the labour which would be available on demobilisation with the least possible dislocation and delay, would he take steps to carry out these recommendations?

Sir A. Stanley said he was aware of the opinions held, and hoped to be able to place before Parliament proposals for legislation with the least possible delay.

* * * *

Electricity Supply.

Councillor Burnam has been elected chairman of the BIRMINGHAM ELECTRIC SUPPLY COMMITTEE.

ARKLOW URBAN COUNCIL has asked Mr. P. J. Tierney to prepare plans and estimates for public electric lighting.

WIGAN CORPORATION has applied to the L.G. Board for sanction to borrow £5,000 for electricity supply extensions.

HAMPSTEAD (LONDON) BOROUGH COUNCIL has applied to the Board of Trade for authority to increase the charges for electric current.

STOCKTON-ON-TEES COUNCIL has voted a war bonus of £50 for the current year to the borough electrical engineer, Mr. J. J. Smith, but it has declined to grant a permanent increase of salary.

WILLESDEN URBAN COUNCIL has instructed the electrical engineer (Mr. Blake) to prepare an estimate for a garage for housing the electric vehicles, and for installing the necessary charging apparatus at the sub-station.

The special committee on wages and salaries of the GLASGOW CORPORATION recommends that, as from June 1 last, the chief engineer of the electricity department, Mr. W. W. Lackie, be granted an increase of £250 per annum on his present salary, which is £1,250.

The extension of the BEDFORD municipal power-house was formerly opened last week. The building was commenced in May, 1917, and the extensions have been carried out under the direction of the borough electrical engineer, Lieut. R. W. L. Phillips. The cost was about £33,000. The total capacity is 4,100 kw.

A general meeting will be held in the Forester's Hall, Charles-street, Cardiff, to-morrow (Saturday) for the purpose of forming a South Wales section of the Electrical Power Engineers Association. The chair will be taken at 6.30 p.m. by the president, Mr. A. L. Lunn, and all engineers interested are invited to attend.

Councillor J. C. White, chairman of the Belfast Electricity Committee, has been appointed by the Board of Trade as a member of the committee appointed to examine and report upon the water-power resources of the United Kingdom, and the extent to which they can be made available for industrial purposes.

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COLERAINE Urban Council recently communicated with the Irish Society on the subject of the possible utilisation of the water-power at The Cutts, Coleraine, for generating electrical energy. The society have now intimated that whilst at the present time they felt no action could be taken in the matter, the matter would not be overlooked if and when the time came to consider the course to be adopted in connection with the development of the water-power in question.

Last week SUNDERLAND CORPORATION referred back a recommendation of the Electricity Committee to increase the war charge to power consumers from 15 per cent. to 33⅓ per cent., and to low-tension network consumers from 10 per cent. to 20 per cent., in order that further particulars may be put before the Council.

The Council also referred back a proposal to increase the salary of the borough electrical engineer (Mr. A. B. Blackman) from £1,000 to £1,200 per annum on the ground that the undertaking was not paying at present.

At the last meeting of the ST. HELENS CORPORATION, Councillor Varley, chairman of the Electricity Committee, said he felt sure that the Council would join with the Committee in expressing appreciation of the services rendered to the town by Mr. E. M. Hollingsworth as electrical engineer, and by Mr. Warr, the assistant electrical engineer, who was also leaving their service. At the same time they congratulated them on their appointments. Mr. Hollingsworth has been with the Council for 25 years and Mr. Warr for 16½ years.

EDINBURGH ELECTRIC LIGHTING COMMITTEE recently appointed a deputation of four, composed of the Lord Provost, the convener of the committee (Councillor Bruce Lindsay), Councillor Stevenson and the town clerk (Mr. Grierson) to wait upon and urge the Ministry of Munitions to give facilities for the Corporation to proceed with the new electric power station at Portobello. The proposed alterations at Dewar-place are being proceeded with in order that the increased power which is required at once might be obtained.

The accounts of the EDINBURGH electric lighting department for the year ended May 15 show gross capital expenditure £1,201,625 (increase £7,767), of which £673,443 has been repaid. Revenue was £167,064, and working and special expenses were £106,823, leaving gross profit £60,241. Interest required £16,261, instalments of loans £39,323, and income tax £7,612, and to meet these items £2,956 has been transferred from reserve fund. Units generated were 26,203,766 (compared with 22,478,407 in previous year) and sold 20,945,404 (17,997,251).

Electric Traction.

The Swansea tramway service has been suspended for some days owing to a dispute as to wages.

In a provisional order, promoted by the GLASGOW CORPORATION, power is sought to construct an additional length of tramway, and to transfer to the Corporation the superannuation fund formed by the Glasgow Corporation Tramways Friendly Society, &c.

The HULL CITY ENGINEER recommends the Cleansing Committee to use electric trucks for the collection of street sweepings near the depots and thereby release horses for heavier work. A further report is being prepared by the Engineer, who has been authorised, if necessary, to visit the Chloride Company's works.

STOCKTON CORPORATION has agreed to co-operate with Thornaby Council in regard to the purchase of the local tramways. Middlesbrough Corporation has also been approached with a view to arranging for joint action, and that the necessary steps be taken to promote a Bill or obtain a Provisional Order authorising the Council to work the tramways when purchased.

The accounts of BLACKPOOL CORPORATION tramways department for the year ended March 31 show gross capital expenditure £317,469, of which £32,497 has been redeemed. Sinking fund amounts to £146,691, reserve fund to £11,346 and permanent way renewal fund to £41,934. Revenue was £119,339 (against £96,224 in previous year), gross profit £50,883 (£41,139) and net profit £30,307 (£21,183), of which £15,000 (£10,000) is to be devoted to relief of rates. Revenue per car-mile was 22·86d. and working expenses, including power, were 13·11d. Passengers carried were 22,251,567 (17,810,538) and car-miles run 1,252,878 (1,131,728).

Imperial Notes.

A successful trial trip of an electric train has been made on the NEWMARKET & ESSENDON (MELBOURNE) ELECTRIC RAILWAY.

It is announced that the Dominion Government will endeavour to arrange with the United States for the joint development of the WATER POWERS OF THE ST. LAWRENCE.

A contract has been arranged with the Calcutta Electric Supply Corporation for the electric lighting of the New Central Avenue, CALCUTTA, by means of half-watt lamps.

According to a recent decision of the AUSTRALIAN DEPARTMENT OF TRADE AND CUSTOMS, the Pardy electrical centrifuge testing apparatus, including motor which is an integral part thereof, is admitted into Australia duty free.

The accounts of WELLINGTON (N.Z.) CORPORATION'S TRAMWAYS DEPARTMENT for the year ended March 31 show gross capital expenditure £758,227, of which £76,020 has been repaid, in addition to £13,084 for horse lines. Revenue was £218,320 (increase £10,374), and the net credit balance, after provision for working expenses, capital charges, reserve, &c., was £11,660 (increase £526). Passengers carried were 33,156,953. Revenue was 17·59d. per car-mile, and working expenses were 12·56d. On the power supply and public lighting section the capital expenditure is £48,138, of which £5,581 has been repaid. Revenue was £19,129 (increase £3,689) and net surplus £947 (decrease £782). There are 5,414 H.P. of motors connected. Units supplied for power, track lighting, &c., were 2,060,327. The capital of electric lighting department is £221,165, of which £42,789 has been repaid. Revenue was £87,536 (increase £8,064) and net credit balance £17,780 (increase £1,522). Working expenses were 2·01d. per unit sold, and total expenses, including capital charges, 2·82d. Units generated were 6,599,135 and sold 4,956,388.

According to estimates prepared by experts there is enough soft coal in the four WESTERN PROVINCES OF CANADA to supply the world for a couple of centuries. The mines of Saskatchewan, Alberta and British Columbia have scarcely been tapped, but have produced a total in one year of 6,000,000 tons, of the value of over five millions sterling. In Alberta and Saskatchewan the coal fields can supply the demands of the prairie provinces for centuries. Steps have also been taken to generate cheap electric power by establishing power plants at the mouths of certain mines. Progress has been delayed on account of the financial situation caused by the war, but there is no doubt that in the future the power problem of the prairie provinces will be largely settled by the inexhaustible supply of coal available in these provinces. The Canadian Dominions geological survey has estimated that the coal beds of these provinces with eastern British Columbia, contain a total of 143,490,000,000 tons, covering an area of 87,000 square miles.

In an article on the development of the ELECTRICAL INDUSTRY IN INDIA, "Indian Engineering" asks the Government to apply, as a remedy for the present lack of progress, a complete considered reorganisation of the system of administration in a broad-minded spirit.

The following points are, it is stated, essential as first steps in the right direction: Dissociation of the Electrical Department from the Public Works Department; the appointment of fully-qualified practical and commercial electrical engineers as electrical advisers to local Governments; the formation of an Imperial Advisory Board, with the Electrical Adviser to the Government of India at its head; and the education of the country to the advantages of electricity. It is suggested that engineers of the Public Works Department should have sound commercial knowledge of business combined with engineering ability, and be given powers to act on their own initiative; that an Advisory Board, with considerable executive and administrative powers, is an absolute necessity; that all electrical advisers to local Governments should be directly under this Board, and that appeals should be made to the Board against decisions of the local Government electrical engineers; that it is essential that the Electrical Adviser to the Government of India should be at the head of the Board. If Government electrical undertakings are run on commercial lines, most of the advantages of electricity will soon be made evident to the financiers, who will then probably come forward themselves. If new projects are referred to the Advisory Board and the whole matter is then left to them instead of having to pass through various departments, the industry will be greatly benefited by the total elimination of red-tape and inexperience. It will rest with managers of supply undertakings to educate their consumers as to the advantages gained by the adoption of electricity.

Miscellaneous.

The Minister of Munitions has suspended until further notice the returns required of persons employed

Up to Oct. 4 the Board of Trade received 1,575 applications for licences under the Non-Ferrous Metal Industry Act, 1918, and 901 licences have been issued.

It is announced that the U.S.A. Government has taken over the operation and administration of all the submarine cables owned in the United States.

The 2,000 miners employed at the Bentinck Colliery, Kirkby-in-Ashfield, who struck work because electric lamps were not supplied, resumed work on Tuesday.

The WESTERN UNION TELEGRAPH COMPANY hope soon to have working a submarine cable between the English coast and the Irish coast, which will obviate the difficulty of keeping communication with land lines.

According to "The Engineer" the WORLD PRODUCTION OF ALUMINIUM in 1913 was 68,000 tons, in 1917 136,000 tons, and the estimated production in 1918 is 230,000 tons, and in 1920 350,000 tons.

The Committee on Production has awarded a further advance of 5s. a week, to employees in the engineering, shipbuilding, chemical and domestic engineers and railway shopmen, with 2s. 6d. per week for boys under 18.

Mr. C. E. Towa, Assistant Secretary of the London Chamber of Commerce, Oxford-court, Cannon-street, E.C. 4, will be glad to receive old or new tobacco pipes (or money to buy new ones) for our convalescent sailors and soldiers. The old pipes will be cleaned, sterilised, repaired and re-polished.

The appearance of PUNCH'S ALMANACK for 1919 synchronises with the opening of the armistice celebrations, so that it has caught the public in the right mood to appreciate its artistic and humorous contents. As was to be expected, the publication deals largely with war and "peace offensive" topics, but there are some excellent non-war pictures. The Almanack is published at a shilling.

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The "London Gazette" of Nov. 19 contains a list of alterations in the list of PROHIBITED AND RESTRICTED EXPORTS. The following items are deleted: (*a*) Brazilian carbon, (*a*) celluloid articles, (*b*) aluminoferric, (*b*) iridium compounds, osmium, palladium, rhodium and ruthenium compounds and stronthium compounds and mixtures, (*a*) sulphuric acid, (*a*) tetanium compounds, (*b*) tungster compounds.

An OFFICERS' UNIVERSITY AND TECHNICAL TRAINING COMMITTEE FOR SCOTLAND has been appointed by the Ministry of Labour to advise as to the course of education and training for officers and ex-officers, &c., of His Majesty's Forces, with a view to finding them suitable employment after the war. The Committee will be under the chairmanship of Sir Alfred Ewing, D.Sc., F.R.S., and amongst the other members are Profs. T. Hudson Beare and R. Stanfield. The Secretary of the Committee is Major G. F. Young, of the Appointments Department of the Ministry of Labour, Balmoral Hotel, Princes-street, Edinburgh.

In the House of Commons last week, Mr. Wardle, Parliamentary Secretary to the Board of Trade, stated in reply to a question that an order had been made by the Board of Trade vesting ENEMY OWNED PATENTS and the benefit of enemy patent applications in the Public Trustee, and under the Trading with the Enemy (Copyright) Act the copyright in any works first made or published in an enemy country during the war also vested in the Public Trustee, who would hold the enemy property vested in him until the termination of the war. The ultimate treatment of this property as well as of enemy owned trade marks was a matter which was being considered by the Government.

The 20 point programme of the LABOUR PARTY includes the following demands: The retention by the State of the railways and canals, the expropriation of the shareholders and the organisation under public control, of a national system of transport. The retention by the State of the coal and iron mines, the expropriation of the present owners and the organisation by the Government and the local authorities of the supply of coal as a public service. The provision and management by the Government (in conjunction with the local authorities), of the proposed super-power stations by which electricity can be provided at the lowest possible cost, without toll to the capitalist companies, for both industrial and domestic purposes.

The following are official values of ELECTRICAL MACHINERY, MATERIAL AND APPARATUS IMPORTED into this country (*a*) during September, 1918, and (*b*) the aggregate figures from Jan. 1 to Sept. 30, with increase or decrease compared with corresponding periods of 1917 :—

Electrical machinery, (*a*) £40,885 (decrease £74,809), (*b*) £534,047 (decrease £513,253); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £19,372 (increase £5,413), (*b*) £127,435 (decrease £61,968); and electrical machinery unenumerated, (*a*) £21,531 (decrease £80,222), (*b*) £406,612 (decrease £451,295), telegraph and telephone cables other than submarine, (*a*) £1,476 (increase £8,831), (*b*) £3,412 (decrease £47,110); telegraph and telephone apparatus, (*a*) £5,329 (increase £1,834), (*b*) £39,606 (increase £14,745); other electrical wires and cables, rubber insulated, (*a*) nil (decrease £1,309), (*b*) £657 (decrease £31,106); with other insulations, (*a*) £2,598 (increase £2,478), (*b*) £3,358 (decrease £5,292); carbons, (*a*) £185 (decrease £8,138), (*b*) £27,217 (decrease £65,499); glow lamps, (*a*) £29,160 (increase £29,000), (*b*) £110,047 (decrease £44,240); parts of arc lamps and searchlights (other than carbons), (*a*) £13,580 (increase £7,980), (*b*) £76,571 (decrease £15,208); primary and secondary batteries, (*a*) £5,814 (decrease £14,314), (*b*) £113,858 (decrease £118,843); meters and measuring instruments, (*a*) £1,713 (decrease £1,200), (*b*) £19,201 (decrease £6,409); switchboards, (*a*) £142 (increase £142), (*b*) £2,273 (increase £1,782); electrical goods and apparatus unenumerated, (*a*) £23,351 (decrease £29,056), (*b*) £385,712 (decrease £20,139). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £83,348 (decrease £11,200), (*b*) £781,912 (decrease £218,926).

The values of EXPORTS OF ELECTRICAL MACHINERY, MATERIAL, &c., (*a*) during September, 1918, and (*b*) from Jan. 1 to Sept. 30, with increase or decrease compared with corresponding periods of 1918, were as follows: —

Electrical machinery, (*a*) £90,358 (decrease £11,599), (*b*) £790,520 (decrease £318,032); including railway and tramway motors, (*a*) £3.470 (increase £1,371), (*b*) £29,531 (increase £4,585); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £63,227 (increase £1,288), (*b*) £481,910 (decrease £179,727); and electrical machinery unenumerated, (*a*) £23,661 (decrease £14,258), (*b*) £279,079 (decrease £142,890; telegraph and telephone cables, submarine, (*a*) £45,214 (increase £45,214), (*b*) £444,970 (increase £315,882); other than submarine, (*a*) £40,566 (increase £21,615), (*b*) £235,654 (decrease £304,384); telegraph and telephone apparatus, (*a*) £12,981 (decrease £6,835), (*b*) £142,641 (decrease £57,696), other electrical wires and cables, rubber insulated, (*a*) £8,823 (increase £4,864,) (*b*) £55,113 (decrease £113,065); with other insulation, (*a*) £20,395 (increase £3,216), (*b*) £79,981 (decrease £166,513); carbons, (*a*) £1,986 (increase £1,286), (*b*) £6,372 (decrease £14,501); glow lamps, (*a*) £4,095 (decrease £5,543), (*b*) £60,868 (decrease £41,768); arc lamps and searchlights, (*a*) £293 (decrease £4,731), (*b*) £16,266 (decrease £6,275); parts of arc lamps and searchlights (other than carbons), (*a*) £391 (decrease £12,034), (*b*) £13,717 (decrease £53,514); primary and secondary batteries, (*a*) £8,406 (decrease £3,505), (*b*) £88,285 (decrease £31,803); meters and measuring implements, (*a*) £13,461 (increase £6,346), (*b*) £92,307 (decrease £10,354); transformers, (*a*) £6,400 (decrease £225), (*b*) £27,404 (decrease £28,174); switchboards, (*a*) £1,489 (decrease £867), (*b*) £23,485 (decrease £3,461); electrical goods and apparatus unenumerated, (*a*) £25,580 (decrease £44,720), (*b*) £305,526 decrease £217,783). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £190,080 (increase £3,081), (*b*) £1,592,589 (decrease £746,409).

Tenders Invited and Accepted.

WALSALL Corporation require tenders by Dec. 5 for supply and erection of 500kw. rotary converter equipment. Specification from the Manager of the electricity department.

MANCHESTER Electricity Committee requires tenders by 10 a.m. Nov. 29 for the supply and erection of three-phase 6,600-volt switchgear. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

DUBLIN Electricity Committee require tenders by noon Nov. 27 for the supply and installation of a 3,000-5,000 kw. turbo-alternato generating set. Specifications from the City Electrical Engineer.

The SLIGO, LEITRIM & NORTHERN RAILWAY COMPANY require tenders by 10 a.m. Dec. 1 for 12 months' supply of stores, including electric telegraph materials, metals, leather belting, &c. Forms of tender from the Secretary, Enniskillen.

The UNION OF SOUTH AFRICA TENDER BOARD require tenders by 3 p.m. Dec. 18 for 800 yards underground telephone cable (paper insulated, lead sheathed, 306 twin conductors) and 800 yards ditto (204 twin conductors). Form of tender, &c., from the Controller of Post Office Stores, Palace of Justice, Pretoria, or the District Stores Clerks, Capetown, Johannesburg, Durban, &c.

SPENBOROUGH URBAN COUNCIL has accepted the tender of the British Thomson-Houston Company for switchgear.

BOLTON TRAMWAYS COMMITTEE has placed an order with Hadfields, Ltd., for points and crossings and the Electricity Committee has accepted the tender of R. Foster for conduits and fittings.

WOLVERHAMPTON CORPORATION has accepted the tender of the Chloride Electrical Storage Company (at £145) for the supply of a battery of 40 cells in ebonite boxes in seven hardwood trays for a 2½-ton electric vehicle.

BRADFORD ELECTRICITY COMMITTEE has accepted the following tenders: Mather & Platt, 100 H.P. a.c. motor and starter; British Westinghouse Company, two 1,500 kw. rotary converters; and B. Thomas, switchboard.

GILLINGHAM COUNCIL has accepted the tender of Edison Accumulators, Ltd., for the supply of two electric motor lorries for collecting house refuse, the cost being :—Complete chassis with accessories and Edison accumulator and set of solid india-rubber tyres, £890; extra increase, due to war, 20 per cent., £178—£1,068.

MANCHESTER ELECTRICITY COMMITTEE has accepted the following tenders: Stewarts & Lloyds, high and low pressure steam and feed pipework for Stuart-street station; Bruce Peebles & Company, two 500 kw. motor converters; Ferranti Ltd., annual requirements of current transformer; British Westinghouse Company, annual requirements of a.c. meters and potential transformers C. Macintosh & Company, Western Electric Company and Callender's Cable & Construction Company, cable as an extension to annual cable contracts.

Appointments Vacant and Filled.

Two assistant electrical engineers are required by a large dynamo firm.

Bury Corporation require a tramways manager. Salary £500. Applications to the Town Clerk by Nov. 23.

An installation inspector is required by the Stepney (London) Borough Council electric supply department. Applications to the Engineer and Manager, 27, Osborn-street, Whitechapel, E. 1, by Nov. 26.

Greenock Corporation Electricity Department require an electrical superintendent. Applications to the chief engineer and manager, Mr. F. H. Whysall, M.I.E.E., Blackburn-street, Greenock.

The Electrical Research Committee requires a technical officer to direct and supervise the research work undertaken by the Committee. Commencing salary £1,000 per annum. Applications to the Chairman, 1, Albemarle-street, London, W. 1, by Friday, Dec. 6.

Mr. A. A. Blackburn, of Belfast, has been appointed, out of 29 applicants, engineer and manager of the Huddersfield Corporation tramways at £600 per annum.

Erith Council has appointed Mr. Weston (Southall) and Mr. Kettle (Tunbridge Wells) as charge engineers.

Business Items.

Messrs. Evershed & Vignoles, Ltd., notify that they have closed their City office at 110, Cannon-street, E.C., and all letters should be addressed to the Company's sole address: Acton-lane Works, Chiswick, W. 4.

The "Z" Electric Lamp Mfg. Company, Ltd., has recently issued a folder containing its priced stock lists of accessories and lighting sundries. The folder is intended for permanent use and revised copies of the stock list are issued monthly to the trade upon request.

Mr. Henry Butcher announces that he will include in his SALE BY AUCTION at the Town Hall, Chesham, on Nov. 28, a complete laboratory electrical installation, some electrical instruments and apparatus, tools, &c. Catalogues (1s. each) and further information may be obtained from Messrs. Henry Butcher & Company, engineers and machinery valuers and Auctioneers, 63-4, Chancery-lane, London, W.C. 2.

Enterprise Mfg. Company, Ltd., notifies that Messrs. Henry Ashdown and Sidney Dicks have resigned their positions as directors of the company, and Messrs. Ernest Joseph and William Harvey Utz have joined the board, Mr. C. H. Roberts remaining as managing director. Mr. D. G. E. Barrie will continue to represent them for the London districts. The company has been appointed London and South Coast agents for Messrs. S. Hodgson & Company, of Halifax, manufacturers of a.c. and d.c. motors.

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Companies' Meetings and Reports, &c.

Dick, Kerr & Company, Ltd.

The annual general meeting of this company was held in London on Nov. 14, Mr. CLAUD T. CAYLEY (chairman) presiding.

The CHAIRMAN said: Gentlemen, you will have already seen that the profit for the year is not much short of that for the previous year, and, in view of the fact that your directors' policy has been gradually to prepare where possible for the reconstruction of the business on post-war conditions, no doubt you will consider the year's results satisfactory. The total on the asset side of the balance-sheet is over two and a quarter million pounds—a record figure. The individual items are not widely different from those of last year, except "contracts, due for work, stock of materials, &c.," which is roughly £100,000 more. This item covers sums due to the company in respect of contracts, with the stock of material carried in respect of them, and so forth. "Capital expenditure" is some £20,000 less than last year, and we do not doubt that you will fully endorse the conservative policy of which this writing down is evidence. Investments stand at £338,000 odd, against £341,000 odd in 1917, the decrease being the net result of two larger transactions. Last year I reported on the acquisition of the bulk of the B preference stock of Willans & Robinson, Ltd. This transaction occurred after the close of our financial year, and was not reflected in the 1917 accounts. Since our last meeting the whole of our holding of preference shares in the United Electric Car Company, Ltd., has been disposed of, so that the latter transaction largely off sets the former. On the liability side the chief variation (other than the issue of shares indicated) is that "creditors and estimated liabilities" shows a decrease of approximately £90,000. Special reserve for contingencies stands at £75,000, and your directors propose to add a further £25,000. The works have continued to be fully employed, and during the past few months, the demand for certain purely war products, having become less urgent, opportunity has been taken to establish a process of gradually changing over, and in this the Ministries of Munitions and Reconstruction have given considerable assistance. While there must inevitably be a hiatus of disorganisation, we hope to be able to retain the continuous services of a considerable portion of our workpeople, first in the operations necessary to re-arrange the factories, and later in standard production, provided raw material is available. The raw material required for the class of machine y in which we specialise is very different from raw material as understood generally by the public. Material such as steel forgings and castings, copper wire, and many other things which are the basis of our manufacture, are the finished article with many other producers.

During the year the work of consolidating into our own organisation those of Willans & Robinson and the United Electric Car Company has been completed, and your management committee has been strengthened and made still more representative by the appointment of Mr. Davenport and Mr. Bennett from Rugby, and Mr. Conner, whom many of you know well as an old and trusted member of our staff. An alliance has also been made with Siemens Brothers & Company, Ltd., by which it is thought much economy can be attained through the amalgamation of selling organisations and co-ordination of designs and products so as to avoid overlapping. Siemens and ourselves are not competitors in manufacture. They are long established as makers of all kinds of cables, dynamo machinery, telephones, instruments, and so on, while we have specialised in apparatus for railways and tramways, steam turbines and the larger classes of electrical machinery. The two manufacturing organisations dovetail into each other perfectly, and only small adjustment is required to bring the commercial sides together with material benefit to both. This arrangement has now been consummated by an exchange of directors, Mr. Mure Ritchie (chairman, Siemens Bros., Ltd.), who is with us to-day, having taken a seat on this board, and I having joined that of Messrs. Siemens. An interesting development is the establishment in France and Japan of companies to exploit our manufacturing rights in connection with apparatus for railways and tramways. It must be gratifying to you to know that Dick, Kerr machinery ranks so highly in these important countries that representative technical and business men are willing to provide the considerable capital required for such undertakings. The companies will also act as our agents in their respective countries, thereby contributing important outlets for the products of our own factories, should there be a surplus available.

I referred last year to the conviction on the part of those studying the position on your behalf that the after-war demand for our products will be very great. The correctness of this opinion is proved by the demand which already exists for all classes of electrical machinery, and especially large sized steam turbine generating plant, upon which we have specialised for some years. The manufacturing capacity of the country for heavy electrical machinery is much below the demand, and in our own case, if we wish to retain the position we hold, we must find facilities not only for increased output but for the production of individual units larger than our present shops admit of. We were faced with the difficulty, if not the impossibility, at all events for a long time to come, of extending the works, obtaining the necessary machinery and building up a strong organisation. We have solved the difficulty in a very satisfactory manner. We were in hope that we would be in a position to give you full details at this meeting, and indeed the date was postponed with this in view. The arrangements which are involved, however, require much careful adjustment, together with Treasury sanction, which has not yet been received. Suffice it to say, therefore, that an option agreement has been entered into with the Coventry Ordnance Works, Ltd., who own an engineering works of modern design and equipment which, although not at present occupied upon electrical work, can very quickly be converted to that purpose. You will, in due course, receive full particulars of the proposal, and you will be asked to consent to an exchange of your shares for those of a new company, which, in the event of the offer being accepted, will control both concerns. The Coventry Ordnance Works has an issued capital of £800,000 and debentures of £600,000. Its proprietors are Messrs. John Brown & Company, Ltd., Cammell Laird & Company and the Fairfield Shipbuilding & Engineering Company. The shops can be easily altered for the production of heavy electrical machinery, and the Company have a considerable output of non-war material, which it is expected can be materially increased. Mr. Cayley concluded by moving the adoption of the report and balance sheet for the year ended June 30, 1918.

Mr. R. H. PRESTWICH (deputy chairman) seconded the motion, which was carried unanimously.

The retiring directors, Mr. R. H. Prestwich and Mr. John Sampson, were re-elected, the appointment of Mr. Bernard A. Firth and Mr. G. Mure Ritchie as directors during the past year was confirmed.

The gross revenue of the AMAZON TELEGRAPH COMPANY, LTD., for the year ended June 30, 1918, amounts to £80,455, and working expenses were £31,598. After providing £701 for income tax, £275 for depreciation of investments, £12,186 for debenture interest, £10,741 for sinking fund, and placing £17,000 to general reserve, the directors recommend payment of a dividend of 4½ per cent., less tax, on the share capital, leaving £6,842 to be carried forward. The managing director, Mr. Frederic E. Nosworthy, who has been at Para and Rio de Janeiro on the Company's business during the whole of the past financial year, has now returned.

Mr. B. M. Drake, who presided over the annual meeting of DRAKE & GORHAM, Ltd., last week, said that he was optimistic with regard to the future of the electrical industry, especially if the recommendations of the Electrical Trades Committee were accepted by the Government and acted upon without further delay. In the Committee's report it was shown that an annual saving of £100,000,000 could be effected in this country if electric power were universally adopted—a sum sufficient to pay the interest on 2,000 millions of War stock. With electricity "on tap" throughout the country there must needs be a demand for the services of those who had had the necessary training and experience to show manufacturers how to utilise the current to the best advantage. In that connection the company was preparing a scheme of guarantees, which would relieve large users from all anxiety as to the saving they would be able to effect.

The President of the WESTERN UNION TELEGRAPH COMPANY states that the contract with the United States Government leaves to the company its non-operating income and the income from its eight transatlantic cables. The Government will maintain all land line reserves for depreciation and amortisation upon the same bases as heretofore: continue the maintenance and operation of the property in as efficient condition as when taken over and return the property, on the termination of Federal control, in as good condition as when received; pay all other land line operating charges, including taxes, bond interest and guaranteed rentals, &c. As compensation the Government will pay the company $8,000,000 per annum. Out of this the company will lend to the Government each year $1,000,000 without interest towards financing approved additions and extensions, funds required for these purposes beyond such amount to be furnished by the Government. If new securities are issued by the company for land line additions or otherwise required, the Government will pay the interest or other costs of such securities. The company will limit its dividend during Federal control to 7 per cent.

Separate meetings of the preference and ordinary shareholders of the BRITISH WESTINGHOUSE ELECTRIC & MFG. COMPANY, LTD., were held on Tuesday in order to consider the scheme for the re-arrangement and increase of the capital. The chairman (Mr. J. Annan Bryce, M.P.), who explained the proposals of the directors, said the main provisions embraced the placing of the ordinary shares on a level with the preference shares, which henceforward would receive a non-cumulative 8 per cent. dividend in lieu of 15 per cent. plus certain contingent rights, and in the event of a liquidation £2 per share only, in lieu of £5; also it was proposed to give the board powers to raise an adfitional £5,000,000 in the form of ordinary shares. The provision of extra capital was absolutely necessary if they were to hold their place in view of threatened competition. The preference shareholders might be reluctant to give up certain substantial rights, but they were receiving a *quid pro quo*. The provision of so much additional capital to rank behind them would ensure the regularity of the 8 per cent., whereas if they remained as they were it was doubtful if they would continue to be paid, while the £2 per share in the event of a liquidation was also rendered more secure. It would be impracticable to issue shares ranking *pari passu* with them, and debentures placed in front of them could only be issued on very onerous terms. He concluded by moving the necessary resolution.

Mr. HERBERT SMITH and others criticised the scheme, but Sir ERNEST HILEY pointed out that the undertaking was now under the control of the Metropolitan Wagon & Carriage Company, which had only come in in 1917, when the company was going on the rocks. It had interested itself purely from the industrial point of view, and was convinced that the increase of capital was absolutely necessary. It was prepared to find that capital in a way suggested without underwriting commissions, but it was impracticable to have a 15 per cent. preference share in front of them.

After further discussion the meetings were adjourned until Monday next.

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CONTENTS.

NOTES 629
Arrangements for the Week 632
Contactor Control Gear in Industrial Work. Illustrated 633
Belgian Reconstruction and Trade 635
Transformer Oil. By W. S. Flight, A.M.I.E.E. Illustrated 636
Industrial Reconstruction in France 638
The Design of Electrically-Driven Lifting Blocks. By H. Wintermeyer. Illustrated 639
The Use of High-Pressure and High-Temperature Steam in Large Power Stations 640
Social Obligations of Industry 641
CO-OPERATION BETWEEN ENGINEERING SOCIETIES. Illustrated .. 642
The Economics of Works Costs. By J. R. Dick, B.Sc. Illustrated 643
CORRESPONDENCE 646
Electricity Supply on the North-East Coast 647
Transport Committee's Report 647
Allocation of Generating Plant by the Ministry of Munitions.—*Concluded* 648
Labour and Industrial Development 648
12-Ampere Combined D.P. Ironclad Switch and Plug. Illustrated 649
LEGAL INTELLIGENCE 649
PARLIAMENTARY INTELLIGENCE 650
Patent Record 650
Volunteer Notices 650
Commercial Topics 650
Electricity Supply 651
Educational 652
Tenders Invited and Accepted 653
Companies' Meetings and Reports 653

Notes.

The Future of Our Railways.

AN interesting report has been drawn up by the Select Committee on Transport. To some extent the report is of a non-committal nature, but certain preliminary conclusions have been reached. Among these it may be mentioned that the Committee feel the organisation of the railways cannot be allowed to return to its pre-war position. On the other hand, it is felt that the temporary arrangements which have been applied for the control of our railways during the war would not be satisfactory as a permanent settlement of the question, and, further, that unification of the railway system is desirable under suitable safeguards. This unification may, of course, be attained in various ways. There might be further amalgamations; or unification of company or private ownership; or, lastly, there might be nationalisation. In the last alternative there might be Government management, or a board of management not represented in Parliament, or the system might be leased to one or more commercial companies. It may be assumed that objections will be raised to all these schemes. There is no doubt that the present form of control has produced some excellent results under very difficult conditions. On the other hand, it must be remembered, that there has been no interference with individual organisations, and thus it has been a triumph of private enterprise. There is a certain amount of talk at the present time of improved methods in one direction or another, and we are glad to see that the Committee, although they are not able to judge of the value of the proposals on a large scale, recommend the granting of facilities to Mr. A. W. GATTIE to carry out certain tests. This, perhaps, is as much as can be hoped for at the moment. Economies are also possible through improved methods of administration. On the part of railway employees there is a somewhat natural desire for nationalisation, with the idea that better pay will thereby be obtained. It may be well to point out, however, that the conditions are conflicting. Dividends paid by railway companies, generally speaking, are notoriously on the low side. The payment of higher wages will reduce these dividends still further, and at the same time the public will resent anything in the way of higher charges. Nationalisation of the railways will not do away with these conflicting conditions, although it would introduce certain economies through unification. Possibly higher wages might also be given, and they are certainly desirable, but in that case it appears that the State would have to subsidise the railways. This, of course, would merely mean that the taxpayer generally would pay for the deficiencies; some cheap facilities might be given, but in that case certain sections of the community would thereby benefit through the generosity of the general body of taxpayers.

The Urgency of Coal.

WE doubt if Government departments at all realise the extreme urgency of coal at the present time to enable our various industries to be re-established with the least possible delay. Take, for example, the electrical industry. This depends for its well being very largely upon supplying the needs of electricity supply undertakings and their consumers. Yet at the present time no new services can be put in unless a permit is obtained from the Director of Electric Supply. This restriction has been put into force owing to the demand of the Coal Controller that electricity supply stations should consume a smaller quantity of fuel, and it is certainly an order that was inevitable. We come back then to the shortage of coal as being the prime cause, and in this connection it must be remembered that we have not merely to consider our own needs, but those of our Allies. For example, the coal mines in the northern part of France have been largely put out of action by the Germans, and the population in the northern plains of Italy, where the winter is severe, are wholly dependent upon imported coal for artificial warmth. It will be understood, therefore, that an increase in our output of coal is a matter of extreme urgency. We are aware that 100,000 miners are to be released immediately from military service, but we do not know how soon this step will become effective. Moreover, in any case, an additional 100,000 men is by no means sufficient. Every suitable man should be secured for this purpose.

The Provision of Raw Materials.

IT may be said that the most important need of our industries at the present moment is the supply of raw materials, and this is even more important than the supply of labour. As far as the electrical industry is concerned, there will, undoubtedly, be a great demand shortly for electrical machinery of all kinds, for many extensions are very much overdue. This is also true of other branches of engineering. Although it is desirable that Government control in various directions should be eliminated as soon as possible, it seems inevitable that there should be control for some time to come over the supply of raw materials. The managing director of one of our well-known manufacturing firms recently expressed the view

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to us that unless there were control to ensure each industry obtaining its proper proportion of materials at reasonable prices the demand would become so keen in certain directions that prices would get altogether out of hand. This view, we believe, will receive general support. Any inflation of prices due to shortage would be disastrous to the smaller and less powerful firms, and although we look forward to the day when industry can go forward free of all restrictions, it would certainly be a calamity at the present time if our smaller firms were to suffer through the action of their more powerful competitors. As an example of what we have in mind we may take the case of lead. During the present week this metal has suddenly risen from about £30 to about £41 per ton. This seems to be partly due to insufficient control. Whatever the cause, it is quite impossible for firms to trade if there are these sudden fluctuations.

Private Bill Legislation.

WE are glad to note that the Chairman of Committees in the House of Lords has intimated that he will give favourable consideration to the introduction during the next session of late private Bills for which urgency can be claimed owing to the Armistice and the prospect of peace. This is a somewhat tardy recognition of the fact that the development of electricity supply in new areas has been wholly arrested during the last few years, and that considerable expansion is to be expected in the very near future. It would have been much more satisfactory if Parliament had continued to consider such Bills during the past year, merely suspending their provisions as in previous years. Further, facilities should have been given for obtaining the consent of the Board of Trade to acquire sites for power stations, and for the holding of Local Government Board inquiries in anticipation of the time when the schemes could be put in hand. This would have given employment to many who have suffered through the dislocation of work of this kind, and would have prevented congestion of legislation of this class. Moreover, there would have been the great advantage that construction could have been started at the earliest possible moment. As it is, even with the indulgence of the House, these legislative steps, in the case of new developments, must take a considerable time, after which there must be the usual Local Government Board inquiries and Board of Trade sanction in all cases, the drawing up of plans and specifications and other detailed work of that kind before contracts can be let. Some elasticity should now be given in all these directions. We must be thankful, however, that the official mind has relaxed even to the small extent of setting on one side certain standing orders.

Industrial Progress and Human Inertia.

IN his recent presidential address to the Institution of Engineers and Shipbuilders in Scotland, Mr. ALEXANDER CLEGHORN made an interesting contribution to the discussion of the vast industrial problems which are now confronting us—which are in all men's minds and need above all frank expression. Deep down in the spirit of men is the craving for self-preservation and security, and yet, coupled with this, there is an almost equally strong instinct of mental inertia which impedes the development of the very industrial progress on which such security depends. The dominant conception of work associates it with grimy and soul-killing toil—a kind of forced labour, to which man is driven by cruel necessity. These attributes of work can only be removed by the plodding application of the fruits of science and man's ingenuity; yet this process, so fruitful of results and so conducive to a state of greater comfort and security, is opposed by a sort of natural inertia. Through all the ages man has opposed this evolution, and there has been a tendency to look back longingly to a primitive golden age of the industrial world rather than to grapple with the problems of the day. The illogical disinclination, under a system of payment by results, to produce as much as possible is probably due in part to this deep-rooted mental habit, as well as to suspicion that the fruits will not be fairly divided. Mr. CLEGHORN refers also to the wide-spread fallacy that there is only a limited amount of work in the world; that the world can only make use of a given amount of manufactured products; and that cheapening and speeding up of production will inevitably throw thousands out of work. Many people almost despair of eradicating this deeply-rooted obsession. Yet experience in America, where, in spite of the widespread use of machinery, the average age of the working man is 20-40 per cent. higher than in this country, he is better housed and clothed, and his children are probably better, far better, educated. Mr. SAMUEL GOMPERS has recently stated that there has been no restriction of output for over 30 years in America. Labour says to the employer: "Bring in all the improved machinery and new tools you can find. We will help you to get the utmost out of them. Work two shifts a day, if you please, or work your machinery for 24 hours with three shifts and we will help you. But we insist upon the limitation of the hours of labour to eight hours per day—a normal working day with full physical effort."

Röntgen Society.—A meeting of the Society will be held on Tuesday, December 3, 1918, at 7.30 p.m., at King's College Hospital, Denmark Hill, S.E., when there will be a visit to the radiographic and electrotherapeutic department. Demonstrations of the apparatus will be given. Members of the Institution of Electrical Engineers are cordially invited to be present.

Reported Production of Potash in Spain.—Much has been said on the special processes for producing potash which have been developed since the outbreak of war. These have rendered us temporarily independent of the German supplies, but such processes can hardly be expected to compete commercially with almost pure potash deposits. It has hitherto been assumed that Germany had a monopoly of deposits of this kind, but according to the "Engineering and Mining Journal," Spain is now entering the market as a large producer of potash, apparently from natural supplies. The circumstance is said to be giving great concern to the mineowners in Germany.

A Collection of War Products.—In a communication to the "Manchester Guardian" on Tuesday on "Lancashire's Armaments Output," Dr. Edward Hopkinson suggests that Manchester ought to possess a collection of actual examples of all the war products of the district (or in some instances models and photographs), whether made under the direction of the Armaments Committee, working under the Ministry of Munitions, or for the Admiralty, the Trench Warfare Department, or the Air Board, and for the Lancashire Anti-submarine Committee. Such a collection would be fittingly housed and the technical records preserved in the College of Technology.

Electric Pumping and Rice-Saving.—In the rice fields of Arkansas, according to the "Electric World," a great effort is being made to increase the output in order to save wheat, and electric pumping for irrigation purposes is making great headway. The local company is supplying electricity for this purpose to 48 rice farmers near Pine Bluff. Rice crops need an almost continuous supply of water, from the time the rice is a few inches high until it is ready for harvest; in Arkansas artificial irrigation methods are necessary for 90-120 days in the year. The power for this irrigation work is supplied from 40 miles away by three-phase 33,000 volts transmission, distributed at 6,600 volts and finally stepped down to 220 volts for use at the motors (averaging 60 H.P. each). The consumption this season is expected to reach 40,000 to 50,000 kw.-hours.

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Royal Society Medals.—Among the medals awarded by the Royal Society this year are the following :—

The Copley Medal to Prof. H. A. Lorentz, of Leyden, For.Mem.R.S., for his distinguished researches in mathematical physics. The Rumford Medal to Prof. Charles Fabry and Dr. Alfred Pérot (jointly) for their contributions to optics, and a Royal Medal to Prof. Alfred Fowler, F.R.S., for his distinguished researches on physical astronomy and spectroscopy. The Davy Medal to Prof. F. S. Kipping, F.R.S., for his studies in the camphor group and among the organic derivatives of nitrogen and silicon. The Hughes Medal to Mr. Irving Langmuir, of Schenectady, for his researches in molecular physics.

The Alkali Industry.—Addressing, as their new chairman, the members of the Newcastle-upon-Tyne Section of the Society of Chemical Industry, at their recent annual meeting, Dr. P. Phillips Bedson, Professor of Chemistry at Armstrong College, Newcastle, referred to the Leblanc process for the manufacture of alkali, and said they were told that they were witnessing its death throes. Were they permitted at that stage to draw aside the veil, however, they would find evidence of attempts to retain the alkali industry on Tyneside by the use of electricity in the production of alkali and bleaching powder from salt. Whether the Tyne would retain the position held since 1796 as a seat of the manufacture of alkali, with its disability as regarded salt, in competition with other districts having an easy command of brine, depended upon whether the proximity of salt or of coal was the determining factor.

Electrochemical Methods of Balancing Shells.—Accordin to " L'Usine," in most munitions works there will be found, in spite of the care of the mechanical processes, a certain number of shells that are badly balanced. It is desirable, if possible to save such shells, and various methods of restoring the balance have been tried. For example, acids have been employed to reduce the surface at specified points, but this gives rise to irregularities and involves certain dangers in manipulation. A better method, which has been more recently employed, is to deposit a certain amount of metal at the weak point by electrochemical means. It is said that a deposit of 40 gms. is usually the limit necessary to correct a 75 mm. shell, and with a current of 12 amperes the process takes 3 or 4 hours. Various devices are described for enabling different defects to be eliminated, *e.g.* for restoring the balance of a shell whose centre of gravity is too low, or situated eccentrically from the axis.

The Peat Bogs of Jutland.—The utilisation of the large peat areas in the north part of Jutland is receiving much attention. The area is said to be as much as 28,000 acres. According to " Ingenioren " this could be completely drained by gravitation, and the total contents might be equivalent to 23 million tons of coal. It is suggested that the peat could be utilised (1) as air-dried briquette used for heating the boilers of adjacent electrical supply works, (2) as machine-made briquettes sold for general consumption as far away as the cost of transport will allow, (3) as peat litter to be sold to neighbouring farmers, (4) the lower parts of the bogs should be reclaimed and used for agriculture. The heating value of the peat is assumed to be half that of coal. The works required should be executed by private enterprise, aided by the State, and the cost of reclamation would amount to £50,000. The first 9,000 acres could be dealt with in 20 years, and the rest of the land occupied in course of time as the peat is cleared away.

Electric Drainage of Marshes.—An interesting lecture by Mr. A. W. C. Dwars, dealing with drainage of marshes, is reported in " De Ingenieur." Electric pumping machinery has several advantages for such work. The level of the subsoil water in the marsh can be effectively controlled and the cost of electrical methods is not excessive. The standard three-phase motor-driven centrifugal pump is specially adapted to drainage work. Tests over 13,600 acres showed an excess in cost for electrical pumping of only £72 per annum—about 1¼d. per acre—as compared with the very cheapest methods available. This estimate assumed a not very favourable cost for electric energy, and in any case the small margin in cost is of small moment compared with the much greater reliability of electrical methods. The author thinks that there is a great future for electric drainage of marshes in Holland. It is pointed out, however, that the overall efficiency of an electric pumping station is not high, and there are considerable opportunities for improvement in this respect.

Electrical Power Engineers' Association.—For the purpose of inaugurating a Bristol & West of England Section, a mass meeting of staff engineers held a very successful meeting at the Grand Hotel, Bristol, on Friday evening last, the 22nd inst. Mr. A. J. Ostler (Sub-station Superintendent, Bristol Corporation) presided over a very keen audience who listened with interest to the address of Mr. W. Raymond Jones, the National Secretary. In an address lasting close on an hour, Mr. Jones sketched the history of the Association and the work that it had accomplished. He emphasised the necessity of staff engineers being organised in view of the threat of the E.T.U. to get all electrical workers into their ranks. At the close a hearty vote of thanks was accorded Mr. Jones for his address, and a strong committee formed to organise the Bristol and West of England power station engineers. The Secretary of the new branch is Mr. F. J. Elliott, 3, Glena-avenue, Knowle, Bristol, who will be glad to have inquiries from prospective members who were unable to attend the Bristol meeting.

Light Weight Traction Motors.—The extreme severity of the winter last year in the United States was the cause of various special troubles on American railways. While electrified steam railways, according to the " Electric Railway Journal," were generally free from the congestion common on steam railways, electric tramways suffered breakdowns, many of which are ascribed to the use of light weight traction motors. The light weight ventilated motor has proved its value, but there are several special precautions that must be observed. The drawbacks that require to be guarded against are : (*a*) Open ventilation exposes the windings to the entry of snow, (*b*) the high armature speed causes more rapid deterioration and wear of bearings, (*c*) the lighter sections in construction involve increased stresses, (*d*) there may be insufficient thermal capacity to withstand abnormal loads. It is essential that the armature should be of adequate strength and that due provision is made for bearing lubrication. High grade steel only should be used to improve the factor of safety. It is observed that a highly ventilated motor has a high continuous rating; whereas a non-ventilated motor could be overloaded only 60 per cent. above its one-hour rating, when loaded to four hours continuous rating, a ventilated motor could be loaded 2½ times its one-hour rating. There must, therefore, be a higher continuous rating for ventilated than for non-ventilated motors.

Institution of Electrical Engineers.—At the meeting on Thursday, Nov. 21, the President, Mr. C. H. Wordingham, remarked that since the last meeting the cessation of hostilities had come upon us with astounding suddenness, and the outstanding sensation we must all have was one of thankfulness to the Giver of all good that, once more, peace had returned, and thankfulness for the clear evidence that this world was ruled by God and not by the Devil. No amount of payment in gold or in kind could make restitution for German bestial ill-treatment of women, their ill-treatment of the wounded and of defenceless prisoners and their wanton destruction of works of art. Until they atoned by repentance and amendment, let the Institution preserve its roll of membership free from the defilement of a known German.

The President then referred to the death of Lieut. Llewellyn Preece and to the loss that had been sustained by himself personally and by the Council. The members passed a vote of condolence with Lieut. Preece's family. The President then announced that the vacancy on the Council caused by the death of Mr. J. O. Callender had been filled by the election of Mr. Percy Allan, subject to his willingness to accept the

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nomination. An informal vote was also taken as to whether the meetings should be at 6 p.m. or 8 p.m. when the Institution returned to its own building, 42 voting for 6 o'clock and 26 for 8 o'clock. The matter was deferred.

Temperature Uniformity in Electric Furnaces.—A contribution to "Engineering" emphasises the importance of a region of uniform temperature in electric furnaces. Compensation may be made for the heat losses at all points within this region by special heating of the ends of tubular furnaces by crowding the coils, the different coils being joined to two or even to three different circuits. In the "Physical Review," J. B. Ferguson, of the Geophysical Laboratory, Carnegie Institute, Washington, recently described a tubular furnace, 45 cm. in length, in which he can maintain a temperature constant within 0·25° C. for more than an hour at temperatures of 1,000 deg. or 1,200° C. and constant within ±0·5° C. for the range lying between 620 deg. and 1,190° C. The central zone of uniformity has a length of 10 cm. or 12 cm. and a diameter of 6 cm. The essential parts of the furnace are two concentric alundum tubes, coils belonging to three different circuits, plugs, and external insulating packing of magnesia (inside), fireclay and calorox (outside). The furnace is provided with an outside shell of sheet iron painted with aluminium. The two ends of the inner alundum tube are first wound with platinum wire over lengths of 10 cm.; the wire is covered with alundum cement and baked, and the inner tube is then slipped into the outer tube, into which it just fits after grinding off the excess of insulation. The peculiar winding is recommended because alundum is not so good an electric insulator as is often assumed; all the coils are covered with alundum cement, but some furnaces did not survive their trials.

Industrial Reconstruction Council.—The series of lectures now being held by the Industrial Reconstruction Council is proving so popular that a second course has been arranged for next year. The first of these will be given by the Minister of Labour on Wednesday, Jan. 8, the Marquess of Crewe occupying the Chair. Other lectures will follow at fortnightly intervals by Judge Edward Parry, Mr. Ernest J. P. Benn, Mr. J. R. Clynes, M.P., Prof. A. W. Kirkaldy, and the President of the Board of Education. The Chair will be taken on the respective occasions by Lord Balfour of Burleigh, the Bishop of London, Lord Leverhulme, Sir George Riddell, and the Lord Mayor of London. The lectures will again be held, by the kind permission of the Saddlers' Company, in the Saddlers' Hall, Cheapside, at 4.30 p.m. A full prospectus of the series can be obtained from the Secretary, I.R.C., 2 & 4, Tudor-street, E.C. 4, and applications for tickets should be made well in advance.

A conference on the Functions of Industrial Councils will be held under the auspices of the Industrial Reconstruction Council on Tuesday, December 3rd, at 6 p.m., in the Hall of the Institute of Journalists, 2 and 4, Tudor-street, E.C.4. The subject will be introduced by Mr. E. McGegan, of the Ministry of Labour, after which the discussion will be open. No tickets are necessary.

The Council is issuing a "Reconstruction Handbook" (price 9d.); also the recent lecture, by Mr. W. L. Hichens, on "The Functions of the Government in Relation to Industry," has been issued in pamphlet form.

Intermittent Faults to Earth.—In an article on this subject in the "E. T. Z." Mr. Petersen considers that such intermittent faults are due to direct-current charges; such faults cause a direct-current voltage to earth over the whole network, and such voltages facilitate the continuance of the arc to earth. After the arc has been extinguished and re-started several times, the voltage-surges and the direct-current charges reach maximum values. In three-phase networks the surges on the insulated phase (*i.e.*, on the phase only indirectly affected by the fault) reach three or four times the normal value of the voltage; on the faulty phase it may be between 3 and 3·7 times the normal value. The direct-current potential of the whole network to earth is from 2 to 2·7 times the value of the amplitude of the phase voltage. The voltage-surge on the sound conductor is a serious matter; still more serious are the surges which arise in the faulty conductor each time the arc starts. Every protective device, which removes the direct-current charges, not only shields the installation against the peak of the surges, but also shields the generators and transformers against short-circuits in the coils and windings. In considering the damping of such surges, formulæ have been proposed for the calculation of the maximum values; these show that the surges are much modified by the partial capacities between phase and phase. Installations at very high voltage with considerable distances between the conductors are therefore more exposed to the dangers of the intermittent fault than networks with a moderately high voltage. The same conclusion may be reached by considering the effects due to the natural process of damping a surge.

Obituary.

H. CECIL WALKER.—We regret to announce the death, in his 42nd year, after a short illness, of Mr. H. Cecil Walker, eldest son of Mr. Henry C. Walker, chairman of Waygood-Otis, Ltd. Mr. Walker entered the shops of R. Waygood & Company in September, 1893, and in time occupied the position of chief electrical engineer to the company. In November, 1910, he was appointed to a seat on the board, and this he retained after the amalgamation with the Otis Elevator Company. He rendered great service in the design of the electric lifts of the company, which have gained it such a high reputation.

Personal.

Mr. C. H. Chambers, Controller of Customs at Dar es Salaam, has been appointed Trade Correspondent of the Department of Overseas Trade for the territory of German East Africa.

Mr. H. A. Colefax, K.C., has been elected chairman of the British Scientific Instrument Research Association in succession to Mr. A. S. Esslemont, deceased. The secretary is Mr. J. W. Williamson, and the offices are at 26, Russell-square, W.C. 1.

Arrangements for the Week.

FRIDAY, Nov. 29th (to-day).

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. 1. Social Evening.

MONDAY, Dec. 2nd.

ROYAL SOCIETY OF ARTS.

5 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Physical Chemistry and its Bearing on the Chemical and Allied Industries," by Prof. J. C. Philip, O.B.E. (Lecture I.)

TUESDAY, Dec. 3rd.

INSTITUTION OF CIVIL ENGINEERS.

5.30 p.m. At Great George-street, London, S.W. Further discussion on "The Tata Hydro-Electric Power Supply Works, Bombay," by Mr. R. B. Joyner, C.I.E. Also Papers will be read on "Road Corrugation," by Mr. E. L. Leeming, M.Sc.Tech.; "Investigations in the Structure of Road Surfaces," by Mr. F. Wood, M.Inst.C.E.; and "Notes on Road Construction and Maintenance," by Mr. T. B. Bower, Assoc.M.Inst.C.E.

NATIONAL ASSOCIATION OF SUPERVISING ELECTRICIANS.

7 p.m. At St. Bride Institute, Bride-lane, London, E.C. Paper on "Cable Lay-Outs for Works and Factories," by Mr. A. W. F. Richards.

RÖNTGEN SOCIETY.

7.30 p.m. Meeting at King's College Hospital, Denmark Hill, S.E.

WEDNESDAY, Dec. 4th.

LIVERPOOL ENGINEERING SOCIETY.

8 p.m. At the Royal Institution, Colquitt-street, Liverpool. Paper on "Air Supplies to Boiler Rooms," by Mr. R. W. Allen, M.Inst.C.E.

THURSDAY, Dec. 5th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At Great George-street, London, S.W. Paper on "The Supply of Single-Phase Power from Three-Phase Systems," by Prof. Miles Walker, D.Sc.

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Contactor Control Gear in Industrial Work.

There has been a steady tendency for some years towards increased use of automatic control gear, which is continually finding new applications. The term "automatic" as applied to motor control gear implies that the functions of control are performed independently of the operator, who has merely to press a button or switch. It has been found that, beyond certain limits, hand-controlled gear of standard types gives rise to difficulties. The contacts of face-plate type starters are not good for large currents; large drum-type controllers are limited by the power required for operation by hand and the cost increases rapidly with size; multiple lever starters cannot be operated with sufficient speed; and the electrodes of liquid starters require periodical renewal. Moreover, the substitution of power for hand operation in dealing with large controllers of these types only meets some of the difficulties. Controllers have been fitted with motors or otherwise arranged for power operation by electromagnets or pneumatic pressure; but, while rendering the manipulation easier, such devices do not overcome the fundamental drawback of having to entrust valuable machinery to the judgment of unskilled operators, and the uncertainty of the human element remains.

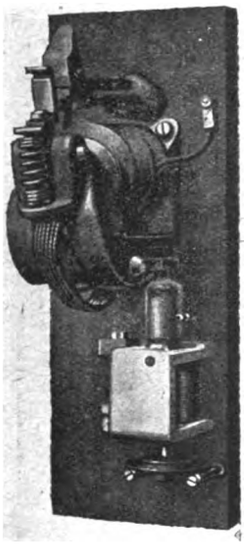

FIG. 1.—DIRECT-CURRENT SHUNT-WOUND CONTACTOR WITH ACCELERATING RELAY.

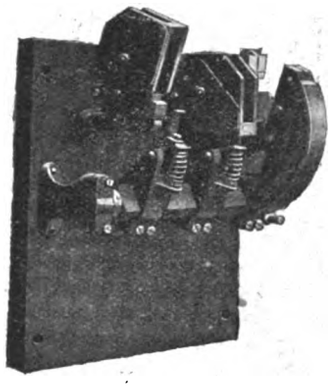

FIG. 2.—250-AMPERE ALTERNATING-CURRENT CONTACTOR.

Automatic control, besides acting as a measure of safety, may considerably reduce the costs of maintenance. An instance is afforded by the experience of the British Westinghouse Company in a certain steel mill with two motors. With hand-operated control the armatures had to be replaced approximately every two weeks, frequently requiring new coils and commutators. After the installation of an automatic controller the motors ran for two years without requiring any repairs to the armatures. The great need for careful manipulation will be understood when it is stated that in this case the circuit is made and broken each time the motors are reversed, about 150,000 to 200,000 times weekly, with a normal full-load current of 300 amperes and peak currents of 700 amperes, as against 1,000 amperes with hand control. During the period of two years the controllers also have shown no sign of wear, except at contacts, which can be very simply and expeditiously replaced, and are in general renewed after operating from 1½ to 2 million times. In many cases automatic control brings other benefits; for example, it may facilitate simpler driving, smaller consumption of current and speedier operation.

A Westinghouse automatic controller varies somewhat in make up according to the nature of the work; but consists in a combination of the following parts:—

Contactors: Series-wound lock-out type (direct current only); shunt-wound type (direct or alternating current); back contact shunt-wound type (direct current).
Speed accelerating relays.
Field accelerating relays.
Overload relays.
Transfer relays.
Master switches: Push-button type, handle type, cam-operated type.

In Figs. 1 and 2 we give illustrations of two typical Westinghouse contactors, Fig. 1 a direct-current contactor with accelerating relay, Fig. 2 an alternating-current double pole contactor. In all these types the contacts roll against each other in closing and are firmly pressed together by a stout spring, thus ensuring large contact surface throughout life.

Blow-out coils are used on all shunt switches, and arc shields made of compressed asbestos but hinged to facilitate ready inspection of contacts can be provided. Shunt contactors are used for line switches, reversing, speed control and acceleration in certain cases, the operating coil being connected directly across the line and energised either by a hand operated switch or automatic relay, according to the nature of the controller. Series lock-out contactors are used for automatic acceleration without speed control; they practically combine in one unit the functions of accelerating switches and current-limiting relays. Used with motors, they are arranged to cut out the resistance placed in series with the armature circuit, the number of contactors varying according to the number of steps required. Back contact contactors are used on direct-current circuits, where the motor is allowed to brake itself by generating current through an appropriate resistance. Series lock-out contactors are used to cut out starting resistance in suitable steps, but are unsuitable for certain special forms of work where shunt contactors combined with series accelerating relays are preferable.

By a combination of these various devices it is possible to make a motor go through almost any cycle of operations, such as starting, accelerating, slowing down, stopping and reversal. In such cases special master switches are used, consisting of a shaft geared to the driven machine and bearing a number of cams arranged to open and close operating switches in the required sequence. The simplest form of master switch, the push button, is used for starting and stopping (and in some cases accelerating or diminishing speed). More complex types employ levers or handles, while when several different control circuits have to be operated simultaneously, master switches of the drum controller type are used. In general, master switches used with controllers for the largest motors are small enough to be operated by hand with perfect ease. Remote control

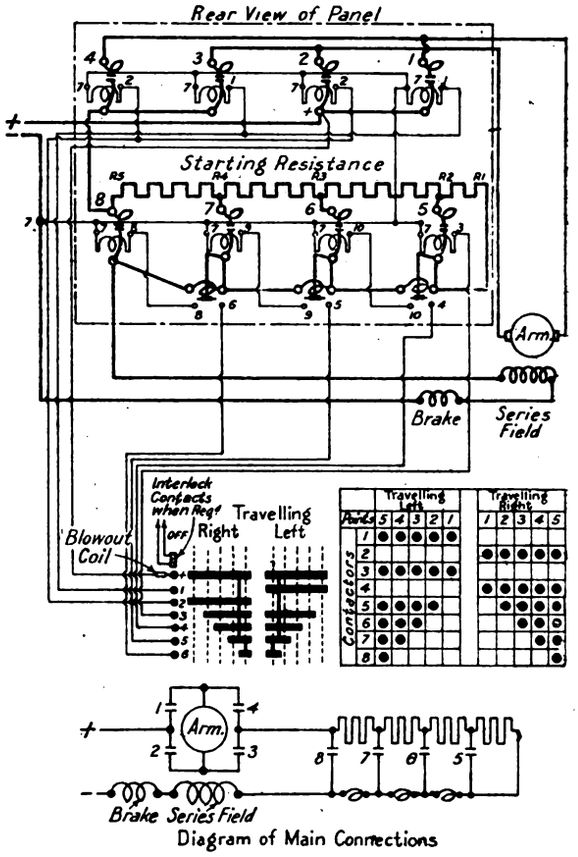

FIG. 3.—STANDARD STEEL WORKS CRANE CONTROLLER FOR TRAVELLING MOTION ARRANGED WITH FIVE POINTS OF CONTROL, FOR USE WITH DIRECT-CURRENT MOTOR.

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is readily effected by master switches, a number of which can be installed to permit control from different places.

Among the applications of automatic gear may be mentioned air compressors and hydraulic accumulators, where the motor must start or stop as the pressure of air or water reaches certain limits. The system can be also very conveniently applied to lifts, while in steel mills and rolling mills generally, where automatic controllers are in constant use with motors driving the main rolls of reversing mills, the screw down gear, the live rolls, and lift tables for three-high mills, &c., it has done good service, the conditions here being especially severe. There are, of course, many other applications in connection with machine tools, of which planing machines are a good example. Comparative tests on planers so driven with those operated with belted drive have shown an increase in output of 33 per cent., with a corresponding decrease in energy consumed.

Another function that deserves consideration is the operation of cranes. Crane contactor controllers are only used on very severe service or where absolute reliability is required. In Figs. 3 and 4 diagrams are given for two of the simplest forms of crane controllers. Many other forms of controllers have been designed—for

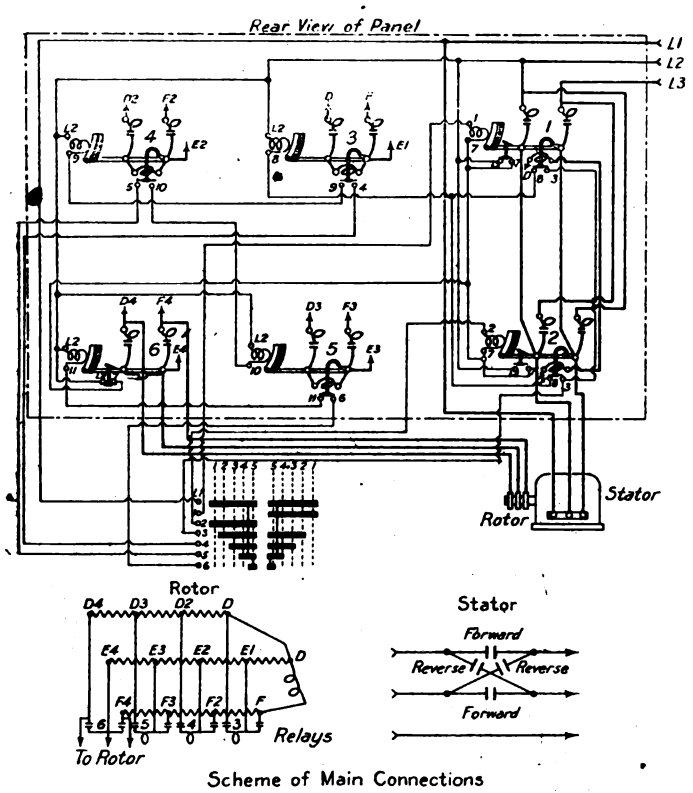

FIG. 4.—SIMILAR CRANE CONTROLLER FOR USE WITH ALTERNATING-CURRENT SLIP-RING MOTOR.

example, with slow speed hoisting notches for variable loads, permitting fine adjustments with almost any load between wide limits on the crane hook. Crane controllers have also been manufactured with dynamic braking notches on the lowering side, and the master controller has been in many cases so arranged that in the event of the man releasing the handle, power is immediately cut off from the motor.

Large dockyard cranes have been equipped with contactor controllers in cases where drum controllers become a heavy item, and also small industrial cranes where the operation is so constant that the maintenance of drum controllers becomes unduly heavy.

In shipyards or industrial establishments where compressed air is used the contactor system has been applied with special success. The automatic control enables power to be saved by giving a more efficient start than is possible with hand control, a further saving of power being effected owing to the fact that the motor is automatically shut down when not required. Another recent application is for blast furnace hoists (the hoist being automatically brought to rest at any required level).

Finally, as yet another illustration of the Westinghouse automatic system, we may mention the "all-electric" control gear employed on the London & South Western Railway electrified line, of which the following particulars are of great interest:—

The control of the trains for multiple-unit working is effected by "automatic relay control," the Westinghouse "all-electric system" being used throughout. This is a multiple-unit system, and it allows of the most efficient handling of trains, since, according to the size required, it may be made up of one or more train units which are self-contained; in this manner all the horse-power available for operating is proportionate to the size of the train, and the advantage of fully loaded motors is obtained.

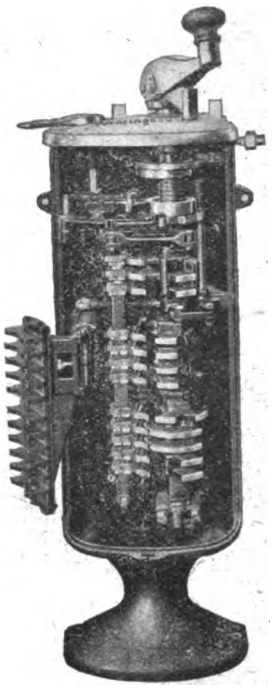

FIG. 5.—MASTER CONTROLLER WITH COVER REMOVED AND ARC SHIELD OPEN.

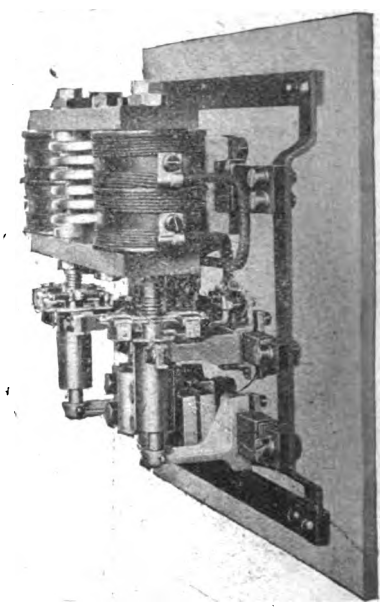

FIG. 6.—AUTOMATIC CURRENT LIMIT RELAY.

The standard series-parallel method of control is employed, but instead of the usual system of cutting out resistance and arranging the connections of the motors as performed by the tramway-type controller, the sections of the resistance are short-circuited in correct sequence, and the correct connections of the motor are made by means of electrically operated contactor switches which are

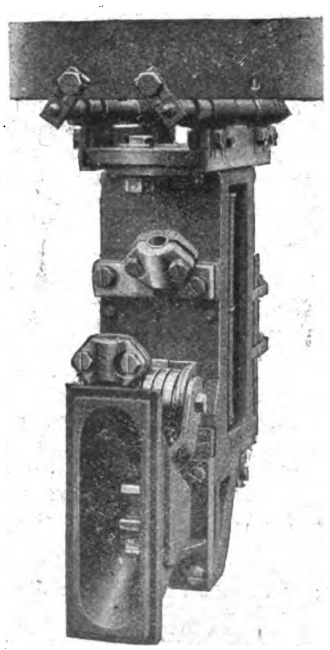

FIG. 7.—SINGLE CONTACTOR SWITCH.

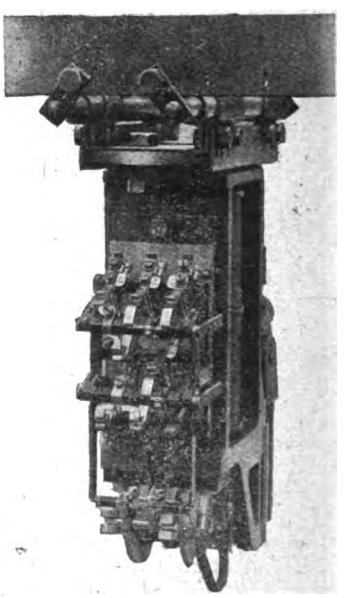

FIG. 8.—REAR VIEW OF SINGLE CONTACTOR SWITCH, SHOWING INTERLOCKING SWITCHES.

operated from the multi-point control line from a master controller. The main pieces of apparatus employed in this system are: Master controllers, automatic relays, contactor switches, interlocking switches, circuit-breakers and reversers. The master controller is a very simple piece of apparatus, which is a point of great impor-

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tance, because it is the only piece of apparatus that is handled by the drivers, who are usually non-technical men. The operation of the controller is extremely simple, the driver having merely to move the controller right round to the "full on" position, and the automatic relays do the rest. It is of the drum-type, and is provided with both main and reversing handles, which are so interlocked that the latter must be either in the forward or the reverse position before the driver can operate the controller. The main handling is so arranged that should the driver release the handle it moves upwards and mechanically releases the drum switch, which flies back to the "off" position, and interrupts the supply of control current, thus opening up the main contactors and cutting off the electric supply from the motors. At the same time air is released from the brake pipes by means of an emergency brake valve, and the brakes are in this manner automatically applied. Should the driver allow the handle to be moved upwards at any time it is so arranged that he must bring the operating handle to the "off" position again before he can release the brakes to accelerate the train. For coasting purposes and when making the ordinary service stops, the driver moves the main handle to the "off" position, and maintains his hold on the handle, thereby preventing the intervention of current and the automatic application of the emergency brakes. In case, however, he has to move from his position at the controller to look out for an "off side" signal, he may bring the handle to the "off" position and then pull the reversing handle to the "mid" position, when he may remove his hand from the main handle without the emergency brakes being automatically applied.

The main handle of the master controller has four operating positions. The first position, usually called the switching position, gives series connections to the motors with all resistance in circuit. The second position brings the automatic relay into operation, and the resistance is gradually cut out of circuit step by step until full series connections are obtained. The third position cuts out the relay and connects motors in parallel, the well known bridge connections being used in passing from series to parallel. The fourth position brings the automatic relay into operation again, cutting out the resistance step by step until full parallel connections are obtained.

The above is a sketch of the general operation of the system, but the automatic relays, contactor switches, reversers, &c., have also points of interest. Readers may be referred to an article on the subject in the "British Westinghouse Gazette" for December, 1914, which contains additional descriptive matter.

The remaining illustrations (Figs. 5–10) show the chief appliances used in the control of this installation. Fig. 5 shows the master controller, described above. Fig. 6 is an automatic current limit relay utilising one series and two shunt coils with a common magnetic circuit. To the shunt coils are fitted plungers with copper discs which, when the coils are de-energised, bridge contacts in the control circuit closing contactor switches and cutting out sections of resistance. Resistance can be cut out at a predetermined rate, the series coil having an adjustable time lag regulating, through the common magnetic circuit, the speed of movement of the plungers. The single contactor switch shown in Fig. 7 (a group of which are seen mounted together in Fig. 10) is operated by a solenoid, and fitted with magnetic blow-outs, a rear view being given in Fig. 8. The reverser (Fig. 9) is of the drum type, the interlocking of the control circuit for operating this reverser being provided for by means of an additional contact drum attached to the main spindle; in this way a fixed relationship between the making and breaking of the control circuits is obtained. Practically all the apparatuses in the driver's cab, and the connecting control and power bus jumpers are fixed to the coach bodies out of the reach of unauthorised persons.

FIG. 9.—REVERSER WITH COVER REMOVED.

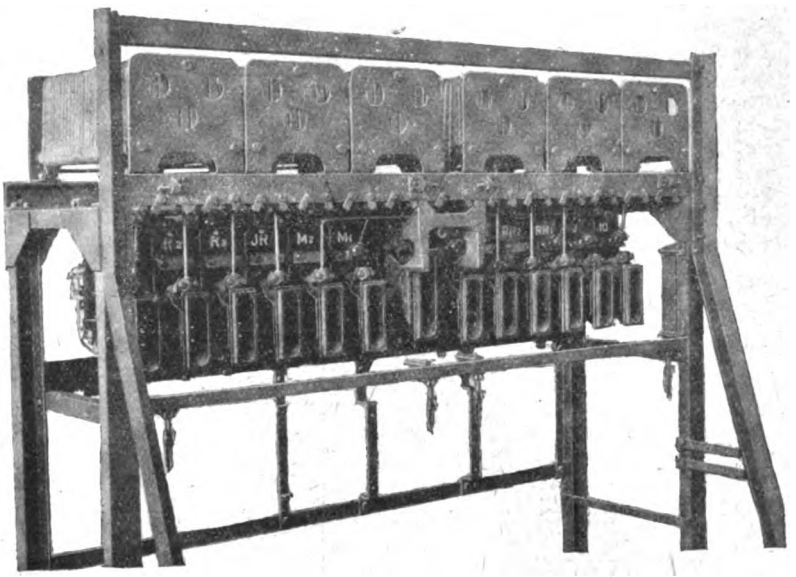

FIG. 10.—SWITCH GROUP, SHOWING CONTACT SWITCHES, CIRCUIT-BREAKER IN MIDDLE AND RESISTANCES.

Belgian Reconstruction and Trade.

In an article in the "Board of Trade Journal" on Belgian Reconstruction and Trade, it is stated that many inquiries are being received by Government Departments from British firms wishing to resume their trade with Belgium at the earliest possible moment. It must be realised that no definite pronouncements can yet be made in respect of exports to or imports from Belgium, as the country would not be wholly re-occupied until the 25th inst., and even then it would be impossible for anything like normal trade to be resumed immediately. The urgent needs of the armies and of the civil population must be the first preoccupation, while it is clearly impossible for ordinary trade to be carried on until transport has been resumed.

The vast problem of the reconstitution of Belgium must be the first concern of the Belgian Government and people themselves, and it will be the duty and privilege of the great Allies who have suffered least material loss or damage to their resources to help in that great task. An Inter-Allied Commission has been sitting for some time, and has been dealing with the practical side of the reconstruction of Belgium. Its main centre of activity is in London, and numerous statements of estimated requirements for Belgian reconstruction have been received and carefully studied in the light of available supplies. Much must depend on the co-operation of private initiative, and it is urgently hoped that firms and individuals in this country will do everything in their power to help to bring about the reconstitution of Belgium and the development of British-Belgian trade relations. A special section of the Department of Overseas Trade has been set up to deal with these matters so far as His Majesty's Government is concerned, and inquiries relating to Belgian trade and reconstruction should be addressed to "The Officer in Charge, Department of Overseas Trade (Development and Intelligence), Belgian Trade and Reconstruction Section, India House, Kingsway, London, W.C. 2." As soon as possible information will be conveyed to the mercantile community of the steps they should take in regard to exports to Belgium. It may, however, be necessary for some time to come to limit imports into Belgium to articles of primary necessity, or to establish some form of priority or licence for goods of which the world supply is limited.

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Transformer Oil.

By W. S. FLIGHT, A.M.I.E.E.

Summary.—Oils may be roughly divided into fixed oils and straight oils. The former give trouble through the formation of sludge. The latter are much more free from this defect. For use in transformers it is necessary to take into account viscosity, specific gravity, dielectric strength and other properties. Examples are given of the variation of specific gravity and viscosity, and the methods of determining the latter are stated. Flash point is also another important property that must be stated. In specifying dielectric strength, great care must be taken that the presence of moisture does not enter into the figure, and in practical use care must be taken that the oil does not take up moisture. The carrying out of dielectric strength tests is described, and the effect of dirt, air and circulation of the oil is considered on the results obtained. The author then discusses the formation of sludge and the practical methods of preventing it. Lastly, minor tests are described, such as the iodine value, acidity, evaporation, sulphur, &c.

The majority of present-day transformers are immersed in oil for two important reasons.

(*a*) The circulation of the oil due to convection currents greatly assists in cooling the transformer and the presence of a large volume of oil gives to the apparatus an additional thermal capacity thereby rendering it capable of withstanding heavier overloads for short periods.

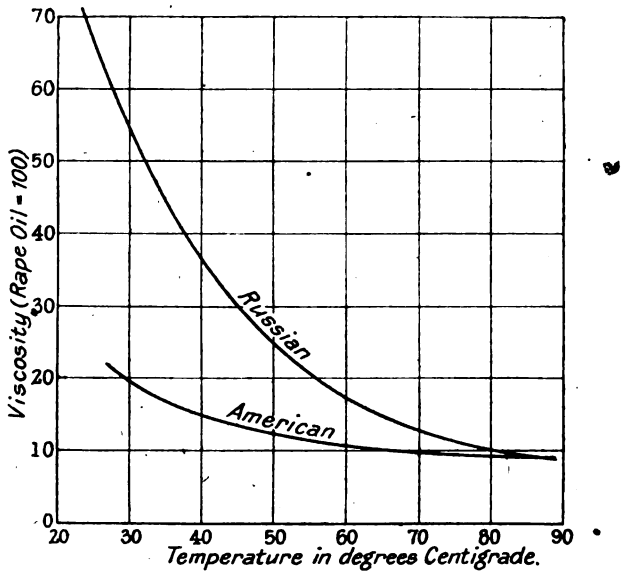

FIG. 1.—CURVE SHOWING DIFFERENCE IN VISCOSITY BETWEEN RUSSIAN AND AMERICAN OILS.

(*b*) The puncture voltage of oil being greater than air, less creepage distances are necessary across the surface of the insulation, and from the live parts to grounded objects.

The selection of an oil suitable for insulating and cooling a transformer is in many respects similar to the selection of the most suitable lubricating oil for any particular purpose, and the following notes deal with some of the principal points that have to be considered in the selection of a transformer oil.

Oils may roughly be divided into two classes, viz. :—

1. "Fixed" oils—*i.e.*, oils which cannot be separated into distinct grades when subjected to fractional distillation. This class includes :—

(*a*) Animal oils, such as whale oil, lard oil, &c.

(*b*) Vegetable oils, such as linseed oil, olive oil, &c.

2. "Straight" oils, such as petroleum obtained from the earth. These consist of a mixture of different oils which can be separated by distilling the crude at different temperatures. The distillates that come over at the various temperatures, each have their own chemical and physical characteristics, so that from one crude there is a large range of oils to select from. The properties of the straight oils depend on the temperature at which they have been distilled and also upon the crude from which they were obtained.

In the early days of the oil-immersed transformer certain of the fixed oils were used, but were found to thicken after use, and have now been discarded in favour of the straight oils.

Among the straight oils there are a large number that possess one or two of the requirements of a good transformer oil, and none that are absolutely ideal. These oils have also the property of not being able to change one of their characteristics without changing others. For example, as the flash-point is increased, the viscosity is also usually increased, and as the viscosity is increased the dielectric strength is usually diminished. This renders it necessary in choosing a transformer oil to make a compromise so that each of the requirements are satisfied as closely as possible without an undue sacrifice of any other.

The chief properties to be considered are as follows :—

VISCOSITY.

The more fluid a transformer oil the greater the velocity of the convection currents for a given temperature difference, so that assuming the specific heat to be the same, a fluid oil will exert a greater cooling action than a thicker oil. In Fig. 1 are shown viscosity curves for two straight oils, one obtained from an American crude and the other from a Russian crude. In common with most Russian oils the viscosity changes rapidly with change of temperature; this change is much less marked in the case of most American oils. Table I. shows the percentage increase in viscosity of the Russian oil over the viscosity of the American oil at the same temperature.

Table I.

Temp. °C.	Viscosity of American oil.	Viscosity of Russian oil.	Percentage increase of Russian over American.
25	23	69	200
60	10	16	60
90	7	7	0

Comparing the cooling properties of the two oils from the viscosities at 25°C. would suggest that the American oil was

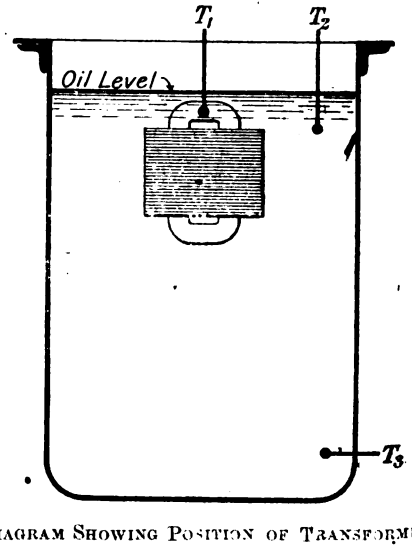

FIG. 2.—DIAGRAM SHOWING POSITION OF TRANSFORMER WHEN THE VISCOSITY OF THE OIL CAUSED A LARGE DIFFERENCE IN TEMPERATURE RISE OF THE COILS.

vastly superior to the Russian oil. At the working temperature of the transformer (60°C. to 70°C.) the cooling properties of the two oils is nearly the same. For the above reason test reports on transformer oils should give the viscosity at the working temperature of the transformer, and not at 15·5°C., as is now usually done.

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A practical proof of the above theory was given in the following tests carried out by the author :—

A small transformer was suspended at the top of a large tank, and just below the surface of the oil, as shown in Fig. 2. The tank was filled up to the oil level with an American oil having a viscosity of 30 at 15·5°C. Sufficient current was passed through the coils to cause the temperature, as measured by a thermometer placed in the centre of the transformer, to rise 52°C. above the air temperature after a continuous run of 7 hours. The oil in the tank was then replaced by a Russian oil having a viscosity of 90 at 15·5°C., and current of

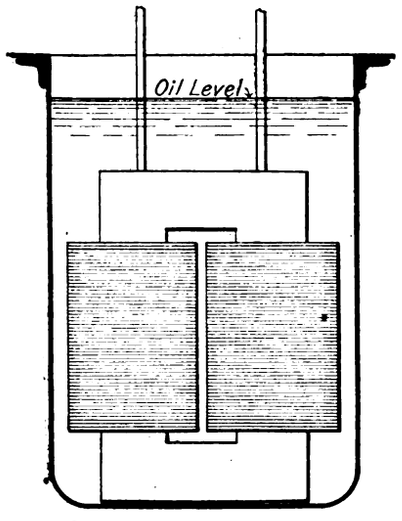

FIG. 3.—DIAGRAM SHOWING POSITION OF TRANSFORMER, WHEN THE VISCOSITY CAUSED ONLY A SMALL DIFFERENCE IN TEMPERATURE RISE OF THE COILS.

the same value passed through the coils for the same length of time as before. The results obtained are given in Table II. :

Table II.

Oil.	Viscosity at 15·5°C.	Temperature rise after seven hours' run.			
		T^1.	T^2	T^3.	Rise by resistance.
American	30	52°C.	48°C.	25	55
Russian	90	74	57	25	90

By placing the transformer at the top of a large tank of oil, with a large quantity of cold oil beneath it, assured that the cooling oil drawn through the coils by the convection currents was always at a low temperature, and consequently a high viscosity at the time it first came into contact with the hot coils. Under these conditions the transformer was operating on the steep part of the viscosity curve where there was a considerable difference in the viscosities of the two oils. To determine the effect of viscosity under normal operating conditions, two 150 k.v.a. single-phase transformers were placed in their tanks and given a full-load back-to-back run. The Russian oil was used in one tank, and American in the other; the position of the transformers with respect to the oil is shown in Fig. 3. The temperature rise of the windings determined by resistance measurements at the end of the eight hours' run showed the transformer immersed in the Russian oil to have a temperature rise about 2 per cent. higher than the transformer immersed in the American oil.

In the case of some water-cooled transformers it was found that the temperature rise of the coils could be reduced by about 3 per cent. when an oil of viscosity 14 at 15·5°C. was used, instead of an oil having a viscosity of 30 at 15·5°C.

Many instruments have been used or suggested for measuring the viscosity of oils, the following principles being employed : (*a*) The syphon, (*b*) the resistance of a paddle, (*c*) capillarity by estimating the rate of flow through strands of yarn of equal size and number, and (*d*) the passage of a known quantity of oil through a small orifice. The latter class of instrument has proved the most satisfactory in commercial work, and the standard apparatus for determining viscosities in this country is the Redwood's viscometer, shown diagrammatically in section in Fig. 4. The centre vessel (*A*) is filled up to the level indicator with the oil to be tested. Water is placed in the outer vessel (*B*), and heated from the extension (*C*). To obtain a uniform temperature the water is continually stirred by means of the vanes (*V*), which revolve on a cylinder fitting on the outside of the oil vessel (*A*). As soon as the oil and water are at approximately the same temperature, the brass ball (*D*) is removed from the agate socket *E*, and the time noted for 50 cubic cm. of oil to flow through the small hole (about 0·067 in. diameter) in the agate block. In order to compare the viscosity of one oil with that of another oil, a standard liquid is chosen, to which all other oils can be compared. Rape seed oil has been chosen in the case of the Redwood viscometer, and the viscosity of this oil at 15·5°C. (60°F.) is taken as 100. The viscosity of any other oil on the Redwood scale is calculated as follows :—

$$\text{Viscosity of sample oil at } X°\text{C.} = \frac{T_1 \times G_2}{T_2 \times G_1}, \text{ where}$$

T_1 = time of flow in seconds of 50 cubic cm. of rape oil at 15·5°C.
T_2 = " " " " sample oil at X°C.
G_1 = specific gravity of rape oil at 15·5°C.
G_2 = " " sample oil at X°C.

The specific gravity of the oil has to be considered on account of the difference in pressure it creates on the orifices. In making comparative tests on a number of oils of approximately the same specific gravity, the correction for gravity in the viscosity test is so small that it is usually neglected. Where rapid tests are required in commercial work the viscosity is usually recorded as the number of seconds taken for the oil to flow at a specified temperature under standard test conditions.

Unfortunately other countries have adopted other instruments as standards for measuring the viscosity of oil. The

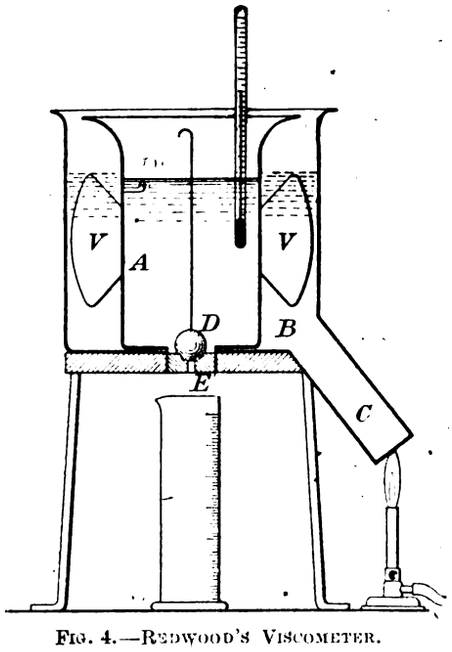

FIG. 4.—REDWOOD'S VISCOMETER.

one in most general use in the United States is the Saybolt Universal viscometer and on the Continent Engler's viscometer. Both of these instruments work on the same principle as Redwood's viscometer, but are of different dimensions, and employ different standards for comparison. Engler adopted water as the standard or unit for viscosity, and having ascertained that 240 cubic cm. of water at 20°C. (68°F.) took 54 seconds to flow through his instrument, he divided the time of flow of 240 cubic cm. of oil by 54, and called the result the specific viscosity of the oil at that temperature—*e.g.*, if a sample of oil takes 360 seconds at 60°C. and 90 seconds

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at 150°C. the specific viscosities are 360÷54=6·66 at 50°C., and 90÷54=1·66 at 150°C.

On account of the differences of dimensions of the various viscometers and the different standards of comparison, figures obtained on one instrument can only be compared with those obtained on other instruments when the conversion factor is known.

To convert a viscosity reading obtained on a Saybolt Universal viscometer to its equivalent on the Redwood scale, divide the Saybolt figure by 1·14.

Due to the fact that some oils decrease in viscosity more quickly than others, it is not practicable to devise an equation that will enable the viscosity of an oil at any temperature to be accurately calculated from the viscosity at any other temperature. For this reason a complete test report on the properties of an oil should include a viscosity curve, similar to Fig. 1, showing the viscosity at any temperature from 20°C. to 80°C. As the determination of this curve occupies a considerable time, it is often found more convenient to compare the viscosities of various samples at three temperatures, such as 20°C., 50°C. and 80°C.

A comparative test of the viscosity of various samples of oil can be made without using any of the standard viscometers. One simple method is to allow drops of the oil to fall upon an inclined plane of glass or metal, and note the time taken for each oil to travel a certain distance. For this test it is essential that the same quantity of oil be used in each case, and that all the samples are at the same temperature. Another simple method is to fill a glass funnel to a certain mark, and note the time taken for the various samples to flow out.

Specific Gravity.—This is the relative weight of a definite volume of the oil compared with the weight of the same volume of water measured at the same temperature as the temperature of the oil. Thus, if 1 gallon of water weighs 10 lb., and 1 gallon of oil is found to weigh 8½ lb., the specific gravity of the oil is represented as 0·85.

When straight oils were first put on the market, and were obtained by simple processes of distillation from the few crudes then available, it was found that by specifying the gravity of the oil, the same product could always be obtained, and in some cases the gravity test was the only one required. This arrangement between supplier and consumer was perfectly satisfactory as long as the condition of manufacture remained unchanged. In the course of time other sources of oil were discovered, and it was found that due to the different chemical composition and different gravities of the crudes, that fractions distilled at the standard temperatures also had different gravities to those previously obtained at these temperatures. Other methods of manufacture, such as heating the oil with acids, heating in a closed vessel subjected to super-atmospheric pressure, &c., were introduced, which resulted in different products from the same crude. Many of the new oils obtained from the newer crudes, or by different processes of manufacture, were found to equal, and in some cases to be superior, to the oils previously available. These products, however, had entirely different gravities from those called for in specifications, and gradually it was realised by oil users that the gravity test was no guarantee of the suitability of an oil for any particular class of work.

In drawing up a specification for oil to be used in a transformer it is sometimes advisable to refer to those limits of gravity which have been found satisfactory in the past. The oil supplier, who is not as a rule so familiar with the requirements of a transformer oil as he is with lubricating oils, then has a rough idea of the type of oil which would be most likely to be suitable. It must be clearly stated, however, that the figures quoted for gravity need not be adhered to provided the other requirements of the specification are satisfied.

Test reports on a transformer oil should always give the gravity of the oil and the temperatures at which it was measured. To calculate the gravity at any other temperature it is approximately correct to assume that the specific gravity of a pure straight oil varies by 0·0006 per 1°C. A knowledge of the specific gravity of an oil is of use in comparing samples taken from different consignments of the same grade of oil, and also in calculating the weight of oil required to fill the transformer tanks, &c.

In commercial testing of oils the specific gravity can be obtained with sufficient accuracy by means of hydrometers, if special accuracy is required the best method is to use a specific gravity bottle. The latter method, however, takes considerably longer than the former.

There is a popular belief that an oil having a high gravity has also a higher viscosity than an oil of low gravity. Although this occurs in certain cases, it is not generally true of all oils. Table III. shows many exceptions in the case of fixed oils, whilst Table IV. gives figures for some straight oils, all of which were submitted for use as transformer oils :—

Table III.

Oil.	Specific gravity at 15·5°C.	Viscosity at 21°C. (sperm oil at 21°C. taken as 100).
Sperm oil	0·880	100
Rape seed oil	0·914	250
Lard oil	0·917	225
Olive oil	0·919	213
Whale oil	0·924	190

Table IV.

Source of oil.	Specific gravity at 20°C.	Viscosity at 20°C. (Redwood).
America	0·825	10
,, ...	0·829	12
,, ...	0·848	23
,, ...	0·855	32
,, ...	0·856	26
,, ...	0·864	55
,, ...	0·868	29
Russia	0·872	70
,, ...	0·878	95
America	0·880	60
,, ...	0·880	65

In America the standard method of measuring gravity is by means of the Baumé hydrometer. To convert Baumé gravity into specific gravity the following formula is approximately correct :—

$$\text{Specific gravity} = \frac{140}{130 + \text{Baumé}}.$$

(To be continued.)

Industrial Reconstruction in France.

Particulars have been published of the French scheme of organisation for industrial reconstruction. In the first place there is the Ministere du Blocus et des Régions Liberées (Office de Reconstitution Industrielle des Régions Envahies), which deals with "everything relating to the re-organisation of local life and means of habitation, the assistance to be given to sufferers in the re-establishment of destroyed property, the repair of war ravages, the restoration of the land, and industrial and agricultural reconstruction." Its function is to lay down programmes of purchases, and to supervise and control their execution.

The Association Centrale pour la reprise de l'Activite Industrielle dane les Régions Envahies, comprises a group of manufacturers in the invaded districts, with the object of "pursuing by every suitable means the reconstitution of plant and stocks in industrial enterprises and factories." Being prohibited by law from undertaking commercial operations, the Association established the Comptoir Central d'Achats Industriels pour les Régions Envahies, in the form of a limited company with a capital of 1,000,000 francs. Its address is 40, Rue du Colisée, Paris. The functions of this body are defined by the law of Aug. 6, 1917, and by an agreement entered into with the French Government on Oct 4, 1917. This law sanctions a credit of 250,000,000 francs, and charges the Ministry of Commerce to purchase and distribute the necessary materials for reconstruction purposes through the "Office de Reconstitution Industrielle." It provides for the transfer of actual operations by agreement to a third party responsible to the Office Industrielle and subject to the audit of the Ministry of Finance. The Comptoir Central is the third party concerned.

The duties of the Comptoir Central are to submit data for purchasing programmes to the Office Industrielle ; to find out and discuss purchases with suppliers ; to place contracts ; to supervise their execution ; to receive and store the material and distribute it to the manufacturers concerned. A further statement on the subject of French reconstruction will be published later. Meanwhile inquiries from British firms interested should be addressed to the Secretary, Commission Internationale de Ravitaillement, India House, Kingsway, W.C. 2.

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The Design of Electrically-Driven Lifting Blocks.*

By H. WINTERMEYER.

Hand-driven lifting blocks have lately in some cases been replaced by electrically-driven mechanism. Probably the main objection to the alteration has been the fact that the apparatus must be easily moved from place to place in the workshop to suit requirements; but now that it is possible to make small light motors of sound construction, this objection has lost some of its force. A few words on the subject of the general design and arrangement of these blocks may be of interest.

Either worm or spur gearing may be used, or a combination of the two; in certain cases, a noiseless Renold chain has been used, and this has the advantage of distributing the work between a number of the teeth. Originally the motor was usually placed above the cable drum; then there was a tendency to place it more nearly on the same level, and finally types have been developed in which the motor is placed within the drum. Fig. 1 shows the motor placed above the cable drum, and here a symmetrical disposition of the parts is usually possible, at any rate in the smaller sizes. If a starting controller of some kind is needed it is usually arranged on one side of the vertical middle line, so as to counter balance the spur wheels on the other side. If a double reduction was necessary in the gearing, the wheels were originally placed with all their spindles in the same vertical line; but this took up too much space, and a more usual plan is that shown in Fig. 2, where the second spur wheel is placed beside that connected to the drum. Another diagram in the original article shows a worm drive; the cable drum is arranged in two halves on either side of the worm, and is placed above the motor. In some cases a composite system of gearing is used; the first reduction is effected by means of a

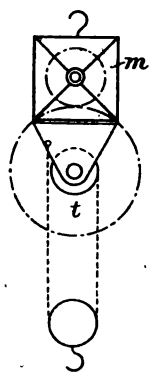


FIG. 1.—BLOCK WITH MOTOR PLACED ABOVE THE DRUM.

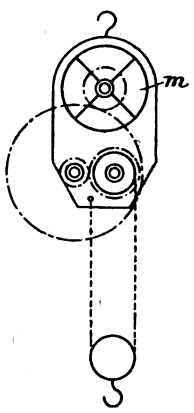


FIG. 2.—BLOCK WITH MOTOR ABOVE THE DRUM AND DOUBLE REDUCTION GEARING.

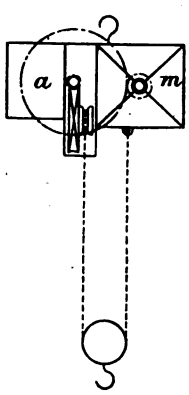


FIG. 3.—ANOTHER TYPE OF BLOCK.

worm, and the second reduction by spur wheels; an iron framework carries on the one side the motor and the starting resistance, and on the other side, the driving gears and the cable drum. The system is thus balanced by the counteracting influences of the weights of the parts. Fig. 3 shows a fundamentally different design, inasmuch as here the motor and the drum are on the same horizontal level. The driving gear consists of a combination of spur wheels and worm, which are arranged in the middle of a framework; at the sides are to be seen the motor and its starting resistance. This is another very common arrangement at the present time. It can be used for lifting loads up to 5 tons with one motor; two motors are needed for heavier loads, seeing that mechanical balance would be impossible with the weight of one heavy motor on the one side. The two motors would naturally be placed on opposite sides, and being coupled in series, would drive a common worm, in a manner similar to that shown in Fig. 3. It is possible to arrange that apparatus, constructed on this plan, should be suspended from two points, and this materially contributes to stability of equilibrium when the block is unloaded.

It is always desirable to diminish the vertical height of the apparatus, as, of course, an increased lift is only possible at the expense of the space taken by the block in a vertical direction. This can be done by placing the centres of the spindles, &c., in one horizontal plane, and thus arranging the motor, starter, gears and cable drum on the same level.

*Abstract of an article in the "Elektrotechnische Zeitschrift," No. 1, 1918.

The following examples are arranged somewhat on this plan. Thus in Fig. 4, the spindle of the motor passes freely through the cable drum, and is connected to the wheel *f*, which is connected by a system of back gearing, *e*, to the wheel *c*, which is in its turn directly connected to the drum. In this way the drum is driven by the motor through a double reduction gear. The starting resistance, *a*, is seen in the drawing; the whole is enclosed in a cylindrical casing, and the gears are in this way protected from dust. The Yale and Towne Manufacturing Co. employ an epicyclic gear with the same result, so that the main parts are on the same horizontal level. The motor here drives a wheel by means of an endless chain, and thus by the epicyclic system the drum is rotated. The starting

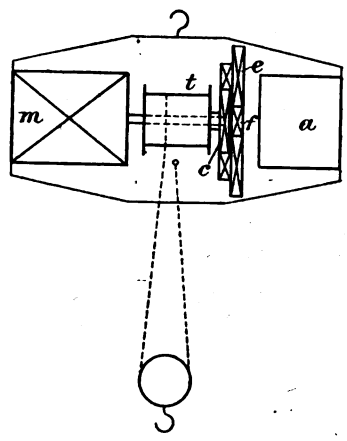
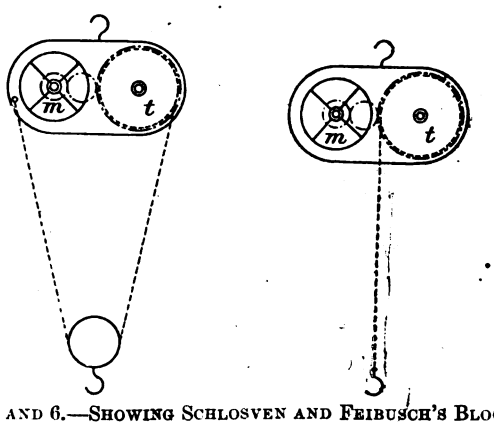


FIG. 4.—BLOCK WITH SHAFT OF MOTOR PASSING THROUGH THE DRUM

resistance on the one side counterbalances the weight of the motor on the other. The firm called this a "triplex block." If a block of this description is intended to lift 1 ton, the minimum distance between the point of suspension and the hook, carrying the load, is 22 in.; the length of the apparatus is 36 in., and the breadth 18 in.; the weight is 400 lb. This block will lift 1 ton through a height of 5 ft. 24 times an hour In a Swiss design a very similar arrangement is adopted. In a block of this kind with a load of 2 tons, the diameter of the drum is 8 in., and the load is carried by four stranded steel cables. Power is supplied from a 2·65 kw. motor, running at 965 revs. per min



FIGS. 5 AND 6.—SHOWING SCHLOSVEN AND FEIBUSCH'S BLOCKS.

Another design, having also the same object of diminishing the height of the apparatus, has the spindles of the drum and the motor parallel to one another, as shown in Figs. 5 and 6. The weights of the motor and starter are used to counterbalance those of the drum and gearing. The design is protected by the German patent, No. 281,874 (1915); here the mean axis of suspension is a tangent to the cable drum, the lifting cable being attached, as shown in Fig. 5, to a suitable point on a part of the frame near the motor. The block can therefore be used, as shown in Fig. 6, for a direct lift at double speed, or, as shown in Fig. 5, where the cable passes round a loose pulley. It is therefore available for light loads at double speed; and it requires very little alteration to make it available for heavier loads at a slower speed. The enclosing case can be removed for cleaning purposes in a few minutes, and if a

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few bolts are loosened, the motor can be instantly removed. A lid in the case can be lifted for purposes of inspection

A further development consists in the arrangement by which the motor is contained within the cable drum. The vertical space required by a block of this kind is reduced to a minimum, and the motor is protected from any possible injury by contact with any external object. If also the driving gears are enclosed within the drum, a type of construction of the most compact kind is attained.

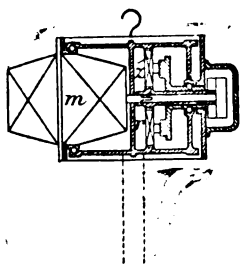

FIG. 7.—BLOCK WITH MOTOR ENCLOSED IN DRUM.

The arrangement by which the motor, but not the gears, is enclosed within the drum has not been very largely adopted; it fails in compactness. One plan is to attach the field windings of the motor directly to the drum; but this is not generally adopted, as such windings are not easily accessible for inspection. It is really necessary that a complete examination of all parts should be easily possible. Fig. 7 shows a plan by which the motor and the gears are quite separate from one another, and are yet contained within the drum; they can be separately removed owing to the use of the dog-clutch coupling. Thus the motor can be removed without interfering with the gears or the braking pulley. In Fig. 7 the drum rotates on ball bearings, and it is driven through the fixed planet gear z, which engages on the one side with the wheel r, connected to the motor spindle, and on the other with a hollow wheel mounted within the cable drum.

In another design the motor is also within the drum; but the epicyclic gearing is so combined with other gearing that a reduction ratio of 1 to 150 is obtained. The gears can be removed through a flap-door at the side without affecting any other part. The motor can be similarly removed at the other end.

In conclusion, it may be mentioned that the polyphase motor of the commutator type can also be used in this connection. It has no starting resistance, and the weight of these things is therefore saved. With reference to the special methods that are employed in the construction of such polyphase-driven blocks, the rotor of the motor is usually connected directly to the worm wheel. These motors are controlled by displacing the brush-carriers, and this is done by means of ropes which pass round a controlling pulley and are operated from the ground. As soon as the ropes are let free a spring drives the controlling pulley into the neutral position. The same result is produced automatically as soon as the load reaches its extreme position; the brushes are then brought into the neutral position and the current is cut off. The brakes are similarly worked automatically; they are removed as soon as the motor starts, and are put on when the current is cut off.

The Use of High-Pressure and High-Temperature Steam in Large Power Stations.

At the meeting of the Institution of Electrical Engineers on Thursday, November 21st, the following discussion took place on Mr. J. H. Shaw's Paper on the above subject (abstracted in our issue of August 16th):—

Mr. J. S. HIGHFIELD said the Paper weighed in a fair way the advantages against the disadvantages of using higher pressures than were used at present. A pressure of 200 lb. was considered high not long ago. The question was:—Could a higher pressure be used with advantage and would the efficiency be greater, having regard to the capital cost. The B.T.H. Company's experiments showed that 350 lb. was workable and advantageous, and the further plants that were being put down were sure to add to that knowledge. He hoped, however, that the developments that were going on would not prevent new additional plant being put down as soon as possible. He thought the most important difficulty was a metallurgical one—the provision of steel suitable for the boiler, tubes and steam pipes. The forcing up of pressures would probably lead to quite a jump in our knowledge of steel plates and metal under different conditions of heat from what we had been used to. The problem of the metal for the turbine blades would also introduce some difficulties, which would also lead to a further jump in our knowledge of metals.

Mr. A. H. ELLIS said he was struck by the number of assumptions in the author's figures. He assumed that 20,000 kw. sets were better than those we had at present. The steam consumption in some of the largest sets recently installed was 11·5 lb., and we had a long way to go to get down to the author's figures. If there were a gain on the turbines and a loss on the boilers, the total gain would not then be much. We had not yet used high-pressure steam long enough to know what conditions the metal got into. This week he had seen the heads broken off stud bolts from a turbine when tapped lightly. The temperature that had been on the turbine for two or three years was about 550 deg. Before going to higher temperatures one ought to find out whether they were safe. They were asked to consider 700 deg., which would mean about 1,000 deg. in the boiler house. Conditions were not the same in a commercial system as in the B.T.H. installation. Things were spread about more, and there were long mains, and the anchoring of steam pipes required consideration. The saving might be wiped out by the capital expenditure. A 77 per cent. boiler-house efficiency was not obtained either in this country or elsewhere in continuous work, especially with coal with 20 per cent. ash or incombustible. The maximum they could obtain was about 65 at present. If somebody could find a boiler which evaporated 10 lb. of water instead of 6 lb. per lb. of coal it would be better than going into metaphysics regarding high temperature on turbines.

Mr. N. PRENTICE said his advice was "do not use steam." He thought a good plan was to use a Humphrey pump and water turbine, the pump working on gas and pumping water against an artificial head, using the pressure of air to give the artificial head, and then taking the water from the boiler and putting it through the water turbine, and so driving the generator. In 1912 he asked for a licence to make a Humphrey pump, with a view to adopting this arrangement, but it was suggested that he should wait until the Siemens-Schuckert Company had finished their experiments with a 1,000 H.P. set of that kind, and, unfortunately, he adopted the suggestion.

Mr. H. M. SAYERS said he first used steam for electric lighting about 35 years ago. They used what was then a high pressure—120 lb. per square inch. By dint of a great deal of trouble he thought he had done pretty well when he got an output which might be defined as one ten-ampere arc lamp working for an hour for a boiler-house consumption of 5½ lb. to 6 lb. of Welsh coal. The last generating plant he was working gave 1 kw.-hour for, say, 2¼ lb. of anthracite peas and a little more of fine coke. That was through the medium of a gas producer and gas engine. They were faced with the difficulty that somewhere the heat of evaporation of the steam had to be thrown away, which meant throwing away a large proportion of the total heating capacity of the coal. He did not deprecate research and experiment, but there would be pretty soon reached a limit from the point of view of wear and tear.

Mr. P. V. MCMAHON said the author stated that one might get 22,000 lb. per hour + 9·54 lb. of steam per kilowatt-hour. He only made it 9·2 lbs.

The AUTHOR said that was for 200 lb. pressure, 150 deg. superheat. It was arrived at by taking the total amount of steam (225,000 lb.), deducting the no-load loss (22,000 lb. of steam), and dividing by the output of 19,485 kw. hours.

Mr. A. P. M. FLEMING agreed that the metallurgical side would want enormous attention. Insufficient attention had been paid to it hitherto.

Major A. M. TAYLOR said he desired to congratulate the author on a laboriously compiled and very valuable Paper, and only regretted that he was forced to criticise where there should be nothing but praise. He thought the author had done insufficient justice to the cause for which he pleaded. He would attempt to show by a profit and loss account, taking the author's own figures (foot of columns (4) and (10) of schedule 1), that financially it would not be successful unless a load factor of nearly 100 per cent. could be realised. In the "Creditor" column he would put the figure obtained by taking 50 L.F./100 L.F. × £4,800 = £2,400 (for a 50 per cent. load factor). In the "Debtor" columr he would put:

1. Shortened life, from, say, 15 years to, say, 10 years, and consequently increased depreciation from, say, 7½ to 10 per cent. per annum. Take the capital cost of boilers, pipework, turbines (excluding cooling towers or condensers) at, say, £5 per annum—£100,000 total cost. Thus, 2½ per cent. extra depreciation on this means £2,500 per annum.

2. Increased radiation losses (standing). Take 10 per cent. on 6,200 tons of coal at 10s. = £310 per annum.

3. Ditto on turbo. Losses 10 per cent. on 15,000 tons = £750 per annum. Total "Debtor" account = £3,560 per annum (2,500 + 310 + 750).

There was thus a *loss* of £1,160 per annum. With a better load factor

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there would be undoubtedly a saving; but, on the two columns of schedule 1 selected by the author, one would not get a saving till nearly 100 per cent. load factor was reached. Had he (Major Taylor) pitched the extra depreciation too high? Even if only 1½ per cent. additional depreciation were taken, corresponding with a reduction in life from, say, 15 years to 13 years, the Dr. and Cr. accounts only just balanced at 50 per cent. load factor. He was sure nobody would dare say that 1½ per cent. extra depreciation was too much to allow. The author of the Paper had in any case done excellent work in putting on record for members of this Institution the case both for and against the innovation; and in a competent manner.

Mr. G. W. PARTRIDGE said no doubt the use of high pressure and temperature steam would come. Mr. Highfield and another member had referred to the alteration in the molecular condition of steam pipes and boiler plates owing to the high temperatures. He had seen steam pipes taken out of the range and a blow from a hammer had broken off the whole flange. Crystallisation had taken place all round the flange. The author ought to have got easily 7 lb. evaporation of steam per lb. of coal. The author suggested using a Lancashire boiler for dealing with all feed water of the station. In his case for nearly two years the feed water had been taken through one Babcock boiler, so that the whole of the rest of the battery had only been evaporating water, and all the loss in the blowing down of boilers, as well as much time and labour in cleaning, was saved. The same arrangement had been used satisfactorily in Holland.

Mr. W. R. COOPER thought it would have been better if the author had expressed his results in thermal units instead of lbs. of coal. 20 per cent. of ash in the coal was an exceedingly high figure. The boiler-house efficiency of 77 per cent. assumed by the author had been, he thought, unfairly criticised. If the boiler-house efficiency were 65 per cent., as had been suggested by one speaker, one could understand the consumption of 5 lb. or 6 lb. per kilowatt-hour, which was often found. Efficiency figures in excess of those quoted by the author were obtained in this country, and similar figures were obtained at Connors Creek (U.S.A.), where the thermal consumption per kilowatt-hour for the whole year was about 20,000 B.Th.U., with 40 to 50 per cent. load factor, and without economisers. The difference of £1,900 in £65,000 for coal, mentioned by the author, seemed comparatively small, and would probably be outweighed by debit charges.

Mr. PERCY ROSLING said coal at 10s. a ton was mentioned. He did not know when that would be seen again. The author might have put it at 20s. and doubled the profit.

Mr. E. T. WILLIAMS drew from the Paper the conclusion that there was nothing to justify extra high steam pressures. There were so many unknown factors that they would have to go very carefully. He thought anything exceeding 300 was problematical at present. With 250 lb. and superheat the temperature could be controlled, but with higher pressures without superheat one had not the same control over the temperature. Further experiments should be carried out in using gas, oil and tar oil under boilers. It was anticipated that oil could be got at reasonable figures in the near future. In a station with which he had been connected they reached for a time the lowest coal cost in the country. They found the figure with the highest output was not the most economical figure, and the best results were obtained by over-running the boilers over the peak and working at the economical load for the remaining hours. One should be guarded in taking the results of special rather than working experiments, as in the former case everything was specially prepared.

Mr. P. F. ALLAN said he was sorry the author had not been able to show a better saving to set against the capital cost, and he did not think sufficient stress had been laid on the fact that maintenance was, as a rule, a fairly large proportion of the cost per unit, and was likely to be increased by these increasing pressures. He did not share the fears of other speakers as to the metallurgical difficulties. Possibly a great deal more had been done during the war in the way of experimenting with new metals and materials and methods than most people realised. Higher pressures were used at sea than on shore, and the conditions of usage were worse, but the troubles as to crystallisation of pipes did not seem to be greater. He felt that the greatest danger they had to contend with was the question of cost, and the author's showing was not very hopeful. He agreed that the boilers and turbines should be considered together. He hoped that the use of oil and gas under boilers would give them the opportunity of reaping greater benefits from the increased pressures than had been shown by coal. They were not at the present time able to get the high capacities they wanted, but it must be remembered that slow speed and low capacities meant enormous cost of electrical plant, and they also meant that one was prohibited from using the high tensions desired. That had to be taken into account when assessing the total cost per unit.

Mr. FLETCHER said over 90 per cent. efficiency could be got out of the generators, and it was only on the prime mover one could hope to get increased output. When exhaust turbines were first brought to notice he arranged for one to be installed. It was an unfortunate day. From the thermo-dynamic point of view, on the entropy chart, his turbine looked splendid; but he found he had not 1½ per cent. The matter of high temperatures and pressures seemed to be one for investigation. No one could say what the results would be until more had been learnt as to the effects of high temperatures on machinery and materials.

Mr. F. W. LEVERS said he would like to see more attention paid to the steam raising than the steam using side of the station. One thing that caused trouble in the boiler house was the valves. Some years ago he tested the Neasden valves at double the working pressure and superheat (180 lb. and 180 deg.), and the results were rather disastrous so far as British makers were concerned. Finally, the set was started up with German made valves. So far as valves were concerned, he did not see that a great deal of improvement had been made. Twelve years ago they were experimenting with nickel steel valve spindles containing 32 per cent. of nickel, and with nickel alloy seats containing 90 per cent. of nickel. To-day we had got as far as 7½ per cent. nickel for the spindles, with a kind of copper alloy containing very little nickel for the seats. There was more scope for economy in the boiler house than in the station itself.

Mr. R. M. BAKER also thought the author's case for very high pressures was not a strong one, considering the high capital expenditure. He could not speak with authority of what was likely to happen in this country, but he would not have high pressure or high superheat in India, where attention to plant was unreliable.

The AUTHOR, in reply to the discussion, said he had not set out to prove that high pressure and high-temperature steam was the right thing, but to draw a just balance, although he thought, if he were putting up a station, he would use high pressure and temperature. Mr. Highfield's remarks bore out part of the discussion at Leeds, where a gentleman related that he had to use very high temperature steam in Australia, and the superheater tubes lasted about two weeks. He believed that was with low-pressure steam. Then he tried wrought-iron gas piping, and it lasted six months. In the works he was connected with they used steam at 580 deg., and they used studs of what the Germans called stahleisen, also steel with high nickel content. Valve makers were coming back to using ordinary mild steel for the lower parts and cast steel for the body and discs. At the Valley-road (Bradford) station a cast-iron disc which was not subjected to more than 450°F. split right through, and they had had cast-iron valves on their turbines go, and had had to replace them by cast steel. With regard to the difficulty of keeping the air out of the water, at Valley-road they used a feed tank with vent piping and condensate pumps, and the water came along and discharged into the suction and the feed pumps; the feed tank was connected to it, so they hoped the water went direct to the feed pumps, and the level of the water in the feed tank went up and down, giving a sort of hydraulic balance. In reference to Major Taylor's remarks, he (the author) did not think that, except if very large sets and boilers were considered, the capital cost was going to be much more for say, 350 lb. pressure than for 250 lb. In the two figures in his schedule referred to by Major Taylor the temperatures were 638 deg. and 686·4 deg. respectively, and maintenance was going to depend on temperature more than pressure. In reference to Mr. Williams' remarks regarding the use of high temperature instead of high pressure steam, there was not a lot of saving to be shown; but the more one superheated at a constant pressure the more heat there was to reject at the condenser. He maintained that he was right in saying the boilers and turbines should be considered separately, otherwise the latest marine type high-pressure boiler might be stuck up against a turbine built for high pressure, and compared with a 250 lb. pressure station, which would be unfair. At Valley-road they were taking out four 1,000 kw. sets, and the cost of the plant they were putting in was less than the cost of the building covering the slow-speed plant. They used cast-steel discs and nickel-copper facings in the valves. They did not use 3 per cent. of nickel now. The valves were made of ordinary mild steel.

On the motion of the PRESIDENT, a hearty vote of thanks was accorded the author.

Social Obligations of Industry.

At the Manchester College of Technology recently Mr. B. Seebohm Rowntree gave the second of a series of lectures arranged by the Department of Industrial Administration of the college. His subject was "Social Obligations of Industry to Labour," and he affirmed that industrial enterprise was only justified if it could answer in the affirmative a threefold question. It must produce something of service to the community, something under good conditions and something which could be placed upon the market at a reasonable price. There was a movement amongst certain manufacturers to try to raise the public taste in the goods that they manufactured. As to the conditions under which goods were produced, he ventured to say too little attention had been directed to that aspect of industry. Employers owed it to their workers to see that the material conditions under which they worked were satisfactory. Of those conditions, the most important was that of the weekly wage. He explained in detail statistics he had prepared as to what wage would enable a man and his family to live and to provide, not only for food and housing, but for clothing, recreation, insurance and other necessaries. Under present conditions, no man of normal ability should be allowed to work at less than 44s. a week, and no woman at less than 25s. a week. That only allowed a dietary more economic than that given to paupers and prisoners, and only what was necessary to maintain a man in efficiency for moderate work. If a man had more than three children, the State should, for such time as those additional children were dependent upon him, provide him with 3s. per week in respect of each. That would work out at about eight millions—about one day's cost of the war. Mr. Rowntree urged that it was to the great advantage of production that workers should be allowed sufficient leisure for recreation and other matters, and that more attention should be paid to the environment of the worker.

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Co-operation Between Engineering Societies.

In the period that has elapsed since the inauguration of the United Engineering Societies Building in New York in 1907 there have been ample opportunities of judging the utility of the step, and the great stimulus which it has afforded to co-operation between leading engineering and scientific bodies. The step was taken at an opportune moment. The co-operation of several leading engineering bodies was at once secured, and since then even those institutions which originally held aloof have found themselves forced by the tendency of events to accommodate themselves and participate. The American Institution of Civil Engineers, for example, which enjoyed a somewhat unique position by reason of its prestige and old-established procedure, afterwards joined in the scheme, and this belated action involved the erection of a supplementary floor to the main building, which is quite obviously visible in the adjacent illustration.

THREE ADDITIONAL FLOORS JUST COMPLETED, JANUARY, 1918. (COST £60,000)
THIS IS THE ENGINEERS' CLUB
(which is directly connected with the Engineering Societies Building)

UNITED ENGINEERING SOCIETIES BUILDING IN NEW YORK.

The fundamental advantages of such a coalition of interests are beyond dispute. A common building makes possible a freedom of intercourse, and a breaking down of the artificial barriers between professional bodies which could never be attained with the water-tight compartment system of working still existing in this country. A single institution which has a lecture hall of its own cannot fill it every evening; many nights are necessarily unused, and this means waste. Some Papers, again, are of necessity of somewhat limited interest to many members, and are poorly attended, although they might appeal strongly to many members of other institutions. When an adequate series of lecture halls of varying sizes can be located in a single building, they can be used in regular sequence. With the offices of all the chief technical bodies near at hand, joint discussions can be quickly and easily arranged. Announcements on the common notice board are at once brought before all the frequenters of the building, so that each society, besides the support of its own members, can reckon on a considerable floating attendance from stray members of other bodies interested in any particular meeting.

With all the offices of the respective societies located in the same building joint action is greatly facilitated. Those of us who have had the fortune, or misfortune, to serve on some of the very numerous technical committees established since the outbreak of war are fully conscious of the inconvenience of periodical journeys to all parts of London. The time occupied would be much reduced if it were a standing practice to hold all such meetings in a centrally situated United Engineering Societies building.

Even more important are the advantages which accrue from the pooling of expenses which such a building makes possible. The joint expenditure is immeasurably smaller than if each institution had to maintain a building of its own. Even the most wealthy bodies would gain in this respect, while there are many smaller ones which cannot afford a lecture theatre or offices of their own, but would gladly share in the corporate life of a united building. The gain in the social direction would be also great. Even when engineering bodies in this country possess a building of their own they have not, as a rule, the resources to do much for the comfort of their members. The buildings are in no sense "clubs," but merely somewhat chilly houses for the reading of Papers or discussions. They afford opportunities for technical study without the lubricant of social intercourse. A United Engineering Societies building, on the other hand, could easily afford an adequate restaurant, smoking rooms and other attractions of clubs; even if not in the main building they might be closely adjacent.

Of all the advantages, however, probably the most important is the great gain secured by the collection of a joint library, adequately housed and arranged and presided over by an efficient and competent librarian. The libraries of most of our institutions are notoriously incomplete, badly arranged and little patronised. Many of the smaller bodies have miniature collections of works which can hardly be called libraries, but would be of undoubted value if incorporated in the general stock.

All these advantages have been enjoyed for some years by the engineering bodies in the United States. We have before us a most interesting account of the Library Service Bureau, which, for a moderate subscription, secures to members many advantages besides the use of the library itself. The work includes the provision of periodical reference cards to specific subjects, the copying, abstracting or translating of articles at a low figure, the preparation of photographic copies, the compilation of statistical data, and the conduct of searches in connection with patents. The library at present contains over 150,000 volumes on engineering, and receives currently over a thousand engineering periodicals. The utility of the inquiry branch of the work is illustrated by a map of the United States covered by dots, corresponding to the places from which requests for information have been received. Many of

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these inquiries come from the most remote quarters, and thus membership carries valuable privileges even at long distances from headquarters.

While we thus dwell upon the tangible advantages of the Engineering Societies building we should like to add that the "intangible" influence of the step has been equally great. We in England have for some years been uneasily conscious of the tendency towards decentralisation of scientific and engineering work. That with extending knowledge there must be specialisation, all will agree. But if the broad field of common interest in technical matters is ignored, if each branch of engineering and technical work drifts away on its own course without consideration for any other, not only are the true interests of engineering as a whole prejudiced, but we are storing up anomalies and discrepancies of nomenclature, method and practice which may require tedious and difficult correction in the future. From another standpoint—the relation of science pure and applied to the non-technical public—this extreme specialisation is unfortunate. We have lost contact with the public, we have failed to secure for science and engineering their due place in the public esteem, largely because we have lost the art of presenting our aims in an intelligible form, and because we have at present no body with a voice to speak for engineering as a whole.

In the United States, incidents during the war have shown quite clearly the emerging of this authoritative voice. The Engineering Council in that country appears to have simplified greatly the problem of securing the proper appreciation of the value of trained engineers for war service, and we have quoted from time to time instances of the recognition by the United States Government of the need for husbanding the supply of the engineers of the future at the chief technical colleges. We can see that the spirit of concerted action in the engineering world will be a great force towards fuller representation of their interests in high quarters. Are we in this country in a position to secure similar consideration for science and industry in the vast social and industrial changes which are foreshadowed in the future?

We fear not. We believe that the engineering industry and the forces which represent the application of science in the service of the nation will receive attention only when there exists a powerful body to make these broad claims heard. And we think that one of the first steps towards this habitual co-operation in engineering matters should be the establishment of a common home where all engineers can gather together and the necessary basis of common action, which in no way prejudices individual action in each respective field, can be built up.

The Economics of Works Costs.

By J. R. DICK, B.Sc.

Summary.—This article deals with the following points:—(1) Symbolic statement of economic laws in general. (2) Law of rent in the agricultural industry. (3) Rent as a function of productivity of the soil. (4) Kelvin's law compared with law of rent. (5) Royalty for manufacturing processes a species of rent. (6) Law of diminishing productiveness in other industries besides agriculture. (7) Factory costs and their object. (8) Analysis of their components. (9) Labour charges, day-work, piecework and premium systems in relation to workman's productivity. (10) On costs or shop charges in general. Part of the oncost is a function of the productivity of the machines. (11) Hyperbolic laws of the capital cost of machines and the running expenses per unit of product. (12) Effects of increasing output. (13) Relation of machine oncost to direct labour cost. (14) Indirect labour and other shop charges. (15) Limits of accuracy in expressing oncosts generally as a linear function of the direct labour. (16) Relative values of direct labour and shop charges, with examples. (17) Establishment charges—how they are allocated. (18) Selling price inclusive of profit—how ascertained. (19) Relative importance of the cost factors. (20) Instances where materials preponderate in the cost—Cable making—Foundry work. (21) Where invested capital cost preponderates.—Electricity supply.

Use of Symbols and Simple Algebraic Formulæ in Economic Problems.

In one of his pungent criticisms of engineering education, Prof. Perry has said that "the average boy learns what is called mathematics in such a fashion that he hates the sight of an algebraic expression all his life after." Possibly, for this reason, many of the writers on current economic questions conspicuously avoid the use of a simple equation or curve to illustrate the principles they discuss, and thus involve themselves in lengthy explanations, which could be clearly summarised into an algebraic formula.

The mathematical treatment of the fundamental problems in economics, such as the theory of value, exchange, rent of land, &c., has been attempted by many experts such as Jevons ("Theory of Political Economy") and Wicksteed ("Alphabet of Economic Science"). Their mode of handling the subject is not merely by the use of mathematical analogies, but is an endeavour to introduce a real calculus of economics, for generalising in a quantitative form the laws of the science. In this article it is not proposed to touch these wider questions, but to show the utility of simple formulæ in investigating some practical aspects of the costs of production of engineering commodities in factories and workshops.

Algebra may be criticised as a purely mechanical means for examining economic problems, when compared with the literary style of Mill, or the apt parables of Bastiat, but it should appeal to the engineer by its power in certain cases to translate general principles into quantitative terms, which is one of the best ways of avoiding ambiguity.

Rent in Agricultural Industry. Rent as a Function of Productivity. Effects of Productivity.

At first sight Ricardo's theory of the rent of agricultural land may appear to have little bearing on the phenomena of manufacturing industry, but Mill and others have pointed out that no consistent explanation could be given of many of them without a clear understanding of this cardinal doctrine of political economy. Its representation algebraically will, it is hoped, achieve two objects. Firstly, it presents an economic principle in a condensed form, and secondly, it establishes a fundamental formula, which, correctly adapted for the quantities current in manufacturing, has a wide application.

If Q is the number of quarters of grain produced per acre, and sold at s pounds per quarter, then, for a certain kind of land,

$$Qs = rI + L \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where I is the farming capital invested, per acre, r the rate of interest, and L the labour per acre, inclusive of superintendence.

On another variety of land cultivated with the same skill and efficiency there is a higher yield of pQ quarters per acre (p being greater than unity), and if the quantities s, r, I and L are the same as before, then

$$pQs > rI + L$$

or

$$pQs = (rI + L) + R \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The quantity R is called the rent of the land, and (2) is the symbolic statement of Ricardo's theory of rent.

The conditions in equation (1) are such that the average

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annual revenue over a number of years covers only the labour and running expenses, together with the minimum ordinary interest on the farmer's capital. Land of which this is true is said to be on the margin of "cultivation," and it serves as the standard of comparison for all other varieties. No land of inferior quality would continue to be cultivated, even rent free.

From (1) and (2)

$$R=(rI+L)(p-1)=Qs(p-1) \quad . \quad . \quad . \quad . \quad . \quad (3)$$

which exhibits the rent as a function of the quantity p, called the productivity of the land.

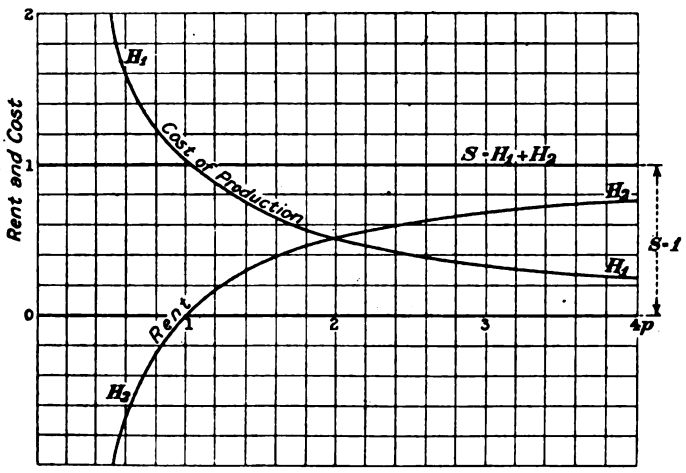

FIG. 1.

The value of p depends on the natural fertility of the soil, the improvements due to previous cultivation and the transport facilities for disposal of the crop. The selling price s is, of course, identical for all the grain in a district, and is fixed by competition. Should it rise considerably, the land whose productivity was unity, and previously taken as standard, will then be able to show a surplus profit over the bare items of annual expense $(rI+L)$, and if the terms of his contract permit, the landlord will endeavour to obtain a rent equal to the whole of the surplus. The converse statement of the theory of rent is quickly recognisable from the equations (1) and (2), *i.e.*, the rent of land is not a factor in fixing the selling price of the grain, as this is governed by the cost of the product from the worst land then cultivated, or $(rI+L)$. The position of the land of unit productivity rises or falls with s at any time, and s again is dependent on the current demand for grain.

On a fertile soil, although the rent charge does not alter the competitive selling price per quarter, it forms an important element in the analysis of that price.

From (2) and (3)

$$pQs=(rI+L)+Qs(p-1) \quad . \quad . \quad . \quad . \quad . \quad (3a)$$

or

$$s=\frac{rI+L}{pQ}+s\left(1-\frac{1}{p}\right). \quad . \quad . \quad . \quad . \quad . \quad (3b)$$

The first of these two expressions $\frac{rI+L}{pQ}$ or $\frac{s}{p}$ is the true cost of production per quarter, where the yield is pQ quarters per acre and the second term, $s\left(1-\frac{1}{p}\right)$, is the proportion per quarter of "excess profit" or rent claimed by the landlord. If the productivity of a farm had a very high value the rent charge would ultimately become the only appreciable factor in the total costs and price, and the actual cost of production would be negligible in comparison. Ricardo's theory shows that the agricultural is differentiated from other industries by the fact that the farmer obtains no advantage from a larger average turnover per acre, as the excess profit all goes to the landlord. The cost of production per quarter $\left(\frac{rI+L}{pQ} \text{ or } \frac{s}{p}\right)$ varies inversely as the productivity p and the graphs of both the "costs" and "rent" factors, as functions of p, are hyperbolas. As we shall see later, this hyperbolic relation is frequently met in other industrial problems, where the efficiency of working or surplus profits per unit of product can be expressed as a function of the productivity of the corresponding investment or labour charges. With a yield of pQ the rent per acre is $R=Qs(p-1)$, which is a linear function of p, while the proportion of the rent distributed over each unit of product (or per quarter) is $s\left(1-\frac{1}{p}\right)$, giving a hyperbolic relation with p.

In many cases of engineering efficiency there exist the two alternative equivalent ways of expressing the same relationship, either as a straight line law when dealing with aggregate quantities, or as a hyperbolic law when dealing with the variations per unit quantity considered.

In Fig. 1 the hyperbola H_1 indicates the variation of the costs of cultivation with p, and the hyperbola H_2 is the graph of the rent charge per quarter as a function of p.

The sum of the ordinates at any point is constant and is equal to s, the selling price.

KELVIN'S LAW COMPARED WITH THE LAW OF RENT. PRODUCTIVITY OF ELECTRICAL DISTRIBUTION PLANT.

Kelvin's law for the maximum efficiency of an electric cable already laid is a particular case of the law of rent. The cost of working the cable can be divided into two parts, each of which is a function of the load or current C. The first of these is the investment charge per ampere carried by the cable of the form A/C, where A is a constant, and the second is the energy loss or running charge of the form $B.C$, where B is a constant. The cable may be regarded as endowed with productivity p as C is increased to pC, and the graphs of these two expressions A/pC and BpC as functions of p are a hyperbola, H_3, and straight line L_1 respectively (Fig. 2). The resultant curve from the summation of the ordinates of H_3 and L_1 has a minimum value, where the two are equal. The total costs per ampere of load are, therefore, a minimum when p is chosen to correspond with that point. The radius of curvature of the resultant curve is large to the right of the best value of p, and a considerable overload is therefore allowable without any serious diminution of efficiency. In fact, the resultant of the straight line and hyperbola (which begins to approximate also to a straight line) will give a nearly constant value for a fair percentage rise in p above its best value. Hence, we get a set of conditions almost corresponding to the synthesis of the total cost per quarter of grain, with the similar result of a constant value for the total costs. It is this fact which justifies those engineers who may be a little contemptuous of Kelvin's law, and design their cables for a maximum temperature rise only. The

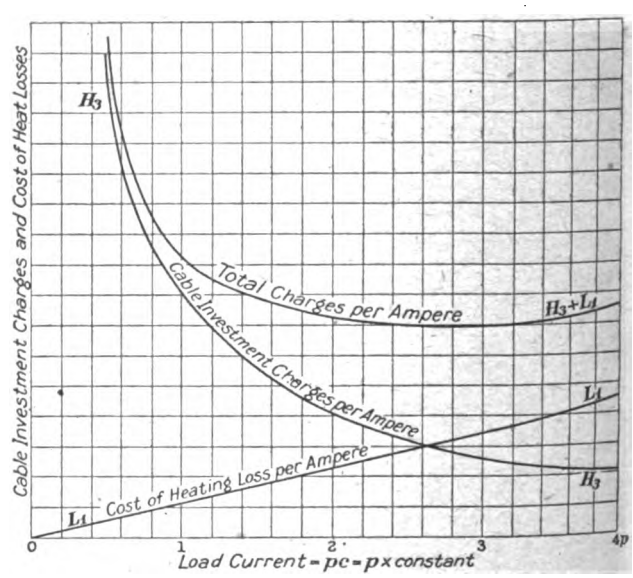

FIG. 2.

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value of the safe working current often lies in the flat part of the resultant curve of L_1 and H_3, and thus approximates to the best value The rule-of-thumb may therefore be right, but it is of interest to see why it is right.

ANALOGY BETWEEN RENT AND ROYALTIES IN MANUFACTURING.

In a manufacturing business the royalty paid for the use of a patented process is closely analogous to rent in agriculture, and thus it ought not generally to affect the competitive selling price of the goods. It is simply the bonus or proportion of "excess profit" which the licensee is prepared to pay to the inventor as his return for the superior productivity or profit earning power claimed to distinguish the new process from the older ones. Royalties under a patent agreement are difficult to fix exactly, as there are no prior results to guide the parties, and the usual plan is to reckon them as a percentage on the value of the output sold. Both parties, therefore, benefit by an increase of output. Rent, on the other hand, is a fixed contractual payment, based on records of the produce of the land over a series of years. The landlord, as long as the lease runs, has no financial interest in any improved turnover, and the farmer generally finds it difficult enough to exceed the average annual yield on which his rent charge was calculated.

"Excess profit" as a war tax embodies no radical innovation; its intention was to equalise industrial opportunity, and to secure to the State the surplus earned by those favoured with lucrative war contracts either direct or proximate, just as the landlord levies a high rent on specially productive land.

The principles governing rent and royalties outlined above are only true where no absolute monopoly exists in the property, whether land or manufacturing process. The owner must actually by bargaining find some user willing to pay the surplus value associated with increased productivity.

The idea of "productivity," although originating in agriculture, our oldest and most permanent industry, is of great importance in examining the various elements of the costs of production in other industries. In its primary conception productivity appears to be in great measure a free gift of Nature. There are few industrial enterprises, however, where man's ingenuity and effort fail to improve the productivity and to obtain enhanced returns analogous to the rich harvests, which Nature's agencies yield on fertile soils under man's cultivation.

LAW OF DIMINISHING PRODUCTIVENESS IN AGRICULTURAL AND IN OTHER INDUSTRIES.

One of the most important aspects of the law of rent is that the selling price is determined by the cost of production on the worst land in cultivation. This apparent anomaly may lead the careless observer to suggest the cultivation only of very fertile lands. Unfortunately the demand for grain by the human race outstrips the supply from lands in this category, and others must be included.

Another proposal sometimes made by those who object to rent, or think it adds to the price of grain, is to cultivate the land intensively and secure the requisite amount of grain in that way. This proposal is ultimately equivalent to lowering the margin of cultivation. From the equation (1) it is clear that an increase in the yield from Q to pQ can only be effected by applying more capital, or by using more labour. But it is a law of Nature that increments of capital and labour in the cultivation of the same piece of land have a diminishing effect, and to secure the improvement of Qs to pQs, the cost advances from $rI+L$ to $(1+x)\ (rI+L)$, and $x(rI+L)$ will after a number of repeated increments exceed the corresponding increment in the value of the yield or $Qs(p-1)$. This is the law of diminishing productiveness, which is true of industry in general. Engineers are familiar with many of its forms, and know how useless it is commercially to try and increase the efficiency of a machine of a definite size or duty beyond a certain limit, by making it more costly. A well-known instance is found in the design of the electric transformer, and another is Kelvin's law already discussed.

The basic principle for fixing the selling price of grain is clearly visible also in the case of manufactured articles. If the demand is such as to induce the production of the same article in factories of different efficiencies, the one with the highest working expenses will control the price. The others will have higher profits due to their superior productivity, while selling at the same price. Below this figure it is obviously unnecessary to go, as long as a demand for the *output of all the factories is maintained.*

The wages of labour are also subject to a law analogous to that of the "margin of cultivation." With a sustained demand a manufacturer will employ very inefficient labour, provided the barest margin of profit is realisable on its output.

In making deductions from equations, such as those given for Ricardo's law, certain precautions must be observed. Human nature will not, in every individual, conform exactly to the general tendency of the mass of individuals represented in the formulæ. For example, the value of the theoretical rent might be described as fixing the point of stable equilibrium round which only small variations can occur, but a shrewd farmer will often succeed in deflecting the value of the rent to his own advantage, and will pay considerably less than the "rack rent" or entire surplus profit. Similar powers of bargaining may favour the manufacturer working under royalty, and the solution of these business problems in detail is more picturesque than suggested by the equations. A long lease in the case of a farmer, or an agreement for the life of the patent in the case of a manufacturer, will often enable them to obtain profits in excess of $(rI+L)$. The tenant or licensee by the length of tenure is encouraged to devote extra capital of his own to the development of his business. On these terms of working for land where $R=0$ the equation at starting is $Qs=rI+L$, as far as the tenant is concerned. By incurring an extra annual expense of $x(rI+L)$ the yield becomes $pQs=(1+x)\ (rI+L)+R'$, where R' is the farmer's additional profit or "tenant's rent," and

$$R'=(rI+L)\{(p-1)-x\},$$

or, alternatively

$$R'=Qs\{(p-1)-x\}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

As already indicated, in farming any further increment of $x(rI+L)$ or xQs, will, at a certain stage in the operations, exceed the corresponding additional yield of $Qs(p-1)$, and R' becomes negative. The land, in fact, refuses to react to repeated doses of capital and labour except in a diminishing and uneconomical ratio.

It soon reaches what might be called its saturation point of productivity, in the same way that an attempt to increase H beyond a certain point on the B-H curve, when designing a magnetic circuit, affords no appreciable advantage.

In manufacturing operations the condition of saturation is not so clearly marked as in agriculture, since the productivity of large scale repetitive work done by machinery is often susceptible of almost indefinite improvement.

In these circumstances the tendency of cheap production from large factories may be to drive the small scale producer out of the market. The larger producers with their margin of potential profit on low works costs may, in the interests of developing a wider market rapidly, get their selling price so close to their costs that there is no prospect of survival for the small concern *in a market that can otherwise be fully supplied.*

(To be continued.)

Aeroplane Rontgen Outfits.—According to "Nature" a "radiological aeroplane" was recently described by Drs. Nemirowski and Tilmant before the Academy of Medicine of Paris. It contains three places for the pilot, surgeon, and radiographer, and is provided with a generator for Röntgen-rays, and an operating-table for operations performed with the aid of the rays, surgical instruments, and medicaments. The "Aerochir," as it is called, is intended to fly over the lines of action, ready to alight and render first aid to the wounded. The invention should be valuable, provided, however, that it is not regarded by the enemy as a target for his fire.

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Correspondence.

A SCIENTIFIC BASIS FOR COSTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Probably most people have felt that the value of the present discussions on large versus small stations lose their value owing to the fact that there is no scientific basis by which to compare their costs. The existing tables, valuable as they are, do not really enable us to compare one station with another, as the conditions are so different. One station may have the same coal costs as another, and yet be using twice as much coal, the difference arising from the rate at which the coal is purchased. Then we have not sufficiently made it clear in our tables that generation costs are only part of the total costs of supply. The cost of distribution may be of far greater importance.

It is very desirable that a scientific basis should be evolved by which the real efficiencies of electricity stations could be accurately compared without reference to such accidental items as the rate of wages, the price of coal, and the rate of interest and sinking funds. Some stations pay more than twice as much into sinking funds as others, and this prejudices their results in the eyes of the inexpert public. The expert should have a means for eliminating anything of that kind when he makes comparisons. We might, for instance, take the ratio of the thermal units of the fuel to the thermal units in the electrical energy delivered by the station to the feeders. Labour might be reckoned as if paid at a standard rate. Careful consideration would evolve a scheme of comparison which would be both equitable and useful for the purposes of the present discussion, and also for many other purposes.

Having obtained a basis by which the generating costs per unit might be arrived at, we need then to arrive at the distribution costs, made up of the whole of the charges involved, such as labour, transforming losses, cable losses, and by no means least, interest and sinking fund charges. It would be found that in many cases the cost of distribution is far more important than, say, coal costs. As has been shown by Mr. Pearce and Mr. Fedden, it may pay to place a station at a situation which is not particularly favourable rather than go further away for an ideal site. This important fact, however, does not have the place in our tables of costs that it should have. If distribution costs were set out in costs tables as a separate item, just as fuel costs are, it would throw a great light on the reason why some stations do well while others do badly. It would also clear up many obscure points in the discussions relating to the super-power stations. Just whether it proved that they are desirable or whether it showed that a multitude of small stations is better, should be carefully kept out of sight until the end. What we want now is a clear and accurate statement of facts without bias to one opinion or the other.

Some years ago I proposed the term Distribution Factor for the distribution costs per unit sold. The idea did not then receive much attention, but the time now seems opportune for the revival of the idea.—I am, &c.,

North Shields, Nov. 23. C. TURNBULL.

CLOSE OF WAR MATTERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Perhaps you would kindly allow me the hospitality of your columns to mention two points which I think might be of interest in connection with the close of the war, and in respect of which inquiries are being made. The first point is with regard to demobilisation. It will be of interest to electric supply companies to know that my Committee has taken the matter up with the Authorities so as to ensure that the electric supply industry is placed among those "key industries" which are entitled to priority in regard to the return of their men in the Army, as we are certainly justified in claiming that among the first men to come back should be those who have left important posts in the electric supply industry.

A further point is in regard to the restrictions placed by the Ministry of Munitions on new connections for the supply of electricity. My Committee has taken this matter up with the Ministry of Munitions in order to get the removal of these restrictions directly the situation permits. It will be seen from the following letter that we have had the full sympathy of the Department, and that the Director of Electric Power Supply has taken what steps he could to assist us in this matter.—I am, &c.,

London, Nov. 22. T. W. COLE.

The following are the letters to which reference is made:—

[COPY.]

Ministry of Munitions of War,
8, Northumberland-avenue, Nov. 14, 1918.

T. W. COLE, Esq.,
Provincial Electric Supply Committee of the United Kingdom.

COAL ECONOMY AND NEW BUSINESS.

SIR: I am directed to refer your letter of the 14th inst., and to say that, while we are all anxious to relax restrictions as early as possible, the Coal Controller considers it necessary to adhere strictly to the rationing scheme under the Household Fuel and Lighting Order.

I have, however, already addressed a letter to him on the question of policy, and am hopeful that before long some definite and favourable pronouncement may be possible. In the meantime the present practice should continue.

I am, Sir, your obedient Servant,
(Signed) ARNOLD B. GRIDLEY,
Director of Electric Power Supply.

Ministry of Munitions of War,
8, Northumberland-avenue, Nov. 21, 1918.

T. W. COLE, Esq.,
Provincial Electric Supply Committee of the United Kingdom.

COAL ECONOMY AND NEW BUSINESS.

SIR: With further reference to my letter of the 14th inst., I have to inform you that I have now had a letter from the Coal Controller, in which he states that he regrets that until the coal situation improves it is impossible for him to agree to any relaxation of the present restrictions.

You will no doubt have observed that this has been recently announced by him in the Press.

You may, however, rest assured that as soon as circumstances admit of restrictions being modified or withdrawn this will be done, and the electricity undertakings notified accordingly.

I am, Sir, your obedient Servant,
(Signed) ARNOLD B. GRIDLEY,
Director of Electric Power Supply.

ENTERTAINMENT OF U.S.A. AND OVERSEAS TROOPS AT CHRISTMAS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: At this time of rejoicing every one of us desires to express gratitude to those who have helped to protect our homes. Thousands of overseas troops will be on leave over Christmas, and unable to mingle with their own folk at home. I desire to appeal to your readers on behalf of the Rotary Club of London to open their homes to one, or preferably two, of these boys. All imaginary difficulties are surmounted. The characters of the guests are vouched for, the railway fares are paid, they will have their food ration books, and, if the hostess has servant difficulties, nothing gives the guests greater pleasure than to assist as they were accustomed to do in their own homes. We have to bear in mind that to them even a humble home is as a palace compared to the average hut or canteen.

Will those of your readers who can help please communicate with me by return?

Trusting that this appeal to my fellow countrymen will not be in vain.—I am, &c.,

147, Queen Victoria-street, JAS. T. MOULD.
London, E.C., Nov. 21.

[We have received a similar letter from Mr. Joseph Meech, of Electromotors Limited, 49, Queen Victoria-street, London, E.C.—ED. *E.*]

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Electricity Supply on the North-East Coast.

In our issue of the 1st inst. we announced that the Parliamentary Committee of Newcastle-upon-Tyne Corporation had issued a report criticising the proposals embodied in the interim report upon electric supply in Great Britain of the Coal Conservation Sub-Committee of the Reconstruction Committee and in the report of the Board of Trade Electric Power Supply Committee. It was also stated that a reasoned statement had been prepared by the Town Clerk of Newcastle (Mr. A. M. Oliver), which represented the views of municipal electricity undertakings on the North-east Coast, and that this statement would be presented to the President of the Board of Trade and the Minister of Reconstruction. This course has now been taken, and we give below an abstract of the statement which represents the views of the Corporations of Newcastle-upon-Tyne, Middlesbrough, South Shields, Stockton-on-Tees, Tynemouth, West Hartlepool and Berwick.

The Municipalities concede that the unification of the production and distribution of electrical energy for areas sufficiently large but carefully defined is desirable, provided that the best use is made of existing systems of generation and distribution, that the generation and distribution of electrical energy is under local public control, and that proper and reasonable safeguards are adopted in the interests of existing undertakers and consumers, and in particular that those municipal undertakings which by their situation, equipment and other circumstances can, in the opinion of the Electricity Commissioners, be economically worked without interfering with the efficiency of any general scheme, should continue to be owned and operated by their present owners. Limitations of areas of supply have in the North-East Coast area operated to restrict expansion and to limit economy of production in regard to municipal electrical undertakings, to an extent markedly greater than has been the case with respect to private supply companies. With respect, however, to the Coal Conservation Sub-Committee's Report the municipalities cannot ignore the fact that a report purporting to deal with problems of national economy in coal consumption has been utilised as a vehicle of attack upon the policy of municipal control of electricity undertakings, and has been made the means of promulgating proposals which, if carried into effect, may be expected, in the North-East Coast area, whatever be the course adopted elsewhere, to consolidate the position of the Newcastle-upon-Tyne Electric Supply Company and its allied and subsidiary companies. The Report of the Coal Conservation Sub-Committee has clearly influenced the Electric Power Supply Committee in arriving at their conclusions. The report cannot, however, be regarded as presenting any elements of finality. Its conclusions are sought to be supported mainly by an estimated coal saving of 55 million tons per annum and by a comparison between the average charge for electricity in the North-East Coast area and the charges of a number of municipalities in the Southern parts of Lancashire. The municipalities challenge the statement that a coal saving such as is estimated will be effected.

The adverse comparison sought to be drawn between the alleged "average charge of less than ½d. per unit" of the North-East Coast supply companies and the charges of the Lancashire municipalities, is misleading and mischievous. No details are vouchsafed showing how this alleged average charge is arrived at, and the municipalities deny that it is in any sense a true and accurate representation of facts. On the contrary, the municipalities assert that where all material factors are taken into consideration, the charges of the North-East Coast supply companies will be found to approximate very closely to those of comparable municipal undertakings. Even should the allegation of an *average* charge of less than ½d. per unit be justified on the ascertained facts, the comparison is none the less misleading and fallacious, because the statement in Table V. of the Coal Conservation Sub-Committee's Report, purporting to give the average prices charged for power by the Lancashire municipalities, gives prices which includes the cost of distribution and other incidental expenses, and relate very largely to low tension units supplied to consumers on their own premises, whereas a large proportion of the units supplied by the North-East Coast supply companies, the prices charged for which are apparently taken into account in arriving at the average charge of less than ½d. per unit, are high tension units supplied in bulk to distributors and users of electrical energy who, generally speaking, have to add the cost of transformation and in some cases that of distribution, together with their profit, in the price actually charged to the ultimate consumer.

The municipalities recognise the desirability of the establishment of some central and impartial authority charged with the duty of fostering electrical enterprise and encouraging the use of electricity in industrial concerns. The municipalities, however, view with grave concern as a dangerous extension of the policy of bureaucratic control which has been increasingly prevalent during the War, the proposal to confer powers which for all practical purposes will determine the development of electrical enterprise throughout the country upon a small body of permanent officials, who will be supreme over all existing and future electricity undertakings, appointed by the President of the Board of Trade without reference to any superior authority, three of whom will hold office subject only to an age limit, and two of whom will be appointed for a short term of years. A small body of technical experts however eminent individually, is in the view of the municipalities unfitted to be entrusted with autocratic powers of the character proposed, and the central electrical authority should be so constituted as to be directly susceptible to the influence of public opinion and should comprise a sufficiency of members of independent judgment and general experience. The first Board of Electricity Commissioners should either be appointed directly by Parliament, or be constituted in accordance with directions given by Parliament so as to secure an impartial and judicial body.

With respect to the delimitation of electrical districts and the constitution of District Boards, all the facts are ascertainable immediately, and these questions, it is submitted, should be disposed of by direct Parliamentary action after preliminary local inquiries. In no case should the decision on matters of this character be left in the disposition (whether by provisional order or otherwise) of a small body of experts as contemplated by the report of the Electric Power Supply Committee. It is unreasonable that any embargo should be placed upon extensions of existing electrical undertakings, whether by the erection of new stations, or the extension of existing stations, during any interval which may occur before the suggested super-power stations are in a position to supply power, especially as, instead of the "temporary lull in manufacturing output immediately after the War" contemplated by the Coal Conservation Sub-Committee's Report, the commercial necessities of the situation may then, on the contrary, as is apparently recognised by the Electric Power Supply Committee, more probably demand an immediate increase in the supply of electric power, which, the municipalities submit, can be effected quickly and economically by enlargements and extensions of the plant of existing undertakings.

The municipalities direct attention to the inequitable character, so far as regards municipal electrical enterprises, of the financial proposals of the Report. The basis of compensation proposed by the Report will act unfairly as between municipalities and companies, and will have the effect of penalising those undertakers who have set up adequate reserve funds and maintained their undertakings in an efficient manner, and of favouring those undertakings which have distributed an undue proportion of their surplus revenues amongst shareholders, or in reduction of rates. It is submitted that if Electricity Boards are to be constituted to take over existing electrical undertakings the terms of transfer of municipally and commercially owned generating stations and distributing systems should proceed upon the same basis, and that whatever terms are given to the one should be given to the other, so that in the case of a municipally owned undertaking the capital of the undertaking should accrue to the municipality which has borne the risk and responsibility of the undertaking in the past.

Again, the municipalities object to the recommendation of the Electric Power Supply Committee's Report that whereas commercial distributors of electricity are to continue to exercise the right of paying dividends, subject only to the limitations of a sliding scale of charges to consumers, municipalities who continue to distribute electricity are to be permitted either to make no profit at all or only a nominal profit. Furthermore, the municipalities take strong exception to the proposal that District Electricity Boards or their lessees should be empowered to supply high-tension electricity in the areas of municipal distributors of electricity, and it is contended that, with the possible exception of electricity used by railway companies for traction there should be for each local area of supply a single distributor of electricity regardless of the question whether the energy supplied is low-tension or high-tension electricity. Finally, it is manifestly inequitable that Power Supply companies (whose areas of supply for power happen to be reduced by the District Electricity Board, to cut out districts which can be better served from other districts) should, to the exclusion of municipalities (who may apparently be subjected to similar reduction of their areas of supply), have conferred upon them, as is proposed by the Electric Power Supply Committee's Report the right of supplying electricity for lighting in places where there is at the time no lighting supply. The municipalities do not concur in the proposals of the Electric Power Supply Committee that a preferential basis of rating should be accorded to electricity transmission mains and that the existing restrictions as to the use of overhead lines should be removed. As regards the latter, while in rural areas, and as a temporary expedient, the use of overhead lines for the transmission of electrical energy may be, in special circumstances, desirable and even necessary, a general concession of this character in urban areas is to be deprecated.

The municipalities observe with satisfaction that the Electric Power Supply Committee's Report recommends that in the national interest generating stations and main transmission lines ought, as a general rule, to be publicly owned, and they submit that the District Electricity Board should, in all cases, be so constituted as to be wholly independent of the influence or control of commercially owned electrical enterprises. To secure this object, it is strongly urged that the District Electricity Boards should consist of representatives of Local Authorities and large consumers to the exclusion of companies generating electricity.

Transport Committee's Report.

The Select Committee on Transport has issued its second report, which deals with railways, canals and transport by road. The following preliminary conclusions have been arrived at:—

That the organisation of the transport agencies of the country—and particularly of the railways—cannot be allowed to return to its pre-war position.

That the temporary arrangements for the control of railways and canals during the war would not be satisfactory as a permanent settlement.

That unification of the railway system is desirable under suitable safeguards, whether the ownership be in public or private hands.

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Any one of the following courses would be consistent with the conclusions reached, but without further evidence the Committee is not in a position to recommend which of these methods should be adopted in the first instance :—

Further amalgamations of railway companies as a step towards unification.

Unification accompanied by private ownership and commercial management.

Unification by means of nationalisation, followed by (*a*) establishment of a Government department to manage the railways; (*b*) constitution of a board of management not directly represented in Parliament; (*c*) leasing of the system to one or more commercial companies.

The Committee point out that the war has considerably modified the position and methods of work of the railway companies, though the changes in organisation and practice have been less than is generally supposed. It is suggested that the main railway systems of the United Kingdom should be brought under a unified ownership and managed as one system if the question of the improvement and development of the internal transport facilities is to be considered from the standpoint of efficiency and economy.

THE GATTIE SCHEME.

The Committee has examined the proposals of Mr. A. W. Gattie for improving the methods of handling goods and traffic by the use of his systems and inventions. The proposals are described as attractive and the inventions as highly ingenious, but the Committee is not able, on the evidence presented to it, to come to any conclusion with regard to the practical value of the proposals or to make any recommendation in regard to their adoption. A recommendation is made, however, that Mr. Gattie's company should be given permission by the Treasury New Issues Committee to raise funds for the purpose of enabling mechanical tests to be carried out, and that such priorities should be granted as may be necessary to allow the machinery and appliances to be obtained as soon as possible.

Allocation of Generating Plant by the Ministry of Munitions.

(*Concluded from page* 622.)

The following figures show the details of plant allocated to the municipal and company undertakings during the war.

List of Municipal Electricity Supply Undertakings which have installed additional generating plant during period June 30, 1914, *to Oct.* 31, 1918.

Name of Corporation.	Plant capacity at June 30, 1914.	Additional plant installed or authorised. Period June 30, 1914, to Oct. 31, 1918.	Proportion of additional plant sanctioned by present director of electric power supply.	Graded.
	kw.	kw.	kw.	
1. Aberdeen	8,380	9,380	5,000	P. 4
2. Barrow-in-Furness	2,525	5,000	3,000	P. 4
3. Battersea	5,092	5,000	...	...
4. Belfast	13,300	10,500	10,500	P. 4
5. Birmingham	33,000	51,650	30,400	P. 2
6. Bolton	7,600	10,900	7,500	P. 4
7. Bradford	16,800	27,450	12,000	P. 4
8. Brighton	12,100	4,000	4,000	P. 4
9. Bristol	15,050	9,000	6,000	P. 4
10. Bury	5,700	3,000	...	...
11. Derby	7,050	7,500	4,000	P. 3
12. Glasgow	54,900	99,050	36,000	P. 4
13. Hackney	4,800	13,400	6,000	P. 4
14. Huddersfield	7,450	4,000	...	...
15. Hull	10,210	5,000	...	...
16. Kilmarnock	3,000	7,000	...	...
17. Leeds	22,940	33,660	12,000	P. 4
18. L.C.C. Tramways	38,500	9,000	...	...
19. Luton	2,450	10,000	5,000	P. 4
20. Manchester	72,300	46,450	...	...
21. Paisley	4,200	8,200	5,500	P. 4
22. Rotherham	5,150	65,350	30,000	P. 2
23. Sheffield	23,225	73,000	*	...
24. Shoreditch	5,680	5,000	...	...
25. Stockport	4,850	11,150	...	...
26. Sunderland	8,500	7,500	...	...
27. Swansea	5,100	5,000	5,000	P. 4
28. Wigan	4,820	6,500	5,000	P. 4
29. Wolverhampton	7,050	16,450	...	...
30. Keighley	4,620	5,380	...	...

* Further 50,000 kw. recommended. Permit in suspense.

The above list excludes the following undertakings where the additional plant was under 5,000 kw. :—Alloa, Ayr, Bedford, Butron, Carlisle, Chesterfield, Ipswich, Kingstown, Leek, Londonderry, Loughborough, Maidstone, Newport, Northampton, Plymouth, Poplar, Portsmouth, Redditch, St. Pancras, Stoke-on-Trent, Southampton, Swindon, Tonbridge, Watford, Warrington and West Bromwich. Including these undertakings the total plant capacity at June 30, 1914, was 500,071 kw. and the additional plant installed or authorised was 645,072 kw. The amount of additional plant sanctioned by the present director was 219,565 kw. These two last figures do not include 50,000 kw. sanctioned for Sheffield as soon as the linking-up agreement is signed with Rotherham.

List of Company Electricity Supply Undertakings which have installed additional generating plant during the period June 30, 1914, *to Oct.* 31, 1918.

Name of Company.	Plant capacity at June 30, 1914.	Additional plant installed or authorised. Period June 30, 1914, to Oct. 31, 1918.	Proportion of additional plant sanctioned by present director of electric power supply.	Graded.
	kw.	kw.	kw.	
1. Central Electric	26,283	7.570	...	...
2. City of London	27,000	6,000	6,000	P. 5
3. Clyde Valley	35,000	37,500	15,000	P. 3
4. Co. of London	19,800	14,400	...	...
5. Lancashire Electric	16,500	6,000	...	...
6. London Electric Supply	25,456	12,000	...	...
7. Mersey Power Co.	4,900	24,500	20,000	...
8. Metropolitan	22,500	4,000	...	...
9. Midland Electric	10,600	10,200	...	...
10. Newcastle-on-Tyne & Associated Companies	86,200	114,200	25,000	P. 3
11. North Metropolitan	16,122	21,938	6,000	P. 4
12. Scottish Central	3,300	6,230	3,000	P. 4
13. Shropshire, Worcestershire & Staffordshire	28,325	15,850	...	...
14. South Metropolitan	6,000	15,000	5,000	P. 4
15. Trafford	5,200	7,950	...	...
16. Twickenham	1,180	4,000	2,000	P. 4
17. Uxbridge & District	1,030	3,650	2,000	P. 4
18. Woking	1,100	1,000	...	...
19. Yorkshire Electric	14,500	12,000	...	...
20. Slough & Datchet	695	1,335	1,000	...
Totals	351,685	324,453	85,000 sanc	(10 tions.)

Labour and Industrial Development.

The fifth lecture before the Industrial Reconstruction Council was delivered by Mr. E. J. P. Benn last Wednesday, the subject being "Labour and Industrial Development." After dealing with the Whitley Report, Mr. Benn remarked that industry was at present faced with two great evils—namely, Bolshevism and Bureaucracy. It would not be possible for Bolshevism to live in such an atmosphere as would be created by the establishment of trade parliaments. Bureaucracy, on the other hand, must be met by other methods. Labour and Capital would soon discover that there would be no wages and no profits to distribute if the rest of our lives were to be spent in filling up forms. There was a risk that that might come about. The great need of the nation at the moment was a greater revival in industrial activity. The national policy to-day was to encourage all forms of civil activity, and the most effective way of doing this was to abolish all control. Central control was a synonym for waste, waste of time, waste of men, waste of money and waste of material. Thanks to the censorship, the most absurd claims were being advanced in favour of the control of industry, and there was a danger that the public might be led to believe that this was good in itself.

There was no reason to complain of control as a war measure. Such measures, however, had no place in times of peace. Among the most specious arguments in support of control, perhaps the most powerful was that in connection with Belgium. Mr. Benn expressed the view that there was a much greater probability of the needs of Belgium being satisfied if industrial freedom were allowed in this country.

With regard to the difference between the official and the business man, it might be said that the official represented brains minus ex-

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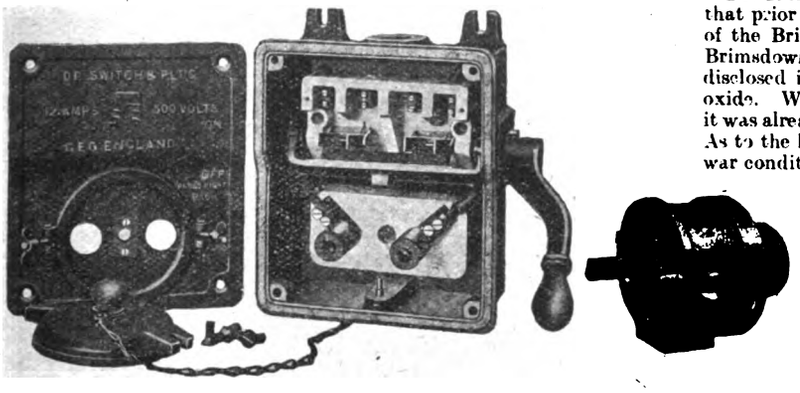
perience, while the business man stood for experience and, unfortunately, minus brains in many cases. The first rule of a bureaucrat was not to do a thing himself, but to find some reason why it should be done by somebody else. This was not due to laziness. The successful business man, on the other hand, acted promptly, and was not afraid of making mistakes. No official in any office had anything to lose by doing to-morrow what ought to be done to-day. It would be well if regulations in restraint of trade could be made illegal. It was necessary to emphasise this danger of control, because most strenuous efforts would be made to keep the system in being. There was to-day a huge vested interest in control, and there was the further danger that most of those who were controlling us were suffering from the delusion that it was for our good. Unless Capital and Labour combined to demand the abolition of the system it was likely to remain.

At the present moment the Germans were overrunning Holland with manufactured goods, the Americans were getting home as quickly as possible, and yet the English were waiting while new forms were being devised and printed before there was a prospect of the release of any of our ten million workers for useful purposes. Whilst we in this country were bound by control, the Germans sold British, French and American flags in Lille in anticipation of our arrival, and did excellent business. There should arise from the commercial community of the country a great cry to the Government—"Hands off industry." Industry must be left to govern itself.

12-Ampere Combined D.P. Ironclad Switch and Plug.

It is now realised that it pays well to install thoroughly satisfactory connections between plant and supply mains, and fuller advantage is now being taken of the convenience and utility of small portable electrical plant in factories, warehouses and docks. For this purpose the General Electric Co. have constructed a 12-ampere combined switch and plug intended for use on circuits up to 500 volts, which will comply with the most stringent requirements.

In designing this device the necessity of producing an article which shall withstand severe weather conditions, shall be capable of withstanding the very severe usage which is meted out to apparatus of this description, and shall ensure the safety of the operator and of the plant



INTERIOR VIEW OF THE SWITCH AND PLUG.

has been carefully studied. The device consists of a double-pole, double-break switch and plug socket enclosed in a cast-iron case. When the device is not in use the plug receptacle is covered by a cast-iron lid which precludes the admission of moisture. When it is desired to draw a supply through the switch the cover is removed and the plug is inserted. As usual in G. E. C. switches and plugs, there is an interlocking arrangement which prevents the plug being inserted when the switch is in the "on" position, and in the event of an attempt being made to insert the plug under these circumstances, a central pin carried by the plug refuses to enter, and contact cannot be established. This central pin also fulfils the function of an earthing device, so that the earthing circuit is always completed before the current-carrying pins are made alive. Moreover, if an attempt be made to withdraw the plug when the switch is in the running position that attempt is frustrated by the interlocking device, and the plug cannot be withdrawn until the switch is in the "off" position. The plug affords an efficient protecting shield to the hand. In order to prevent reversal of polarity by the plug being inserted the wrong way round the spacing of the pins is unsymmetrical.

The plug is designed to take the trailing cable from the plant, and a suitable brass gland with a packing device is embodied in order to render the entrance to the plug watertight. This apparatus, a general view of which is shown in the figure, is constructed by the General Electric Co., of Witton, Birmingham, and Queen Victoria street, London, E.C. 4.

Legal Intelligence.

Tungsten Filament Patents.

On Wednesday last the Controller of Patents (Mr. W. Temple Franks) heard applications by the Cosmos Lamp Works, Ltd., for licences in respect of patents Nos. 5,026/1912, 16,620/1914 and 109,298/1914, relating to improvements in tungsten filaments for electric lamps and the processes of obtaining the same. The patents are in the name of Julius Pintsch (A.G.), of Berlin, though in the case of 5,026/1912 there had been communication from Pintsch to the late Joseph Hubers.

It was stated that Cosmos Lamp Works, Ltd., was a British company, with a capital of £50,000 in £1 shares, of which 49,955 were owned by the British Westinghouse Company, four by British subjects and the other by an American citizen. Applicants were the purchasers from the Public Trustee of the Brimsdown Lamp Works, the British name of the German people who owned the three patents in question. The two patents, 5,026/1912 and 16,620/1914, were on the schedule of the patents comprised in the sale of the Brimsdown Company's stock, &c., as being patents under which they had been manufacturing. Patent No. 5,026/1912 had been worked at the Brimsdown Works, and there had also been a good deal of investigation as to No. 16,620/1914. As to No. 109,298, nothing very substantial had been done; the patent represented merely an addition to No. 16,620/1914. The patent 5,026/1914 was a patent for a process for getting ductile filaments of tungsten alloy. That was a process that had been worked commercially by the Brimsdown Works and by the Cosmos Lamp Company since they bought the business. Although much work had been done and many experiments made at the Brimsdown Works, they had never yet succeeded in getting a commercial filament substance which would give 50 c.p. No. 5,026/1912 was the process actually worked by the Brimsdown Company, and No. 16,620 was an improvement particularly applicable to the filaments as made by No. 5,026. It was really a further treatment of the filament, as it had been obtained by No. 5,026 or by other processes. Applicants urged that they should have an exclusive licence, but on behalf of Dr. Mond the application for an exclusive licence was opposed. Prior to the war, of course there was facility for continual communications between headquarters in Germany and the Brimsdown Lamp Works; improvements could be communicated and the results of experiments and raw materials could be supplied. Since the sale of the business by the Public Trustee much labour had been expended in investigating that particular process, and as a result of their experience they thought it would take some considerable time before there was any chance of establishing a commercial success, and they felt that unless they could get the monopoly rights they would not be able to continue the investigations beyond a very short time.

DR. RABINOVITCH, works manager of the Cosmos Lamp Works, said that prior to the purchase by the company of the whole of the property of the Brimsdown Company he was the chief research chemist for the Brimsdown Company, and he had carried out work on the inventions as disclosed in Patent No. 5,026/1912, with tungsten oxide and thorium oxide. Witness described in detail the various experiments, and said it was already possible under these processes to obtain very fine filaments. As to the last of the patents, they had not yet been able, on account of war conditions, to experiment to any large extent, but he thought there was something in it of value as an improvement on the first specification.

Replying to Mr. TERRELL (for Dr. Mond), Witness said he knew that in Germany they had been carrying out experiments with those processes. As to the suggestion that it caused a sensation in Germany, witness thought it might have done so from the scientific, but not the technical, point of view. They had already obtained good filaments, but only in fine sizes. He had made excellent filaments which would do for the smaller lamps up to 25 c.p., and they were now trying to see if they could get filaments that would do for a bigger power.

MR. C. TERRELL submitted that there was no case for the granting of the exclusive licence to the applicants.

DR. ALBERT L. MOND (Hubers & Mond) said Mr. Hubers (who was now dead) helped the Pintsch people to establish their works in this country. He had reason to believe that there were other people who would possibly be desirous of manufacturing under these patents. Early in 1914 the manager of the Brimsdown Works, who had great experience, was called to Berlin to investigate that new process, and witness knew that in 1914 experiments were carried out on instructions received from Berlin, and on several occasions witness had been to the Brimsdown Lamp Works and seen the manufactured wire. Under a microscope he saw at least three or four yards in one continuous crystal. Witness said it was possibly the stopping of the manufacture of drawn tungsten wire that led to the invention. He had read and considered various articles that had appeared in the technical press in Germany since 1915, and he could say that it was quite a commercial article in Germany, and a certain amount of fame attached to the invention. He thought it was disadvantageous that the exclusive licence should be granted. It was necessary to use thorium for manufacturing filaments other than drawn tungsten filaments. All the lamps manufactured at Brimsdown were manufactured under patent No. 5,026.

Some discussion ensued on the question of royalties, and the Controller intimated that the application would be considered.

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Claim for Electrical Plant.

Last week Mr. Muir Mackenzie, Official Receiver, heard an action by Messrs. Barlow Bros., electrical engineers, to recover from Messrs. Thomas & Regar £105. 10s. 8d. for work done and materials supplied in connection with the erection of a skin dressing plant.

Mr. LORT WILLIAMS appeared for plaintiffs, and defendants did not appear, and the case was consequently taken as an undefended action. Counsel for plaintiffs said that defendants had admitted indebtedness to the amount of £58, which they said was the contract price, and the only issue was whether there was a contract or not. A portion of the balance of the claim was for electrical work done by plaintiffs to defendants' orders which had nothing whatever to do with the original work plaintiffs were engaged to do; the original work was the erection of the skin dressing plant only, and as to which judgment had been obtained.

Mr. HENRY MOOR HARRIS, manager of Messrs. Barlow Bros., proved having received an order from the defendants to fix up the skin dressing plant, and said that there was no agreement as to the price at which the work should be done. Nor was there any contract, while the work was being proceeded with. Defendants gave an order to repair the motor for the plant and to connect it with the new plant. That work was done and the charge for it was £29. 4s. 9d. They also did work in connection with the lighting of the premises for which £9. 10s. and £8. 10s. 6d. were claimed. That work was also outside the original order.

The OFFICIAL REFEREE, in giving judgment for plaintiffs for £105. 10s. 3d. with costs, said that as the plaintiffs had already been paid £58, execution would be limited to the balance of £47. 10s. 3d., and the costs would be on the High Courts scale.

Parliamentary Intelligence.

PRIVATE BILL LEGISLATION.

The Chairman of Committees in the House of Lords has intimated that he will give favourable consideration to the introduction during next Session of late private Bills (*i.e.*, Bills not deposited in December in accordance with Standing Orders) for which urgency can be claimed owing to the armistice and the prospect of peace. The concession will apply to Bills which will include those which have been held up owing to the war and measures dealing with new projects calculated to promote the work of reconstruction. Application for leave to introduce late Bills should be made early in the Session to secure due time for their consideration. A similar relaxation of Standing Orders will be allowed in the House of Commons.

Royal Assent.—The Royal assent was read on the 21st inst. to the following new Acts of Parliament: Clyde Valley Electrical Power Order Confirmation Act; London United Tramways Act.

Patent Record.

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

October 26, 1918.

17,476 RAILING & TAYLOR. Means for gripping flexible conductors or cords of electric lamp-holders.
17,504 SCOTT. Electric switches.
17,513 SOC. FRANCAISE RADIO-ELECTRIQUE. High frequency alternators and their use as relays in wireless telephony. (26/10/17, France.)
17,514 LATOUR. Telephone apparatus. (3/10/17, France.)

October 28, 1918.

17,527 ESCOTT, LEEMING & HORTON. Electrical recording graph.
17,543 KENT. Electric fiurnaces.
17,567 TRENT. Electrical fuse.
17,575 ZALOCOSTAS. Switch control for automobile electric tail lights.

October 29, 1918.

17,621 KILLICK. Magnetos.
17,631 COMPARE & COMPARRI WIRELESS CONTROL SYND. Oscillators or vibrators for wireless telegraphy, &c.
17,639 B. T.-H. CO. (G. E. Co.) Systems of frequency transformation.
17,641 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Heat conserving apparatus. (21/11/17, U.S.)
17,650 HEBERLEIN. Electrolysing solution of nickel salt.

October 30, 1918.

17,708 BRUSH ELECTRICAL ENGINEERING CO. & ROBERTS. Electricity generating and supply means.
17,722 B. T.-H. CO. (G. E. Co.) Systems of electrical distribution.
17,731 LUCAS. Electrically-heated fabrics.
17,735 MCKAY. Electrical fitting connections.
17,745 JONES. Electrodes for sparking plugs.
17,754 BURGESS BATTERY CO. Manufacture of electric dry batteries. (20/10/17, U.S.)

October 31, 1918.

17,777 ROBINSON. Electrical switches.
17,794 JONES. Electric lamp holders.
17,817 COOK & MURPHY. Automatic voltage or current regulator for generators.
17,824 ABLITT. Separators for electric accumulators.
17,837 NAYLOR & TYLER. Non-spellable battery cells.
17,811 BEAVER, CLAREMONT & RICHARDS. Detective and protective devices for electric cables.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.
Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.
Orders for the Week.

Monday, Dec. 2 to Saturday, Dec. 7.—Drills as usual.

Commercial Topics.

Samples of Foreign-Made Goods from South America.

A large range of samples of foreign-made goods, which have recently been received from various parts of South and Central America have been on exhibit at 95, New-street, Birmingham, on Wednesday, Thursday and Friday of this week. The articles include general hardware, tools, electrical goods, enamelled goods, &c.

* * * *

Release of Men from H.M. Forces.

Employers desirous of obtaining the release of former employees should address their requests, with full particulars, to Sir Stephenson Kent, Controller-General, Civil Demobilisation Re-settlement Department, Ministry of Labour, 8, Richmond-terrace, Parliament-street, S.W.

An employer who wishes to ensure that a man now serving with the Forces shall be earmarked for early release when general demobilisation begins, should ascertain his full name, regimental number and rank, the full name of his unit, and the Expeditionary Force or command where he is serving, and should then fill up and send to the Local Employment Exchange a specially printed postcard (E.D.406), copies of which may be obtained from Employment Exchanges.

* * * *

Transformation of the Ministry of Munitions.

By the Act which was passed last week "the purposes of the Ministry of Munitions shall include the supervision and regulation of the diversion to the production of articles required in times of peace, of industries established or utilised during the present war for the purpose of the production of war material, and all powers which may be exercised by the Minister of Munitions with a view to facilitating the supply of war material or otherwise for promoting the prosecution of the present war may be exercised by him with a view to securing that such diversion as aforesaid shall be carried into effect in such a manner as may be most conducive to the national interests, and all orders, regulations, rules and notices made or given by the Minister and in force at the passing of the present Act shall until they expire or are altered or revoked, continue in force as if this Act had been in force at the time when they were made or given."

* * * *

Empire Radio-Telegraph Schemes.

It is reported that various schemes are under consideration for the development of radio-telegraphy throughout the Empire, particularly in the Far East, the Pacific and the West Indies. It is proposed to establish stations at Singapore, Colombo and Hong Kong that will be able to communicate with the systems about to be established in China and with those already in existence in Japan. The stations to be established in the Southern and Western Pacific will come into line with the Australian and New Zealand systems. Some of the islands of the British West Indies are already connected by radio-telegraphy, but it is proposed to extend and improve the system so that all the colonies in the Caribbean Sea will be in communication with each other and with London. All these systems will be State-owned.

* * * *

Munitions Machinery for Civil Work.

It is announced that contractors in possession of plant and machinery owned by the Ministry of Munitions who wish to utilise such plant and machinery for civil work may do so provided they notify the superintendent engineer in their area within one week from the date upon which the plant and machinery was first used for purposes other than those for which it was provided. The utilisation of such plant and machinery will impose no obligation upon the contractor to purchase, or the Ministry to sell, although should a sale not be effected to the contractor he will be required to pay a reasonable hire which, unless an agreement exists to the contrary, will in no case exceed the rate of 20 per cent. per annum upon the cost price of the machine, and also to release the machine when required to do so by the Minister.

* * * *

A Protest Against Bureaucracy.

Under the title "Freedom's Battle Yet to Win," the Liberty and Property Defence League has issued a manifesto to the electors urging them to send to Parliament men who will insist upon the removal of all restraints on rational personal freedom and upon setting free all private enterprise from bureaucratic control. It is submitted that State management during the war has notoriously not been of a character to create a desire for its continuance in times of peace. Everyone engaged in private trade and industry knows that the one and only hope of future prosperity lies in the stern insistence on "Hands off" to the State. All that the trades and industries of England want is to be left alone to conduct and develop their affairs on business principles, free from the meddling of State departments and the supervision of prowling and mostly ignorant officials. Freedom is the very life-blood of industrial prosperity, and those who desire to see their country prosper must ensure that government does not fall into the hands of the worshippers of the State, but of men who will bow to a nobler idol, the noblest of all—Liberty. It is urged that it is not "reconstruction" by legislation that England wants, but restoration of all the freedom and all the rights that have been taken away during the past eventful years, and the fullest opportunity to extend the bounds of personal liberty and to make secure all the rights rational human beings should possess.

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War Restrictions Removed.

A partial withdrawal of the war restrictions on the metal trades is notified, and the Government are prepared until the existing Orders under the Defence of the Realm Act are withdrawn, to release, without special priority permits, stocks of non-ferrous metals, so far as they are available, for general industrial purposes. Applications should be made to the Controller of Non-Ferrous Materials Supply, Ministry of Munitions, Hotel Victoria, Northumberland-avenue, W.C. 2.

No permit is now required for the manufacture or sale of iron and steel wire or wire ropes for the home trade. The Government will continue to issue priority permits for work of special national importance where necessity arises, and firms may still issue priority certificates where the Order as to priority of March 8, 1917, allows them to do so. Any orders covered by such permits or certificates or by existing permits or certificates not cancelled by specific instructions of the Government will still be executed in accordance with that Order.

Licences will be granted, when necessary, by the War Trade Department for the export of goods manufactured from non-ferrous metals as freely as possible to all destinations unaffected by the blockade.

Colonial and foreign applications with regard to iron and steel wire or wire ropes must be made in the usual way, the former to the Priority Department, 1, Caxton-street, Westminster, and the latter to the War Trade Department, 4, Central-buildings, Westminster, S.W. 1.

Until further notice manufacturers of forgings, stampings, and castings, in iron, steel, or malleable iron, may accept orders for priority below Class B subject only to the Order as to priority dated March 8, 1917. For this purpose the prohibition of the manufacture of iron, steel, and malleable iron for orders ranking below Class B, imposed by the Control of Steel Supplies Order of Nov. 20, 1916, is suspended.

The current maximum prices for home sales of iron and steel remain in force.

On and after the 1st prox. all restrictions as to the sale or purchase of calcium carbide will be removed, subject to a maxmium price to consumers of £40 per ton for quantities of 1 cwt. and over (granulated 10s. per ton extra). No application for the use of this material or returns of stock need be made to the Ministry of Munitions after the above-mentioned date.

* * * *

Electricity Supply.

The Wardley Mills, WALKDEN (LANCS), are to be driven electrically.

Mr. Mortimer Watson has been appointed manager of the Holsworthy Gas & Electric Supply Company.

Mr. Barker, of the Chelsea Electricity Supply Company, has refused to accept the position of works superintendent at Aylesbury, to which he was recently appointed by the Council.

HUDDERSFIELD Corporation has decided to place under the control of the Electricity Committee the generation of electrical energy for tramways, as well as for lighting and power purposes.

In a report presented to Somerset County Council the Special Committee on Reconstruction recommends the erection of two electric generating stations—one at Radstock and another at Dunball—for the supply of cheap electricity for power and industrial purposes in the rural areas.

HAMPSTEAD (LONDON) BOROUGH COUNCIL has received authority from the London County Council to borrow £462 for mains (repayable within 25 years), and £11,461 for machinery and boilers (repayable within 15 years). Loans amounting to £3,636 outstanding in respect of boilers which are to be superseded are to be deducted from the amount of the authorised loan.

A representative and enthusiastic gathering of engineers was addressed by the President of the Electrical Power Engineers' Association (Mr. A. L. Lunn) at Cardiff on the 23rd inst. and a South Wales Section of the Midland Division of the E.P.E.A. was formed. A provisional committee and secretary were elected and all inquiries should be addressed to Mr. H. W. Jones, Hon. Secretary, "Adper House," Church Village, near Pontypridd, South Wales.

At the last meeting of RADCLIFFE (LANCS) Urban Council it was stated that, in accordance with the recommendations of the Association of Lancashire and Cheshire Electricity Undertakings, the staff and workmen employed in the electricity undertaking would be granted such an advance of wages as war bonus which (with the bonus already allowed) would make a total war bonus of £1. 3s. 6d. per week above pre-war standard wage, plus the equivalent of 12½ per cent. on earnings.

Various LIGHTING AND OTHER REGULATIONS made under the Defence of the Realm Act have been cancelled. Regulation 11, which enables the Home Secretary to make orders regarding lights, is still retained, but all orders made under it have been cancelled, except the lights on vehicles, the Lights (Driving of Animals) and the advertisement lights Orders. Regulation 2 which empowered the Naval and Military authorities to call for extinguishing of lights has been revoked. Restrictions on publication of inventions and designs, the prohibition of signalling, the display of lights, use of fireworks, &c., have also been abolished.

BELFAST ELECTRICITY COMMITTEE has decided to lay a system of mains throughout the City in connection with the new harbour station to provide a power supply suitable for the requirements of mills and factories and other large or small power users. The area in which there is the greatest demand will first be provided for. Consumers who contemplate adopting electric power either in large or small quantities within the next two years have been requested to furnish particulars of their estimated requirements to the city electrical engineer as soon as possible.

The DUBLIN PORT AND DOCKS BOARD have asked their engineer to report on the whole of the electrical undertaking at the port, and the Works Committee have been instructed to report upon a proposal to remove the chimney shaft at the generating station and install a new fan at from £500 to £600.

DONCASTER Rural Council will support the application of the Electrical Distribution of Yorkshire, Ltd., for a provisional order to supply electricity in Cadeby, Conisborough, Denaby, Edlington, Sprotborough and Warmsworth; Emley Urban Council will support the company's application for an order for the district.

In a report by Mr. J. A. Robertson, of Salford, the recent recommendation of Mr. Papworth, until recently burgh electrical engineer at STIRLING, to install condensing plant is supported. Mr. Robertson said that he had no hesitation in coming to the opinion that, with the present prices ruling for coal supplies, the installation of condensing plant was a commercially sound proposition. The fuel consumption at present is equal to approximately 14 lb. per unit generated, and a saving of 30 per cent. should be quite easily obtained. The proper course was for specifications to be issued stating the requirements at the works, and asking for tenders with guarantees for satisfactory operation.

In regard to the Electric Power Supply Committee's report, Mr. Robertson states that in the industrial districts in the North and Midlands of England the demand for a cheap and abundant supply of electric power has become very pressing, and in any scheme put forward they will be dealt with first. In the case of Stirling, the present demand for electricity is being met from the existing station. The maximum demand is between 300 kw. and 400 kw. To transmit this amount of power through a distance of 10 miles required the provision of high-tension mains, transformers and converting plant. The transmission from a station near Glasgow was not a practical proposition at present. The Scottish Central Power Company's station was not a super-station of the kind contemplated by the Board of Trade Committee, and he did not think the cost of generation sufficiently low to justify them shutting down their works at Stirling in favour of a bulk supply from that source. The company might, however, be asked for terms for a bulk supply.

The Electric Supply Committee has decided to postpone the matter until Mr. Papworth's successor has been appointed, but the Scottish Central Company has been asked to state the terms upon which it would supply Stirling with electricity in bulk to meet the present load, and also the present load plus electric tramways.

Ald. Chas. Markham, of CHESTERFIELD, who is a pronounced advocate of cheap electric power for industrial purposes, is hopeful of seeing electric supply available in the district at about a farthing per horse-power per hour. Mr. Markham considers that the advent of the by-product and coke-oven plants has completely changed the aspect of trade in the district, and he believes that a great future awaits the development of the coalfields to the westward of Chesterfield. It will be possible with the aid of cheap electric power to win coal again from the drowned-out seams on the Newbold side of the town, while in regard to the search that is being made for petroleum, Mr. Markham is hopeful that success will be eventually achieved.

At last week's meeting of BATH CORPORATION Ald. Sir. H Hatt, chairman of the Electric Lighting Committee withdrew the recommendation to increase the salary of the city electrical engineer (Mr. F. Teague) from £600 to £700 per annum as from Nov. 1 last. He said he took that course, not because the members of the committee had altered their minds with regard to it, but because the Finance Committee had considered an application from the clerical staff and were not in a position to recommend the increases asked for. He had consulted Mr. Teague as to the withdrawal of the recommendation, and he left himself entirely in the hands of the committee. They did not feel justified in withdrawing the recommendation respecting the salary of Mr. Morris, who now held the position occupied by Mr. Nethercot.

The Committee's proposals were agreed to.

Last week WALSALL CORPORATION authorised an expenditure of £3,370 for a 500 kw. rotary converter and of £410 for an additional feeder panel for the generating station. It is also proposed to purchase a duplicate condenser motor for the Birchills station at a cost of £325.

In submitting the minutes of the Electric Supply Committee last week, Councillor D. HAYWARD said the report was very satisfactory, particularly so far as coal consumption was concerned, which was now 5·39 lb. per unit sent out, compared with 6·61 lb. for the corresponding quarter last year. The output had increased 30 per cent., which, in view of the restrictions was also very satisfactory. They had sold another £800 worth of the obsolete plant.

The report was referred back for further consideration.

Electric Traction.

Mr. Harrison has been re-elected convener of the EDINBURGH Tramways Committee.

Ald. E. Russell Taylor has been unanimously re-elected chairman of the LIVERPOOL Tramways Committee.

Mr. F. W. Ketley has resigned his position as general manager of the Norwich Electric Tramways Company.

BLACKPOOL TRAMWAYS COMMITTEE proposes to purchase about four acres of land for the erection of central tramcar depot.

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ACCRINGTON TRAMWAYS & ELECTRICITY COMMITTEE recommend the Council to increase the salary of Mr. H. Pilling, tramways manager, from £400 to £500 per year.

Mr. R. L. Acland, borough electrical engineer and tramways manager at Chesterfield, has resigned in order to become manager of a London motor transport firm.

In the House of Commons last week, Mr. Wardle stated, in reply to a question, that Mr. A. H. Pott had received a salaried appointment under the Board of Trade Tramways Committee. His duties were those of a visiting technical officer, and the proposed salary was £750 a year.

The latest award of the committee on Production advances the wages of tramway and motor omnibus workers by 5s. per week. The claim to equal pay for men and women has not been established, and the claim that youths and girls doing adults' work should receive adults' pay has also not been conceded.

The LONDON UNITED TRAMWAYS, LTD., has applied to the Board of Trade, under the Statutory Undertakings (Temporary Increase of Charges) Act, to enable it to increase the existing fares on all its lines by reducing the length and (or) number of stages on the system, subject to an obligation not to exceed 1d. per mile for ordinary passengers and ½d. per mile for workmen (with a minimum fare of 1d.). The average fare per mile under the existing scale is estimated to be slightly under ½d.

NEWCASTLE-ON-TYNE TRAMWAYS COMMITTEE has passed a resolution recording its appreciation of the services of the motormen and conductors, also the maintenance and power stations staffs, during the very trying conditions created by the war over the last four years. The committee, however, regret that, without agreement with those responsible for the service, employees left work on Nov. 11, and did not resume work on Tuesday, Nov. 12. The nature of a tramway service is such that holiday traffic must be catered for, and this is recognised by giving to all employees two weeks' holiday with pay. In view, however, of the special circumstances in the present case, the committee decided to pay all employees two days' extra pay.

Imperial and Foreign Notes.

In connection with the reorganisation of the Victorian railways, the conversion of suburban passenger cars to conform to the requirements of electrification is practically complete.

The "Industrial Australian and Mining Standard" says there is a probability that the manufacture of telephone instruments will shortly be undertaken in Australia as an avenue for the employment of returned soldiers.

Mr. S. Gardiner, consulting engineer, of Melbourne, has suggested to the board appointed to consider the MELBOURNE TRAFFIC PROBLEM, that a tube railway be constructed between North Melbourne and Joliment, and that the Coburg, Essendon and Williamstown lines be diverted from Flinders-street.

The "Daily Chronicle" states that from Sunday next the Wireless Press service between London and America will be resumed. Some of the Marconi stations, which have all been under Government control during the war, have now been released. The resumption of the commercial wireless service is hardly practicable until more stations are released.

The POWER CONTROLLER FOR CANADA has received an application for permission to export power to New York State. The Cedars Rapids Power Company proposes to increase its plant near Soulanges Canal, and claims that the increased output cannot be wholly utilised in Canada, but is required in New York State. The application is for permission to export any surplus that there may be after the Canadian requirements are satisfied.

President Wilson has approved a scheme for the permanent control of all wireless communication by the U.S.A. Navy.

The Municipality of Saavedra (Argentina) propose to establish an electric lighting service in the town of PIGUE.

The U.S.A. Postmaster-General announces the consolidation of the services of the Western Union and the Postal Telegraph Companies under Government control as from Dec. 31.

The Danish Government Telegraph Dept. and the Great Northern Telegraph Company, of Copengahen, have granted all English soldiers as well as civilians permission to send cables home at 25 per cent. of the ordinary rate.

The United States Navy has recently equipped at Annapolis, Md., a powerful radio-telegraph station which is capable of communicating over a distance of at least 4,000 miles. Four steel towers of 650 ft. carry the antennæ. The power plant is in duplicate and that the working of the station will require about 100 men, all of whom will be supplied by the United States Navy. The cost of the station was £300,000.

In the ITALIAN CHAMBER OF DEPUTIES the Minister of Finance submitted a decree granting the State (from a date not yet fixed) the exclusive right of provision and sale of certain articles, including electric lamps and petroleum, petrol, paraffin and other mineral oils, light and heavy (exclusive of lubricants). The Bill also provides that the State shall take over the monopoly of the extraction of mercury in Italy. The Decree must be approved by Parliament.

Miscellaneous.

It is announced that the WESTERN UNION CABLE COMPANY will shortly have working a cable between the English and Irish coasts, thus obviating the difficulty of keeping up communication with land lines.

In connection with the recent strike of miners at the New Hucknall and Bentinck Collieries the miners held two meetings before resuming work. The terms of the agreement include a condition that the owners are to be allowed until the end of the year to test the Fuller electric lamp; whatever lamp is finally selected a complete installation will then be immediately ordered, but it must be completed by the end of March. On these conditions the men agreed to resume work.

The Government have decided in principle that any increased charge incurred for WORKMEN'S COMPENSATION in respect of disabled soldiers, sailors and airmen returning to civil employment shall be borne by the State, and they have adopted a scheme which has been worked out by a Home Office Committee, under the chairmanship of Lord Peel. It is proposed that an arrangement should be entered into by the Government, under which the insurance companies would undertake to insure disabled men at the general rate for the occupation, and not to increase their general rates in the future as the result of the employment of disabled men, the Government, under certain conditions, to reimburse the loss (if any) which the companies may incur.

On Nov. 20, Lady Hugh Grosvenor performed the ceremony of opening a canteen which the Crypto Electrical Company has recently erected for the convenience and comfort of its employees. Mr. Swainson, representing the Y.M.C.A., in whose hands the catering arrangements have been placed, congratulated the company on the excellence of the appointments of the canteen, which at present does not cater for more than 300 meals at one time. The opening ceremony was followed by an excellent concert, under the chairmanship of Mr. T. E. Goodyear (chairman of the company) who expressed the hope that the entertainment would be the precursor of many pleasant entertainments, lectures, &c., for the enjoyment and benefit of all employees.

On the 23rd inst. an interesting presentation took place at the SIMPLEX COMPANY'S WORKS, in Birmingham, when Mr. J. F. Avila was presented with a handsome weather glass by the workpeople and staff of the firm. Mr. T. Birkett made the presentation, and said that the Simplex manufactures had been well maintained during Mr. Avila's administration, which extended throughout the war period, and now that he was returning to take up his old position as London and South of England manager, he could rest assured that the good name of Simplex would be upheld in the future.

Mr. Avila replied, and attributed the success of his work in Birmingham to the admirable way in which all co-operated during the long and painful struggle, out of which we had come so happily victorious. He was convinced that the troubles of peace were not likely to be greater than those of war, and he was confident from his experience at the works that they would be able to negotiate satisfactorily the "Reconstruction" period.

Educational.

At a meeting of CARDIFF TECHNICAL INSTRUCTION COMMITTEE last week Principal Coles presented a report of the war work done at the college. About £6,000 worth of machinery, the property of the Ministry of Munitions, was at the college, and the committee decided to schedule the machines which they desired to retain for future technical instruction in the city. It is proposed to extend the facilities at the college for tuition in lathe work and practical engineering. A sub-committee was appointed to consider the question of providing suitable accommodation.

On Saturday a representative deputation from the universities and institutions of university rank of Great Britain and Ireland waited upon the Chancellor of the Exchequer and the Minister of Education, in order to urge upon the Government the need for further assistance to enable universities to maintain the standard of their work and develop their activities. The financial requirements of the universities were stated by Sir Oliver Lodge, and in reply Mr. Bonar Law said the Government would consider sympathetically any recommendations which might be made to him by the President of the Board of Education. Dr. Fisher promised that the most careful consideration would be given to the arguments and representations of the deputation, and to such written statements as the universities might submit before the end of the year.

At the half-yearly meeting of the Governors of the UNIVERSITY OF MANCHESTER last week the report of the Council stated that there had been a great increase of women students during last year. There were more new students in medicine and technology, and hope was expressed that the new Doctorate of Philosophy (Ph.D.), obtainable in any faculty by graduates of approved Universities after a course of training in advanced study and research extending over not less than two years, would encourage research, not only on the part of foreign and colonial graduates who under pre-war conditions had migrated to German and Austrian universities, but also on the part of their own graduates.

Prof. R. B. WILD, who presided, said they would probably have a considerable number of students who, under arrangements made by the War Office for officers, would need special training for careers which they had not contemplated before the war. They would have to modify some of the conditions of entry into the University, for they could not expect the soldiers to wait until the beginning of another session. He foreshadowed large extensions in the work of the University. Referring to Sir Henry Miers' visit to America, he said an exchange of students and graduates would be of mutual advantage. Manchester was well situated for research work, owing to its industrial life and environment, and a large increase in the laboratory accommodation was needed. Besides the Chairs of Russian and Italian he would like to see others of Spanish and Scandinavian in order to complete the modern language school.

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Tenders Invited and Accepted.

BOOTLE Corporation invites schemes and tenders for the supply, delivery and erection of a complete street lighting equipment by means of half-watt lamps for four miles of tramway route throughout the borough. Particulars from the borough electrical engineer, Mr. T. Dawson, Clothier Electricity Works, Bootle.

WALSALL Corporation require tenders by Dec. 5 for supply and erection of 500kw. rotary converter equip ent. Specification from the Manager of the electricity department.

The SLIGO, LEITRIM & NORTHERN RAILWAY COMPANY require tenders by 10 a.m. Dec. 1 for 12 months' supply of stores, including electric telegraph materials, metals, leather belting, &c. Forms of tender from the Secretary, Enniskillen.

PLYMOUTH Corporation has accepted the following tenders: Johnson & Phillips, switch parts; Siemens Bros. Dynamo Works, switchgear, J. Howden & Company, steam turbo-alternator; British Electric Transformer Company, transformers.

MESSRS. DICK, KERR & COMPANY, LTD., have recently received an order for two 5,000 kw. turbo-alternator sets and condensing plants for the Union Minière du Haut Katanga, which is one of the largest copper producers in the world, outside the U.S.A., having extensive mining properties in the Belgian Congo. The turbines will be of the Willans-Zoelly type operating on steam at 145 lb. per square inch pressure and exhausting into a vacuum of 28 in. (Bar 30 in.) and will carry an overload of 6,250 kw. for 2 hours. The condensing plants are each designed to deal with 66,000 lb. of exhaust steam per hour and have 10,000 sq. ft. of cooling surface. The turbines will be coupled to Siemens' alternators designed for a normal output of 5,000 kw. at 0·9 power factor (5,560 k.v.a) when supplying three-phase current at 50 cycles and 6,600 volts pressure, and will be capable of carrying overloads of 25 per cent. for 2 hours or 50 per cent. momentarily. The ventilating air for these machines will be filtered in dry air filters of the Premier Cooler Company's make; the machines will each be fitted with a direct-coupled 110-volt exciter of the overhung type and will operate in conjunction with an automatic voltage regulator.

The following tenders were accepted by the BRITISH GOVERNMENT DEPARTMENTS during October:—

War Office.—W. Goodyear & Sons, H. Heaton & Sons, W. Makinson & Sons and A. Wiseman, cable drums; Austin Motor Co. (1914) and Keighley Gas & Oil Engine Co., generating sets; E. Brook, Ltd., and Electric Construction Co., motors, &c.; British Rubber Mfrs., Connolly Bros., Hooper's Telegraph & India Rubber Works, India Rubber, Gutta Percha & Telegraph Works Co., Johnson & Phillips and Siemens Bros. & Co., insulating tapes.

H.M. Office of Works.—Waygood & Otis, lift, at Treasure-building, Whitehall.

India Office.—General Electric Co., cells; T. Bolton & Sons, copper plates; Elliott's Metal Co., copper wire; Bullers, Ltd., insulators; Marconi's Wireless Telegraph Co., wireless gear.

General Post Office.—British L. M. Ericsson Mfg. Co., protective apparatus; Gell Telegraphic Appliances Syndicate, telegraph apparatus; British L. M. Ericsson Mfg. Co., Peel-Conner Telephone Works and Western Electric Co., telephone apparatus; Evershed & Vignolles, testing apparatus; Telegraph Construction & Maintenance Co., submarine cable; I. Frankenburg & Sons, W. Geipel & Co., Henley's Telegraph Works Co., New Gutta Precha Co., Siemens Bros. & Co., Telegraph Construction & Maintenance Co., and Western Electric Co., telegraph and telephone cable; Siemens Bros. & Co., Leclanché cells; Western Electric Co., induction coils; London Electric Wire Co. & Smith's, switchboard cords; Bullers, Ltd., insulators; British Insulated & Helsby Cables, cable distribution plugs; London Electric Firm, insulated tails; British L. M. Ericsson Mfg. Co., telephones; F. Smith & Co. (inc. in London Electric Wire Co. & Smith's) and Shropshire Iron Co., bronze wire; British Insulated & Helsby Cables, tinned copper wire.

Appointments Vacant and Filled.

A fuel and ash superintendent is required by Wolverhampton electrical engineer's department. Salary, including all war bonuses to date, £281. 5s. Applications to the Town Clerk by Dec. 17.

Manchester Electricity Committee require a shift engineer. Salary £250 plus £35. 2s. bonus. Applications to the Chairman of the Electricity Committee, Town Hall, Manchester, by Dec. 4.

Applications are invited for the position of professor of physics in the University of Cape Town. Salary £800 per annum. Applications by Jan. 1 to the High Commissioner for the Union of South Africa (32, Victoria street, London, S.W.1), from whom particulars can be obtained.

Messrs. W. R. Murray (Ayr), J. H. Thompson (Carlisle) and A. G. Walsh (Musselburgh) are on the short list for the post of burgh electrical engineer of STIRLING.

Mr. E. C. Kelly, publicity manager for Simplex Conduits, Ltd., is resigning in order to take up the representation of "The Engineer" for the Midland District.

Mr. W. H. Herod, who has been for 10 years with the London office of the Oerlikon Company, has joined the staff of the engineering department of the General Electric Company, Ltd., 67, Queen Victoria-street, E.C. 4.

Business Items.

In catalogue No. 186 of the Mitchell-Rand Mfg. Company, of New York City, there is listed and priced a large number of the company's insulating materials.

About 40 leading British firms have combined to form the London Iron & Steel Exchange, Ltd., whose offices are at 113, Queen Victoria-street, E.C. 4.

The Postmaster-General advertises for sale some plant, &c., at the P.O. Factory, Bovay-place, Holloway, N.7. Particulars and forms of tender from the Controller, P.O. Stores Department, Studd-street Depot, London, N.1. Tenders by 10 a.m. Dec. 6.

Leeds Corporation electricity dept. has for sale by private treaty a 2,000 B.H.P. Belliss engine, a 2,000 B.H.P. McLaren engine and two sets of surface condensing plant with air pumping engine, circulating engine and air pumping and circulating motors, and two 1,400 kw. two-phase alternators and exciters. Offers to the manager, electricity dept., 1, Whitehall-road, Leeds.

Bankruptcies and Liquidations.

An application for the discharge of James Brockie, mechanical engineer, 41, London-road, Forest Hill, London, S.E., was heard on Oct. 8 and adjourned sine die.

The Telephone Company of Egypt, Ltd., is being wound up voluntarily, and Mr. A. W. Wynn, 3, Fredericks-place, Old Jewry, London, E.C. 2, has been appointed liquidator. A meeting of creditors will be held at 3, Fredericks-place, on Dec. 9.

A meeting to receive an account of the winding up of Collings-Bishop, Ltd. (in vol. liq.), will be held at 67, Queen Victoria-street, London, E.C., on Dec. 23.

Companies' Meetings and Reports, &c.

British Westinghouse Electric & Manufacturing Co., Ltd.

At adjourned meetings of the preference shareholders on Monday amended proposals for modifying the rights of the holders of the preference shares were adopted. The CHAIRMAN (Mr. J. Annan Bryce, M.P.) stated that a conference was held between the financial group which was supporting the company and certain representatives of the preference shareholders on Thursday last, and certain concessions were made by Mr. Dudley Docker, as representing the financial group, and since then, after a further conference between a number of the preference shareholders themselves, it was decided to accept the offered terms. Those terms would be embodied, as regards one important point, in an amendment to the resolution which was before them last week, and as regarded the other important point in the new articles of association. The first concession made was that the dividend on the preference shares, instead of being 8 per cent. simple, should be 8 per cent. cumulative, and the second concession was that there should be a right of conversion from preference shares into ordinary shares at any time within two years after the first allotment of the new ordinary shares.

Mr. ROBERT H. BENSON said that the first point to be noted was that there was to be an 8 per cent. dividend on their preference shares, cumulative instead of contingent. There had never been a sufficient margin heretofore over and above the payment of 7½ per cent. dividend, nor was there likely to be unless fresh capital was found to rank behind their shares. Mr. Docker and his friends of the Metropolitan Carriage Wagon & Finance Company proposed to create £5,000,000 new ordinary shares, to rank behind the preference shares, and to issue them at par as fast as the development of the electrical manufacturing business demanded. There was to be an issue very soon of £1,000,000 of ordinary shares and the subscription was to be guaranteed at par without underwriting by the Metropolitan Carriage Company and their friends, and that £1,000,000 was to be followed by other amounts as further capital was required. Each £1,000,000 of capital put in behind their 8 per cent. preference shares, assuming that it was worth 6 per cent. per annum, meant a margin for them of £60,000 a year; so that when the whole contemplated £5,000,000 new ordinary share capital was issued there should be a margin of £300,000 a year to guarantee punctual payment of the dividend on their preference shares. If they could build the company's business up into a success comparable to that of the Metropolitan Carriage Company, then the shareholders would see their money back on their old £5 shares, and possibly more. They must remember that Mr. Docker and his friends were the largest preference shareholders. He concluded by moving an amendment to the resolution as proposed at the previous meeting, making the dividend on the preference shares cumulative instead of non-cumulative.

Mr. N. HERBERT SMITH seconded the amendment, which was adopted.

A separate meeting of ordinary shareholders was afterwards held, at which the proposed resolution modifying the rights and privileges attached to the shares, so that they should rank *pari passu* with the existing preference shares, was carried.

At an extraordinary general meeting of the company resolutions altering the memorandum of association, consenting to the increase of the capital, as proposed (including the proposed changes in the rights attaching to the shares) and adopting new regulations, were agreed to.

A dividend of 6 per cent., less tax, has been declared by the POWER GAS CORPORATION, LTD.

The CHLORIDE ELECTRICAL STORAGE COMPANY, LTD., has declared a dividend of 5 per cent. (tax free) on the ordinary shares.

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The dividend on the 6 per cent. cumulative preference stock of the BRITISH ELECTRIC TRACTION COMPANY, LTD., for the half-year to Sept. 30 is payable on Dec. 16.

A half-yearly dividend of 3½ per cent. (less tax), making 6 per cent. for the year (against 5 per cent. in 1917), has been declared by CALLENDER'S SHARE & INVESTMENT TRUST, LTD.

The directors of RUSTON & HORNSBY, LTD., have declared an interim dividend on the ordinary shares at the rate of 5 per cent. per annum, less tax, for the half-year ended Sept. 30.

MELBOURNE ELECTRIC SUPPLY COMPANY, LTD., has declared a final dividend on the consolidated ordinary stock of 5 per cent., free of British income tax, making 10 per cent. for the year ended Aug. 31.

A final dividend on the ordinary shares of 7 per cent., making 12 per cent., free of British income tax, has been declared by the ADELAIDE ELECTRIC SUPPLY COMPANY, LTD., for the year ended Aug. 31.

An interim dividend of 7½ per cent. has been declared on the ordinary shares of the BRITISH EVER-READY COMPANY, LTD. The usual dividend at the rate of 10 per cent. has been declared on the preference shares

The CEARA TRAMWAY, LIGHT & POWER COMPANY announces payment of interest on the debenture stock at £1. 19s. 3d. per cent. in cash and the balance of 10s. 9d. per cent. in profit warrants.

The Treasury sanction has been given to the issue of new capital by SIEMENS BROTHERS & COMPANY, LTD. It is stated that 80,000 shares of £5 each will be offered at par, and also £500,000 of 4½ per cent. debenture stock at £87. 10s.

The directors of the ELECTRIC CONSTRUCTION COMPANY, LTD., have declared interim dividends at rate of 7 per cent. per annum on the preference shares and at rate of 6 per cent. per annum on the ordinary shares, less tax, in respect of the year ending March 31, 1919.

In a circular issued by the directors of HUDSON'S CONSOLIDATED COMPANY, it is stated that the company has acquired an important group of properties, producing one of the elements indispensable to the manufacture of high-class steel, and electric plant is being erected.

The following COMPANIES WILL BE STRUCK OFF the Register of Joint Stock Companies unless cause to the contrary is shown before Feb. 12, 1919: Grindell-Matthews Wireless Telephone Syndicate, Patent Protection Association, Prested Miners' Gas-Indicating Electric Lamp Company.

The net profit of the AMALGAMATED WIRELESS (AUSTRALIA), LTD., for the half-year ended June 30 was £3,650. 15s. 9d., which, with £574 brought forward, made a total of £4,224. 16s. 2d. A dividend for the half-year at the rate of 5 per cent. per annum was declared, after placing £500 to reserve, £224. 16s. 2d. being carried forward. The number of vessels equipped with the company's apparatus is continually increasing.

The report of the MONTEVIDEO TELEPHONE COMPANY, LTD., for the year ended July 31 last states that, after providing for all charges in Montevideo and London, and making provision for income tax and excess profits duty, the net profit amounts to £27,780, against £26,324 in the previous year. Interim dividends paid in May absorbed £4,343, leaving £23,438, which added to £6,332 brought forward makes £29,770. After applying £8,000 to depreciation of property and plant, and transferring £9,000 to reserve for renewals, the directors recommend a final dividend of 3 per cent., tax free, on the ordinary shares, making 6 per cent. for the year, leaving £8,428 to be carried forward.

At the recent meeting of the INTERNATIONAL LIGHT & POWER COMPANY, the chairman (Mr. Follet Holt) said that he had little to add to the short but entirely satisfactory statement in the report concerning their Caracas property. At Parana the supply of electric current, thanks to the high efficiency of the power plant, yielded good profits, but the gas department was less fortunate. A dividend on account of accrued arrears, equivalent to two quarters at the rate of 6 per cent. per annum, had just been paid to the preference shareholders, and they were considering how they could best deal with the remaining arrears. They had spent during the past few years about £50,000 on improving their properties. During the war period they had passed through very difficult times, and he wished to thank Messrs. J. G. White & Company, Ltd., who had looked after the technical management of their subsidiaries and controlled them with the greatest care and skill.

An extraordinary meeting of the ORIENTAL TELEPHONE & ELECTRIC COMPANY was held last week, when a resolution was passed declaring that £1. 6s. per ordinary share—being part of the moneys resulting from the conversion into money and collection of certain capital assets, and being surplus money, notwithstanding the distribution of which there will still remain assets sufficient to answer the whole of the liabilities and paid-up share capital—be appropriated as capital among the holders of the ordinary shares. This course was foreshadowed in the report of 1917, in which it was stated that the directors proposed to increase the capital to £400,000 by the creation of a further 100,000 ordinary shares of £1 each, and to take power, subject to the preference dividend not being in arrears, to capitalise and distribute undivided profits.

The report of the BARCELONA TRACTION, LIGHT & POWER COMPANY for 1917 contains a letter from the president, in which it is stated that progress in Spain was satisfactory. On the new power plant at Camarasa there is some hope of bringing one unit into operation before the end of 1919. Subsequent to June, 1917, £260,000 prior lien "A" bonds were sold, and early in the present year a further £400,000 of the bonds were sold in Spain, thereby providing the funds required in 1918. Combined surplus earnings of the Ebro Irrigation & Power Company, the Ferrocarriles de Cataluña and the Ferrocarril de Sarria a Barcelona were larger by $479,648 than in 1916. Net revenue was $2,354,964, against $1,875,315, and interest on prior lien "A" bonds $378,352, against $331,900, leaving $1,976,612, against $1,543,415. The extension of the Ferrocarriles de Cataluña proceeded. The line was opened for traffic to San Cugat in December, 1917, and to Rubi in September, 1918. It is expected that the railway will be completed to Tarassa in 1919. Traffic returns have been satisfactory.

The report of the directors of the WESTERN TELEGRAPH COMPANY, LTD., for the year ended June 30 last states that the revenue for the period amounted to £1,465,911. 3s. 5d., and the working expenses to £528,602. 4s. 6d. After providing £32,747 for debenture stock interest, and £385,520. 19s. 2d. for income tax and excess profits duty, the balance is £519,040. 19s. 9d. With the sum of £35,432. 19s. 2d. brought forward, the total is £554,473. 18s. 11d. The directors have transferred £250,000 to general reserve, £30,000 to land and buildings depreciation fund, £50,000 to maintenance ships reserve fund, and £25,000 to the provision on account of investment fluctuations. Three interim dividends of 1½ per cent. each, and a final dividend of 1½ per cent., also a bonus of 2 per cent. have been paid, amounting together to £166,344, making a total distribution of 8 per cent., tax free, for the year ended June 30, 1918, leaving £33,129. 18s. 11d. to be carried forward. The deputy-chairman, Sir John Denison-Pender, K.C.M.G., has been elected chairman, in succession to the late Sir John Wolfe Barry, K.C.B.

At the ordinary general meeting of the AMAZON TELEGRAPH COMPANY, LTD., on Tuesday, the chairman (Mr. CHAS. W. PARISH) stated that while Brazil as a whole had gained from the war, owing to increases in her exports and the development of new industries, they had not been so fortunate on the Amazon, where difficult conditions had been experienced. Shortage of tonnage and the restrictions on imports into this country and the United States had been severe handicaps to business. Still, those difficulties had been of benefit to the company, as they had necessitated the sending of a large number of telegrams. Their traffic receipts amounted to £59,158, compared with £51,166 for the previous year, an increase of £7,992. Brazilian Government subsidy and interest were both slightly higher, and the gross revenue amounted to £80,455, an increase of £8,311. While most of the expenditure items showed a slight increase the cost of maintaining cables had amounted to only £12,476, or £2,409 less than in the previous year. The total working expenses were £31,598, or under 40 per cent. of the gross revenue. The net revenue was £48,857, against £40,605, an increase of £8,252, or over 20 per cent., and the available balance was £32,139. After placing £17,000 to general reserve, they recommended payment of a dividend of 4½ per cent. (less tax), leaving £6,842 to be carried forward. It was impossible to foretell what conditions were likely to prevail in the rubber market during the remainder of the current year, but it appeared to be the general opinion that, when peace was settled and normal shipping facilities were available, there was bound to be a great demand for rubber, and if that should be so it should bring in additional revenue to the company. The expectation of a further expansion in the service of local deferred messages had been justified, as 107,262 more local deferred words had been sent during the year under review, an increase of 133 per cent., and the receipts from that class of traffic were £5,459 more than in the previous year.

New Companies, &c.

ARMA MANUFACTURING COMPANY, LTD. (151,850.)—Private company. Nov 2, capital £5,000 in £1 shares, to take over the business of a manufacturer of and dealer in dry cell batteries carried on by Edouard Armelin. First directors: E. Armelin and H. A. French.

ELECTRICAL COMPANY (GLASGOW), LTD. (10,145.)—Private company. Reg. Nov. 4, capital £2,500 in £1 shares, to carry on the business of engineers, patternmakers, boilermakers, millwrights, metal workers and manufacturers, &c. First directors: G. B. Crockatt, J. Dickie, J. A. Hood, W. Neilson and A. J. Smith. Reg. office: 65, Bath-street, Glasgow.

INTERALLIED TRADE & BANKING CORPORATION, LTD.—Reg. Nov. 18, capital £1,000,000 in £1 shares, to promote and foster trade and commerce between the United Kingdom and other countries, &c. First directors are Sir M. Bonham Carter, A. Lowenstein (Belgian), J. C. Van der Faelin (Belgian) and B. H. Binder.

MANCHESTER ALUMINIUM COMPANY, LTD. (151,804).—Private company. Reg. Oct. 29, capital £5,000 in £1 shares, to carry on the business of importers and exporters and dealers in metal, metal scrap or ores, aluminium, &c. First directors are J. D. Paton and J. Ashworth. Reg. office: 25, Market street, Manchester.

Mortgages and Charges.

GEORGE W. GREEN & COMPANY, LTD.—Debenture dated Oct. 8, 1918, charged on company's undertaking and property, present and future, securing £300. Holder: G. W. Green.

LAING, WHARTON, LTD.—Mortgage debenture dated Nov. 1, 1918, charged on Company's undertaking and property, present and future, securing £1,000. Holders: Ministry of Munitions.

Satisfaction in full on Oct. 25, 1918, of debentures dated July 26, 1918, securing £500.

SMALL ELECTRIC MOTORS LTD.—Mortgage dated Oct. 29, 1918, to secure £2,500, charged on Eagle Works and land adjoining in Beckenham. Holder: S. H. G. Turney, 7, Park-square, London, W.

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CONTENTS.

NOTES 655
Arrangements for the Week 657
Some Experiments With Long Electrical Conductors. By John H. Morecroft. Illustrated 658
The Future of Electric Traction 660
The Organisation of Technical Staffs. By a Correspondent 661
Science and the Future 663
Transformer Oil. By W. S. Flight, A.M.I.E.E. Illustrated.—*Continued* 664
Natural Gas Fuel in America 667
Government Control of Industry 667
TRADE UNIONS FOR ENGINEERS 668
Some Developments in Industry During the War 669
Mr. A. P. M. Fleming's Address to the North-Western Centre of the Institution of Electrical Engineers 670
CORRESPONDENCE 671
The Use of High-Pressure and High-Temperature Steam in Large Power Stations 672
Volunteer Notices 672
Electricity in Birmingham Industries 673
PARLIAMENTARY INTELLIGENCE 673
LEGAL INTELLIGENCE 673
Patent Record 674
Commercial Topics 674
Electricity Supply 675
Companies' Meetings and Reports 677

Notes.

Instructions for Demobilisation.

GENERAL instructions have now been issued which are to be followed by men who are anxious to leave the Colours and by employers who are anxious to get back some of the men who have been taken from them during the last year or two. No doubt a certain amount of formality is inevitable in work of this kind. This should, however, be reduced to a minimum, more particularly in dealing with men who are required very urgently by various industries. There is no question that our industries have been seriously depleted by recruiting officers. We do not complain of this, but, from the point of view of regaining our industrial position, it is essential that many of these men should be got back to work as soon as possible. Perhaps the most serious complaint to be made against the present regulations is that some of the forms are to go through the Labour Exchanges. As is well known, these are notoriously inefficient and have never given satisfaction. Probably they never will give satisfaction, and they will form an instance of the disadvantage of Government enterprise as compared with corresponding enterprises run by private capital. Be this as it may, we trust that the authorities will do all they can to simplify the procedure. At present it is noticeable that the daily papers are filled with advertisements of situations vacant, whereas there are very few advertisements of those who are anxious to get back to work. As to munition workers, the position is not so clear; but, in any case, the demand is evidently very one-sided. In the general instructions stress is laid upon the importance of "pivotal" men, and there is no question that these men should be released first. Certain industries are named in this connection, and although civil, mechanical and mining engineering are to be found among them, we are surprised that there should be no mention of electrical engineering. This branch of engineering surely includes as many pivotal positions as other branches.

The 48-Hour Week.

INVESTIGATION of the reports issued by the Government during the war in connection with welfare of munition workers lead inevitably to the conclusion that the 54-hour week, and any more extended periods, such as have been commonly adopted, are far from satisfactory. They necessitate working before breakfast, which in itself is inefficient. This is followed by a break of half an hour, which again entails general loss of time. There is no question that from the point of view of efficient working it is far better to abolish work before breakfast and to adopt a 48-hour week, or possibly 47 hours, such as has been in force among a certain number of firms. This not only leads to better efficiency, but also to less lost time and less absence on account of sickness. We are, therefore, glad to note that some of the engineering associations are adopting the shorter week. It is regrettable, however, to read that in the case of the employees of Messrs. J. Dawson & Company, of Newcastle-on-Tyne, a resolution has been adopted pledging them to oppose this offer, which is characterised as "an insult to the intelligence of the present-day workman." As an alternative, a 36-hour maximum working week, with no reduction in weekly rates of wages, is put forward, with the object of absorbing unemployed workers who could then be employed on productive work. Although the transition from the making of munitions to ordinary manufacturing will, no doubt, be difficult, and will entail, as the Government has already realised, a certain amount of expenditure for only a small equivalent in output, it is, nevertheless, unfortunate that the frame of mind exhibited by such a resolution should be evident at the present time. We fear it shows a lack of appreciation of the fact that both employers and employed must work together, that production is all important, and that the present high cost of living is dependent to no small extent upon the high rates of wages at present holding.

Science and the Future.

THE address delivered by Mr. A. A. CAMPBELL SWINTON to the Royal Society of Arts on November 20th was in several respects complementary to that delivered last year. At the commencement of the last session he dealt mainly with the development of science in the past; on this occasion he took some speculative flights into the future. At the same time, he reverted to several topical problems, such as the relative claims of scientific and "humanistic" education, the encouragement of inventors, and the relation between industry and the State. Some of these are highly debatable matters, but on several points we find ourselves in cordial agreement with the author. We concur, for example, with his contention that the conception of an inventor or scientist as properly and necessarily poor has been overdone. No doubt necessity is the mother of invention, but in many cases extreme poverty has been a crippling circumstance. Scientific men naturally revolt from the popular impression that in their case the labourer can dispense with his hire. Mr. SWINTON also paid a fitting tribute to one branch of education that is apt to be overlooked—namely, the acquirement of knowledge through the medium of technical books and periodicals. When so

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much is said on the encouragement of education at universities, schools and colleges, it seems rather strange that the claims of technical journals, which have borne so much of the brunt of educational work, receive scant notice. We agree also that, generally speaking, the facilities in the way of libraries need development. They should be more readily available in the evening, which is the only time when most people can make use of them, and it should be possible to borrow scientific works with the same freedom as books of travel, biography or fiction. An even greater need, on which we recently laid stress, is the centralisation of such libraries through the medium of a United Engineering Societies Building.

Looking Ahead.

IN the latter part of the address Mr. CAMPBELL SWINTON struck the right note in emphasising the need for taking long views in judging scientific discoveries. While the war has brought such devastation in material property, it is satisfactory to think that one important asset, the scientific knowledge of the world, has suffered little, and has even been extended. In judging the utility of such knowledge we must look far ahead. We must remember that long periods of time were necessary for the development of the steam engine and the dynamo, and that in the centuries to come, when our coal fields are exhausted, or when the population of the world threatens to surpass the facilities for its maintenance, science may have restored the balance by new strides unthought of now. So, also, with the developments of the immediate future. While at present we seem to be approaching the limits of efficiency in converting coal into electric power, there may yet be possibilities opened up in unexpected directions, possibly by the discovery of more highly conducting materials for transmission, or through new processes for using water-power or solar energy. It is remarked that up to the present the only proved method of converting latent energy into electrical energy in bulk is the heat engine. But it is still possible that, in the future, the primary battery, the thermopile, and even photo-electrical processes for the conversion of radiant energy from the sun, may come into their own.

Industrial Developments During the War.

WHEN the complete history of the war is written one of the most remarkable sections will be that describing the industrial development in Great Britain. Last week Mr. F. KELLAWAY, M.P., Parliamentary and Financial Secretary of the Ministry of Munitions, delivered an address to the Industrial Reconstruction Council, in which he outlined some of the developments that have taken place. Certain of the figures given by Mr. KELLAWAY are already known, and were emphasised at the exhibition recently promoted by the Tariff Reform League. The present address, however, gives a more detailed survey in some respects, and serves to show the extent to which German peaceful penetration was practised in order to control our "key" industries. Mica may be taken as an illustration. About 50 per cent. of this mineral is produced in India and 15 per cent. in Canada; but at the outbreak of war the mica market of the world was on the point of being transferred from London to Hamburg, thanks to the skill with which Germany had obtained a large measure of control of the Indian mines. In the case of tungsten, practically the whole of the ore was handled by Germany. Endeavours were made by two firms in this country to manufacture tungsten, but difficulty was experienced, and one of these firms was only able to maintain its position by contracting to supply the whole of its output to Messrs. Krupp. A large plant has now been established at Newcastle. As is well known, zinc was practically controlled by Germany, although the zinc concentrates are mostly obtained from Australia. With regard to potash the position is different, because the chief potash mines belonged to Germany, and without doubt the German owners of these mines hoped to re-establish their position in the world's markets after the war owing to these advantages. This hope, however, is doomed to disappointment, owing to the fact that large quantities of potash go to waste every year in this country in the dust or fumes from blast furnace gases, and this is now being recovered, so that we shall be independent of German sources. These are only a few of the many cases in which we are meeting our own needs. In all probability some people will take the view that it is not worth while to continue these activities if the products can be obtained more cheaply from Germany after the war. It is scarcely to be supposed, however, that those responsible for the safety of the country will accept this view. When it is remembered how long it takes to bring about large industrial developments it will be realised what a very heavy risk was run by this country, and that if Germany had been more successful from the military point of view at the beginning of the war there might have been insufficient time for any such developments to take effect.

Boy Welfare.

THE subject of boy welfare has been forced on the attention of employers during the war, for the new industrial conditions appeared to create special difficulties in regard to boy labour. From all over the country complaints were received; juvenile crime was on the increase, boys were getting out of hand, and jobs were thrown up for trivial causes, all of which interfered with the required increase in output. This was due, no doubt, to the fact that under the stress and strain of severe work the boy was in danger of being overlooked, both as a future workman and as a future citizen. Consequently, in March, 1916, the MINISTER OF MUNITIONS decided to take steps to ensure that the boy had a chance of development in spite of the urgent needs of war. The Boy Welfare Department was the result, and a scheme was put forward based on what was being done by employers who were known to be successful in handling their boy labour. This proved to be acceptable, not merely because it led to an increase of output or profit, but because it was found that it created an improved tone in the works. We have now received the first issue of the "Boys' Welfare Journal," in which the history of the movement is outlined, and which includes a number of short articles dealing with various aspects of such welfare. Primarily the "Journal" is intended for welfare supervisors, and we think this point of view is the one which should be adopted. Nevertheless, we notice one article which is addressed to boys. We cannot imagine, however, that there will be many boy readers of this "Journal." Any boy would far rather have a copy of the "Boys' Own Paper," or some such competitor. We suggest, therefore, that the editor would do well to restrict the contents to such as will be useful to the supervisor. It is pointed out very properly that welfare is not a philanthropic movement, nor is it efficiency camouflaged. There is a broader basis for the movement than that. Boy welfare has shown its value during the stress of war, and it would be very unfortunate if it were neglected in the days of peace. We hope that the present "Journal" will do something to keep the importance of the subject before the employer, so that every works will number a Boys' Welfare Supervisor among its staff.

Industrial Reconstruction Council.—The last of the first series of lectures arranged by the Industrial Reconstruction Council will be held in the Saddlers' Hall, Cheapside, E.C. 2, on Wednesday, December 11th. The chair will be taken at 4.30 by the Marquess of Salisbury, K.G., and a lecture on "Science and Industry" will be delivered by Sir William S. McCormick, LL.D., of the Department of Industrial and Scientific Research. Applications for tickets should be made to the Secretary, I.R.C., 2 and 4, Tudor-street, E.C. 4.

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Institution of Electrical Engineers.—A meeting of the Institution will be held next Thursday to discuss the subject of "Electric Welding." Copies of "Notes on Arc Welding Regulations" (by Mr. H. M. Sayers) can be obtained on application to the Secretary. It is not intended, however, to limit the discussion to "Regulations," but that it should cover "Electric Welding" in general. Those wishing to take part in the discussion are invited to send their names to the Secretary before the meeting if possible.

Large Trolley-Wheels.—In the "Electric Railway Journal" some account is given of the experience of the Oakland, Antioch and Eastern Railway with 10 in. trolley-wheels. Formerly 6 in. wheels were used, the trolley pole tension being 35–40 lb., and the life in these circumstances was only about 90 miles. By using 10 in. wheels the tension can be reduced to 25–30 lb. and a life of 6,000 miles or more is obtained. In addition various incidental maintenance troubles are diminished.

Wind-Driven Dynamos.—An account was recently given in "Ingenioren" by Mr. H. C. Vogt, of some experience of the utilisation of wind-power for driving dynamos. The mills described had sails 100 ft. in diameter and an area of 3,930 sq. ft. With a mean wind velocity of 24 ft. per second 290 H.P. was obtained. Power is transmitted from the main shaft by a series of cog wheels with the spokes in tension; rope and chain gearing were found not to answer. By means of gearing the speed of the main shaft, 12½ revs. per min. is increased to 1,500 revs. per min. for the dynamo.

Institute of Metals.—A general discussion on "The Relation of Science to the Non-ferrous Metals Industry" will form the central feature of the forthcoming annual general meeting of the Institute of Metals. At that meeting there will also be presented several important Papers, the publication of which has been withheld owing to the operation of the Censorship. The meeting, which will be the first peace-time gathering of the Institute for five years, is, therefore, to be anticipated with great interest, as is also the Annual May Lecture, which will be delivered by Prof. F. Soddy, M.A., F.R.S., on the subject of "Radioactivity." A Local Section of the Institute of Metals has been formed in Sheffield, the recently dissolved Sheffield Society of Applied Metallurgy forming the nucleus of the new section.

Exhibition of British Science Products.—There will be an exhibit of British books on applied science and technology, including industrial administration, at the Manchester Exhibition of British Science Products which is to be held at the College of Technology, Manchester, from December 27, 1918, to January 9, 1919. The exhibition will be largely a reproduction of the one held at King's College, London, during August and September of this year. Mr. C. H. Barber, 24, St. Ann-street, Manchester, will take charge of the exhibit, and will be in attendance at the stall during the Exhibition. Intending exhibitors of books are requested to communicate with Mr. H. M. McKechnie, secretary to the Manchester University Press, 12, Lime-grove, Oxford-road, Manchester.

Royal Naval Division.—A relief Committee was formed in November, 1914, in connection with the Divisional Engineers of the Royal Naval Division by members of the Institution of Electrical Engineers, in whose premises the recruiting was carried out, assisted by members of the Institution of Civil Engineers and of the Institution of Mechanical Engineers. Necessitous cases, mainly due to delay in the payment of separation allowances, were at first investigated and relieved by the Soldiers' and Sailors' Families Association. The late Mr. Wm. Duddell took an active interest in this. A fund was subscribed in anticipation of further need for assistance, but the Divisional Engineers afterwards became dispersed, and, while nominally belonging in some respects to the Royal Naval Division, ceased to exist as the Divisional Engineers. Meanwhile, the Royal Naval Division Comforts Fund, with offices at 11, St. James'-square, S.W.1, has been actively engaged in sending food to prisoners of war in Germany, and is now winding up its organisation with a financial deficit. The surviving members of the Committee and contributors to the Divisional Engineers' Fund have agreed to hand it over to the Royal Naval Division Comforts' Fund, and the sum of £31. 18s. 2d. has accordingly been thus dealt with.

Changes in Specific Inductive Capacity.—In a short contribution on the above subject by Messrs. H. C. P. Weber and T. C. MacKay, to the "Journal of the Franklin Institute," some interesting facts are disclosed. The authors originally employed a form of substitution resistance method, a high frequency generator and telephone being used. Ultimately a bridge method was used, the two proportional arms being each of 9,000 ohms resistance, and the other two arms respectively the condenser containing the sample and a calibrated air condenser. The sample holder consisted of massive iron electrodes kept at the required distance of separation by small glass stops. The capacity was of the order of 0·0002 m.f. Impregnation was found to change the thickness of the paper by 10–35 per cent., according to the nature of the substance. Curves are presented showing the effect of temperature on capacity, with various materials, *i.e.*, paper containing respectively montan wax, carnauba wax and ammonium stearate, and these substances by themselves. An increase in temperature from 20 deg. to 100 deg. in most cases gave rise to a decided rise in capacity, but in some cases a fall occurs as the higher temperatures are reached, following the initial rise. For acids and acid derivatives there is an appreciable difference between results obtained with impregnated paper and the pure material, but the latter are less influenced by temperature changes. The nature of the change seems to bear a definite relation to the composition of the material, and further work on the subject seems desirable.

Personal.

Mr. Theodore N. Vail, president of the American Telegraph & Telephone Company, is to assist as personal adviser to the U.S.A. Postmaster-General in the organisation of the telephone, telegraph and cable systems under Government control.

It is reported that Sir William Maxwell, formerly Director-General of Indian Posts and Telegraphs, retired from that appointment as from Sept. 26.

Arrangements for the Week.

SATURDAY, Dec. 7th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. At the Swan Hotel, New-street, Birmingham. Annual General Meeting.

MONDAY, Dec. 9th.

ROYAL SOCIETY OF ARTS.

5 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Physical Chemistry and its Bearing on the Chemical and Allied Industries," by Prof. J. C. Philip, O.B.E. (Lecture II.)

JUNIOR INSTITUTION OF ENGINEERS, NORTH-WESTERN SECTION.

7.30 p.m. At the Manchester Photographic Society, Carr-street, Blackfriars, Manchester. Paper on "Pressure Gauges," by Mr. G. A. Napier.

TUESDAY, Dec. 10th.

INSTITUTION OF ELECTRICAL ENGINEERS, NORTH-WESTERN CENTRE.

7 p.m. At the Engineers' Club, Manchester. Address by the President, Mr. C. H. Wordingham.

INSTITUTION OF ELECTRICAL ENGINEERS (SCOTTISH CENTRE).

7.30 p.m. At The Rooms, 207, Bath-street, Glasgow. Paper on "The Use of High Pressure and High Temperature Steam in Large Power Stations," by Mr. J. H. Shaw.

JUNIOR INSTITUTION OF ENGINEERS, NORTH-EASTERN SECTION.

7.15 p.m. At the Mining Institute, Newcastle-on-Tyne. Paper on "Pumps, Condenser Systems, &c.," by Messrs. T. W. Stewert and H. J. Aldis.

WEDNESDAY, Dec. 11th.

ASSOCIATION OF ENGINEERS-IN-CHARGE.

7.30 p.m. At St. Bride Institute, Bride-lane, Fleet-street, London, E.C. Paper on "The Winning and Transport of Fuel," by Mr. J. H. Anderson, M.I.Min.E.

THURSDAY, Dec. 12th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. Discussion on "Electric Welding." Paper entitled "Notes on Arc Welding Regulations," by Mr. H. M. Sayers, M.I.E.E.

FRIDAY, Dec. 13th.

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Gt. George-street, London, S.W. General Meeting.

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Some Experiments With Long Electrical Conductors.*

By JOHN H. MORECROFT.

Summary.—Working at frequencies from 12 to 152 cycles per second, an artificial antenna made up of numerous sections each having lumped capacity and inductance (and closely simulating an actual antenna), is carefully studied. The effective capacity, inductance and resistance are measured and found to agree with theory; and the theoretical effects of capacity and inductance loading are similarly experimentally verified.

The object of this Paper is to give an elementary non-mathematical discussion of long electrical conductors, showing how the apparent inductance, capacity and resistance of such conductors depend upon the frequency, loading &c.; also to show the distribution of current and potential particularly with quarter wave length oscillations used in radio antennæ.

A "long electrical conductor" is one on which an appreciable portion of a wave length is developed. The conductors considered have electrical lengths from one quarter to one twentieth of the wave length of the impressed frequency. However, the electrical length of a conductor depends entirely upon the frequency used in exciting it.

In a short conductor (loaded only at its end) the current is practically the same throughout the length of the line, but in a long electrical conductor it varies widely. Thus a transmission line 100 miles (160 km.) long might have a current of 100 amperes at the generator end and 98 amperes at the load end while the 1,000 ft. (300 m.) antenna might have 100 amperes at the beginning and no current at all at the farther end.

An electrical conductor, such as an antenna, differs from the ordinary alternating current circuit, in that its inductance and capacity are *distributed*; to such a conductor formulæ which solve circuits having concentrated inductance and capacity do not, in general, apply. To illustrate this point consider two circuits as illustrated in Fig. 1. In sketch *a* are shown an inductance *L* and

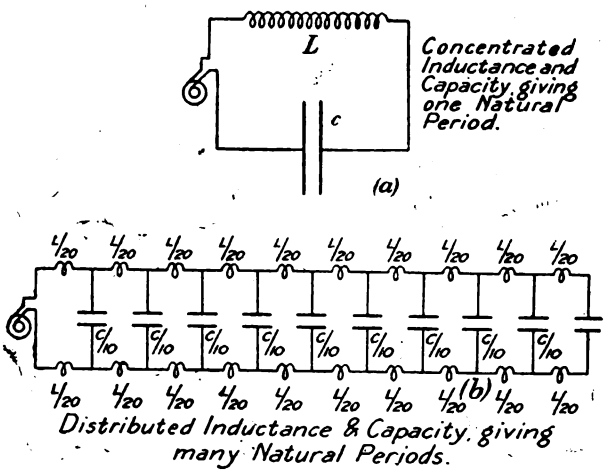

FIG. 1.

capacity *C*; if the voltage of the exciting alternator is constant and the frequency varied at a certain frequency the current is a maximum and power factor is unity. There is only *one frequency* where these conditions hold, given by the well-known formula,

$$f=\frac{1}{2\pi}\sqrt{LC}.$$

In sketch *b* is shown the same amount of inductance and capacity but divided and distributed uniformly. If we excite this circuit as before, there will be *many frequencies* at which the power factor is unity and the current has a maximum value and none of these frequencies satisfy the above formula for resonance. There can be only one frequency which gives a *real* maximum of current but the other resonant frequencies give current values nearly equal to the maximum.

Experiments were carried out to illustrate this feature of multiple resonance of the distributed *L* and *C* conductor, an artificial line being used in the laboratory, made up of nine coils and condenser sections. The coils were wound of stranded conductor. Each had an inductance of 0·0415 henry and resistance of 0·702 ohm. They were air core coils and weighed about 75 lb. (34 kg.) each. The capacity units were specially built telephone condensers, having rather small losses (at the frequencies used) and capable of withstanding 750 volts. Measurements showed an average capacity of 0·915 μf. About 400 condensers were used in some tests.

With such a relatively large current capacity ordinary ammeters and voltmeters could be used for most measurements. This line made up of coils and condensers is styled a "lumpy line"; but when the number of lumps is greater than six per wave length the lumpy line acts almost like a uniform line. In most tests there were more than 25 lumps per wave length.

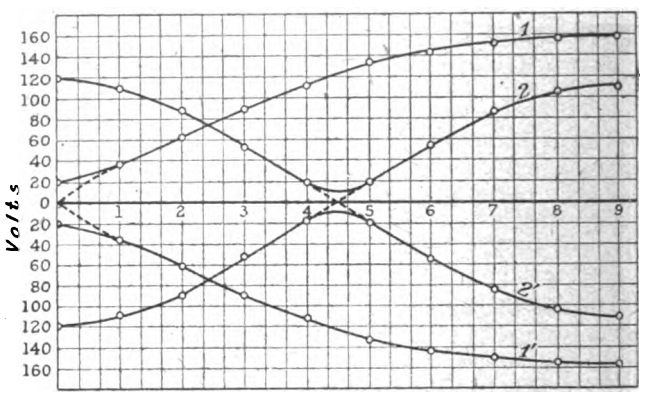

FIG. 2.—STANDING WAVES. VOLTAGE AT SECTION POINTS.

Impressed frequency 1-1′=22·8 ∞; 2-2′=45·5 ∞. Section constants R=0·702 ω; L=0·0415 h.; C=36·6 mf.

In the first experiment a constant voltage of 20 was maintained. The frequency impressed varied from 12 cycles to 152 cycles per second. Three resonant points (maximum current) were obtained and a fourth one nearly defined.

Besides the ammeter and voltmeter, a wattmeter was used to measure the power supply to the line. Thus it was possible to obtain the apparent resistance of the line, the reactance and the angle of phase difference between *E* and *I*.

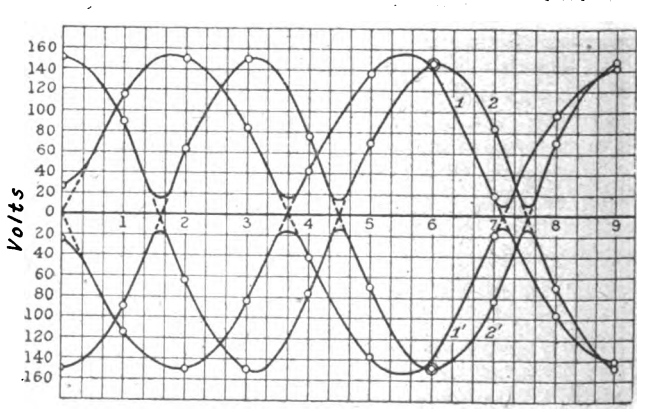

FIG. 3.—STANDING WAVES. VOLTAGE AT SECTION POINTS

Impressed frequency 1-1′=114 ∞; 2-2′=135 ∞. Section constants R=0·702 ω; L=0·0415 h.; C=36·6 mf.

Clearly such a line cannot be said to have any definite resistance or reactance unless the frequency is specified. The resistance, for example, varies between 3 ohms and 350 ohms, the reactance between 165 positive ohms (inductance) and 165 negative ohms (capacitance), the angle between the voltage and current changes periodically from 75 deg. lead to 75 deg. lag.

When the resistance of a long line is small compared to the reactance the frequencies at which resonance occurs are all odd

* Abstract of a Paper read before the Institute of Radio Engineers.

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multiples of the lowest frequency. Thus 68 cycles is three times 22·8 cycles (the lowest frequency) and 114 cycles is five times the lowest frequency. But if we define resonance in the more general sense as being that frequency which makes the reactance of the line zero, both even and odd multiples of the fundamental frequency give resonance. Thus we have as the resonant frequencies of this line 22·8, 45·5, 68·0, 90·0, 114·0. Within experimental error these are all multiples of the fundamental frequency, 22·8 cycles per second. The results of above tests could be predicted by the use of suitable formulæ, such as are given in Kennelly's "Application of Hyperbolic Functions to Engineering Problems."

There was no perceptible leakage in the condensers, but some loss (very small at the frequencies used) due to dielectric hysteresis.

The current I_A should vary in accordance with the variations of tanh al as the frequency varied. By inspection of charts or tables

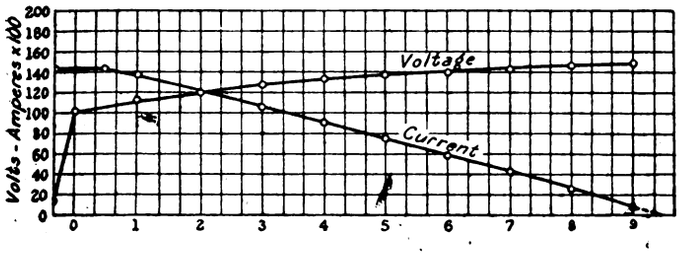

FIG. 4.

Line No. 2. Section Constants $L=0{\cdot}0415$ h.; $R=0{\cdot}702\omega$; $C=9{\cdot}15$ mf.; Load coil, $L=0{\cdot}617$ h.; $R=10{\cdot}7\omega$; Frequency $=20{\cdot}5\sim$.

it may be seen that with the values of al occurring in the test tanh al goes from maximum values of about 11 to minimum values of about 0·08.

The calculated range of current variation is then

$$\text{maximum } I_A=\frac{20}{33{\cdot}7}\times 11=6{\cdot}4 \text{ amperes}$$

$$\text{minimum } I_A=\frac{20}{33{\cdot}7}\times 0{\cdot}08=0{\cdot}05 \text{ ampere.}$$

Actually the variation was from 5·00 amperes to 0·06 ampere, a very fair agreement, considering that the condenser losses were

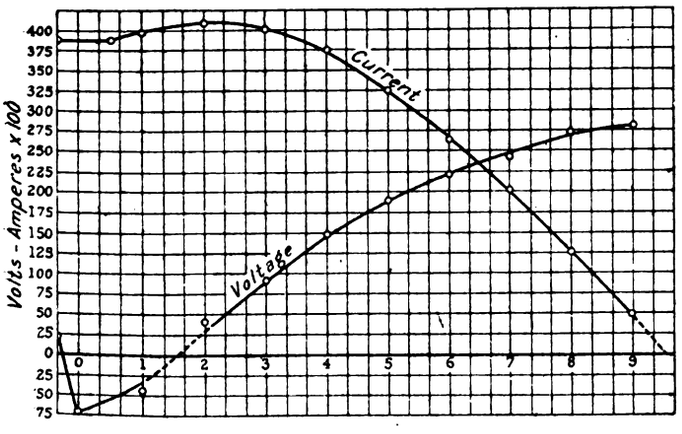

FIG. 5.

Line No. 2. Section Constants $L=0{\cdot}0415$ h.: $R=0{\cdot}702\omega$: $C=9{\cdot}15$ mf. Series Condenser $=165$ mf. Frequency $=52{\cdot}8\sim$.

neglected. Such losses decrease the theoretically predicted variation of current, as the test actually showed. Such an open circuited line will give various voltages at the far end as the frequency is varied, the impressed voltage remaining constant. Theoretically, if E_A=impressed voltage, E_B=voltage at open end, al=electrical length of line, then $E_B=E_A/\cosh al$, where $\cosh al$ is the hyperbolic cosine of the complex angle al.

This formula predicts that with an impressed voltage of 20 volts at 22·8 cycles the voltage at the open end should be about 220 volts. The measured value was only 157 volts at about eight times the impressed voltage. The condenser losses undoubtedly account for this discrepancy, as a very slight condenser loss increases the minimum value of $\cosh al$ very much.

When an open circuited line is one quarter wave length long standing waves are set up on the conductor, due to successive reflections from the open end and generator end combining in the right phase to change travelling waves into stationary waves. The standing wave for quarter wave length conductor has a minimum potential at the generator end and maximum at the open end; this form of wave is nearly represented by an ordinary sine or cosine wave. The current curve is also nearly sinusoidal, its maximum occurring at the generator end and zero value at the open end.

These curves of current and potential distribution are shown in text-books on radio telegraphy; but experimental results are rather meagre. Curves of voltage distribution were therefore obtained for the nine section conductor previously described, for that impressed frequency which gave quarter wave length and also several others, each being such as to make the line some multiple of $\pi/2$ hyperbolic angles long. These frequencies are resonant, making the reactance of the line zero. The form of voltage curve for each frequency is shown by the author in the original Paper.

In Fig. 2, curve 2–2′, the voltage distribution curve would apparently go through zero at the centre of the line. Actually there is no voltage node in the sense that the voltage is zero. This cannot occur unless energy is being supplied everywhere along the line at the same rate as it is being dissipated at that point. As this is practically never the case the so-called nodes are only pseudo nodes, the minimum amount of voltage being fixed by the amount of energy which must flow past the nodal point to maintain the line in a state of oscillation. In Fig. 2 this minimum voltage is about 10 volts. Another typical case is shown in Fig. 2

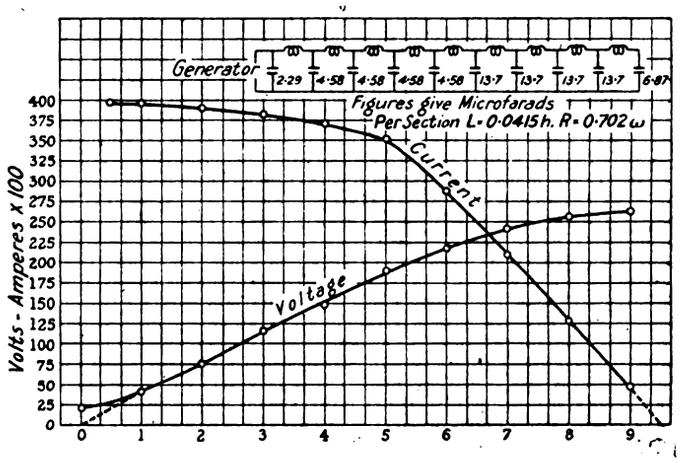

FIG. 6.

There are certain problems where distributed capacity and inductance may play a very important part in determining the node of oscillation. Thus a long Marconi aerial, having a natural wave length of 7,500 metres, if adjusted to emit a wave length of 10,000 metres or more, will not obey the ordinary equations for oscillations, connecting frequency, inductance and capacity. Also in determining the distributed capacity of coils ordinary formulæ give erroneous results, since the current and potential distribution largely affect the value of the constants to be determined.

An antenna is always excited to oscillate in the quarter wave length conditions as shown in Fig. 2, curve 1–1′. It could not be made to oscillate strongly at the half wave length condition of curve 2–2′, but might oscillate very well at the three quarter wave length condition and at one and a quarter wave length oscillation as shown by curve 1–1′ of Fig. 3.

A long uniform antenna could be made to have any of these three modes of oscillation (or others), but the normal operation for radiation efficiency requires oscillation at the quarter wave length condition. Further experimental data were obtained on current and voltage distribution in a line oscillating at quarter wave length. If a series inductance or condenser be added in the laboratory model the distribution of current and potential will be the same as occur on an actual antenna to which such adjustments have been made for the purpose of lengthening or shortening the radiated wave. Experimental data on such oscillation are given by the author in the original Paper in the form of a series of diagrams. The natural frequency was 45·2 cycles. By adding 0·142 henry in series, the quarter wave length frequency dropped to 32·6 cycles per second; and by adding 0·617 henry this was further reduced to 20·5 cycles. The current and potential distribution shown in Fig. 4 give the conditions on a long uniform aerial emitting a wave

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about 2·5 times the natural wave length. As inductance is added in the base of an antenna the potential tends to become uniform over the whole length of the antenna; the current decreases from the ground end toward zero at the open end on a nearly straight line instead of a sine curve as it does for an unloaded antenna.

The current and voltage distribution are nearly sine waves, as for the unloaded line, irrespective of the frequency. But when the frequency is less than the natural, less than one quarter of a complete sine wave occurs, and when the frequency is greater more than one quarter of a whole sine curve occurs. Many antennæ have an irregular distribution of capacity, as for example a T antenna, which has more capacity per unit length at the top than at the beginning. Fig. 6 shows the distribution of current and potential in such an antenna. The total capacity and inductance of the line is the same as was used for the previous uniform line, but the natural frequency is now only 40·1 cycles as compared to 45·2 cycles for the uniform line.

In the following table are shown the total inductances and capacities for each line, the frequencies calculated from these quantities, the frequency which actually gave quarter wave length vibration and the ratio of these two frequencies.

Total L.	Total C.	$\frac{1}{2\pi\sqrt{LC}}$	Measured frequency.	Meas. freq., Cal. freq.
Line 1 0·374	329·00	14·3	22·5	63·6 per cent.
Line 2 0·374	82·30	28·7	45·2	63·5 per cent.
Line 3 0·374	16·45	64·2	100·5	63·8 per cent.

In each case above the lines have no added series inductance or capacity the line was quarter wave length long and the voltage and current curves were nearly sine waves.

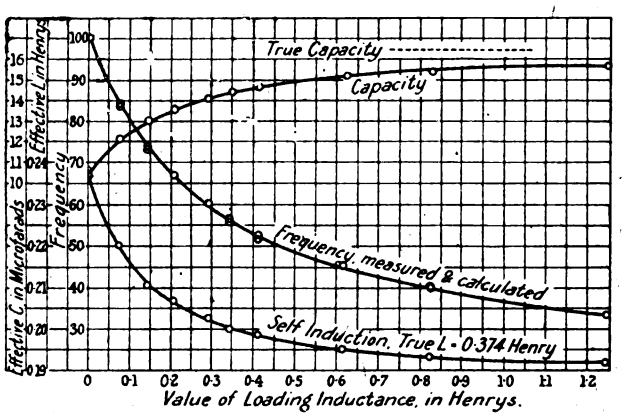

FIG. 7.

The natural quarter wave length period of such a uniform line is a function of the form of current and potential curve of the line. Now even when inductance or capacity is added in series with such a line the current and potential curves are both sine curves when the frequency of impressed E.M.F. is such as to give quarter wave length vibration; it seems, therefore, that the effective capacity and self-induction of such a line can be predicted for any amount of loading. With this idea in mind a series of results was obtaincd to show how the line acted as the series inductance loading was continually increased.

The results were plotted in the forms of curves, and are given in Fig. 7. They have an immediate application to ratio calculations, but apply directly only to a uniform antenna such as some of the Marconi stations use; with suitable modifications they can probably be suited to fit other fairly simple forms of antennæ. The common measurement to get antenna capacity is more or less meaningless, because the capacity of the antenna is a function of the frequency with which it is vibrating. As the series loading of an antenna is increased the effective capacity of the antenna varies from 63·6 per cent. of its true capacity up to 100 per cent. true capacity, while the inductance decreases from 63·6 per cent. to 50 per cent. of its true value. The calculated frequency is 48·7 cycles, which agrees with the experimental result.

In the concluding portion of the Paper the author briefly discusses the determination of resistance, and shows that the values obtained by experiment are in good accordance with those experimentally determined. Thus in one case quoted the total actual resistance of the line was 6·6 ohms and the effective resistance with no added inductance should be 3·3 ohms. Actually it came out to 3·56 ohms. It is shown that the results obtained experimentally could have been readily predicted from the laws of wave propagation.

The Future of Electric Traction.*

So much is going to be done in the future by electrical operation that I am led to mention that it has been my lot to take a somewhat active part in certain phases of the Government Electric Power Supply Enquiry and to come into contact with many of those who are interested in the supply of cheap current for industrial use, and this has led to the conclusion that there is a very strong desire on the part of all who are likely to be large consumers to see that the views expressed by the Electric Power Supply Committee as to the creation of suitable super power stations in well-selected districts are carried out, though there are various objectors to the details of the methods proposed. The leading idea is, however, one of co-operation in any well-devised scheme, and a recognition of the prospective advantages of at last having some central authority, possessing both knowledge and power, to deal with this great electrical question of power supply.

The railway demand for electric current will be far in excess of that for any other industry, and it is open to doubt whether it is wise to divorce the control of generating stations for railway supplies from the management of those who are responsible for the operation of the traffic, and the same question arises when some of the great municipal supplies of tramway working as distinguished from lighting are considered. The movement of traffic of all kinds requires the instant command of power, and knowledge of the requirements is not likely to be appreciated by those who have never come in contact with traffic problems. The super power station is a modern necessity, and the question of this control requires much discussion and thought.

Electrical progress is so rapid that it cannot prosper without a due recognition of the necessity for accepting changes of method, and the vigorous youth of the industry connected with it is such as to require the continuous assistance of broad-minded men whose one desire should be to assist in advancement.

It is not only in the manufacturing districts that electric current will be required, as we now see that its use is extending to agriculture, and it is stated that crops subjected to the new electrical treatment show most advantageous results. This being so, it may be that the distribution of current in agricultural areas will not only assist the farmer in working the light railways which I mention elsewhere, but the very fact of current being thus used will facilitate its distribution along roads in the country where, if he will, the farmer can make use of it for the stimulation of his cornfields.

Had it not been for the war, I believe a very great extension of the use of electric power would have taken place in railway working, whereas no great additions to electrical plant—where they had not been initiated before the commencement of hostilities—have been possible during the last four years.

So far there does not appear to be any reason for supposing that when we can begin again to do work of this kind it will be rapidly extended for long lengths of main line of railway, but electrical working will remain for the present as a great stimulator of suburban traffic.

It really is remarkable how, when each suburban line has been worked by electrical trains with great frequency and increased rapidity, there has been a very great growth of passenger traffic, and I cannot help thinking that the probable course of events will be that we shall find that electrification of the lines immediately round our great towns will quickly take place all over the country, and probably be added to in widening circles as time goes on; but it is not until these widening circles begin to touch one another, and thus enable longer-distance trains to run between one great centre and another, that we shall see electrical working used for long-distance passenger trains.

The additional revenue required to pay interest on the large capital outlay can be made most rapidly from the suburban traffic in well-selected districts and then the extension of main-line work can be carried out without an outlay which taken by itself might be unremunerative.

For shunting and operating in and about large towns where there are already electrical railways for suburban traffic, there seems to be an immediate future, and we shall possibly see the application of such methods to heavy goods trains at a later date.

When expressing the hope of seeing great progress in the future for electric traction, I would again, as I have done on several occasions in this room, venture to suggest that there is much to be gained by regenerative control on electric railways. The difficulties of obtaining it in all forms of electric traction are known, but let us hope they may be swept away. It seems a barbarous thing to continue to convert power at every stop into heat by the abrasion of the tyre and the brake block instead of turning the stored-up energy of the train into useful work by the generation of current.

* Extracts from the Presidential Address of Sir John A. F. Aspinall to the Institution of Civil Engineers.

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The Organisation of Technical Staffs.

BY A CORRESPONDENT.

These notes are presented as an attempt at a general statement on the subject they deal with, and, therefore, do not contain more than passing references to associations and societies which have already been formed, or are in course of formation, with the object of carrying into effect the principles here broadly considered. It is hoped that for that very reason they may be of wider service as an analysis of fundamental points than if they had concerned themselves more with particular aspects of the question, and may be of use, in consequemce, to all nembers of technical and administrative staffs, whether they are or are not already connected with some such association or society.

Certain ideas have grown up during the war which have become current coin in every man's thought, and one is afraid that perhaps some of them are being taken too much for granted, without any adequate conception being formed at the same time of all that they imply. One of them is the idea of Reconstruction : the building up of things overthrown, the remodelling of old customs, the refashioning of former relations, all with the stipulation that nothing can possibly be the same as it was before it was disturbed. One would fain hope that we are not saying so much about Reconstruction that we shall have none of it in the actual end after all. We may find ourselves settling down with things much as they used to be, and, forgetting, we may think we have made all things new, when really all we have done has been to agitate the mass and let it come to rest again. When the people at Alice's mad tea-party moved round one place there was a sort of reconstruction, but when Alice wanted to know what happened when they came to the beginning again, they changed the subject. How many people who talk glibly about the Whitley Report know really what the Whitley Report is ?

Thus we reach our point. It is fully realised that in the industrial world many temporary arrangements have been arrived at, by mutual consent or perforce, which will, without any doubt, not allow themselves to be settled by a mere relapse along the lines of least resistance, and the Reconstruction Committee's Sub-committee on Relations between Employers and Employed (Chairman, the Right Hon. J. H. Whitley, M.P.) have issued their suggestions for the solution of some of the problems that have arisen. They recommend, with a view to provide means for carrying out their proposed policy, the formation of Joint Standing Industrial Councils in the several industries to which their Interim Report refers, which are those where representative organisations on the side both of employers and of employed already exist. These Councils are to be composed of representatives of employers and employed, regard being paid to the various sections of the industry and the various classes of labour engaged. In speeches delivered throughout the country some time ago, Dr. Addison made it clear that the Government, in considering points to be laid before them affecting bodies of workers, whether employers or employed, would deal only with persons definitely appointed to act as accredited representatives of the various bodies, and so capable of speaking officially, not merely as individuals, but as the mouthpiece of a large number of people with some common interest at stake. The moral to be drawn is that, as representatives cannot be appointed except by an organised body, any section of the community with a point of view which it would lay before the Government must organise itself in order to be able to do so.

Hitherto, in the engineering industry, as in many others, there have been very complete organisations both of employers and of manual workers ; but between these two classes, as it were, there has been a large and more or less unconsidered body of men forming technical and administrative staffs of works and kindred places who for some reason or another have not seen fit, or been able, to organise themselves. The individuals composing this body have done the best each could for himself in the past ; but it would appear that this course is no longer sufficient to meet in any broad way the needs of the case. Questions arise relating to their duty to the State and to their employers which demand discussion. The State says, through Dr. Addison, that it will meet representative persons, and the Whitley Committee recommend that all questions as between employers and employed should be dealt with by the Joint Standing Industrial Councils already referred to, or by the kindred District Councils or Works Committees. For both purposes, therefore, if they wish to be heard at all, technical staffs must organise. Paragraph 23 of the Whitley Interim Report states, as the considered opinion of the Committee, that " an essential condition of securing a permanent improvement in the relations between employers and employed is that there should be adequate organisation on the part of both employers and workpeople. The proposals outlined for joint co-operation throughout the several industries depend for their ultimate success upon there being such organisation on both sides ; and such organisation is necessary also to provide means whereby the arrangements and agreements made for the industry may be effectively carried out."

But we must go a step further. The Reconstruction Committee addressed questions to the Sub-committee " to make clear certain points which appeared to call for further elucidation," and the answer to question 3 is : " It is intended that the Councils should be composed only of representatives of Trade Unions and Employers' Associations, and that new organisations should be admitted only with the approval of the particular side of the Council of which the organisation would form a part." It appears, therefore, that not only must technical staffs organise in order to obtain Government recognition in any question which may arise, but they must also organise *on trade union lines* before they can have the least chance of representation on Whitley Councils, which will continually be discussing matters vitally affecting the conditions of their work and their relations to their fellow-workers and employers. That is to say, unless they form trade unions, they will practically be left out in the cold in a matter where it is of first importance to themselves, and perhaps not also without importance to others, that they should be right inside and on the spot. Nor must there be undue delay, for the answer quoted above indicates that existing organisations will probably have a preferential position, and will be more readily admitted to Councils than those formed later.

A frank word of warning is here necessary. The past history of trade unions has left behind a feeling that they are out to tyrannise, to strike, and to fight. This may be true, and there is much to excuse their attitude, for they have had much to win, and a hard place to rise from. Shall we not hope, however, that in spite of present unrest a better spirit may prevail even amongst the older trade unions ? But this fact of the past has made men in responsible positions shrink from the idea of joining a trade union, for they feel that by so doing they may be committed to a purely aggressive policy, to an idea of grabbing as much, and giving as little, as they can, and to the necessity of having their relations with their employers upset at the whim of a small percentage of their fellow-members. The Committee have evidently felt the need of referring to the point, for they say : " It has been suggested that means must be devised to safeguard the interests of the community against possible action of an anti-social character on the part of the Councils. We have, however, here assumed that the Councils, in their work of promoting the interests of their own industries, will have regard for the national interest." Members of technical staffs in responsible positions, especially if they have had workshop experience before being associated more or less closely with the management, would probably better than anyone else appreciate the point of view of both sides, and would thus be amongst the

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most valuable members of the Council. For the sake of others, therefore, as well as for their own sake, it is clearly the duty of technical and administrative staffs to organise on trade union lines; and it is to be hoped that by doing so they may inaugurate a milder, yet not less effective, era in trade unionism, and by their actions remove the stigma which may at present be causing individuals amongst them to hesitate about joining any such organisation. A modification of this sort would clearly react beneficially as far as the general relations between employers' associations and trade unions are concerned, and the whole scheme is so much in the interests of the community at large that no one can afford to neglect it.

It is true that, even if such trade unions be not formed, technical workers might, as an act of grace on the part of the Joint Industrial Council, be granted representation, should the Council decide in this sense, but there is no guarantee that any such course would be taken. It is also recognised that it may be desirable for the Councils to co-opt, in an advisory capacity, persons having special knowledge, who are not members by any right of their own. But that does not meet the point that it is absolutely necessary to have some say in the general deliberations of the Councils as they affect the social and financial status of individuals and bodies, quite apart from any advantage the Council might obtain from the technical knowledge of co-opted persons, and a further argument for the immediate formation of trade unions of technical and scientific workers is here presented.

It must be clearly realised that the formation of a trade union by technical staffs does not necessarily mean that that union can claim, as its resulting right, direct representation on a Council, and it will probably be found that small unions must work together and nominate a joint representative. It is very obvious from this that any trade union which may be formed should be as strong numerically and in the standing of its members in the industry as can possibly be arranged. Whether it is desirable to have a union for each branch of engineering, electrical, mechanical, civil, and so on, with a federation for joint action and a joint council, or to have one union essentially for all, with sectional committees for the various divisions of the industry, is a very important problem, but one not vital to the general principle, except in so far as its solution may be determined by this very question of the strength of union which is required to secure adequate representation. It would appear likely that at least federation, if not actual amalgamation, will be necessary for this purpose, and it is obviously suitable that the joint representation should be of bodies of persons having at least this in common that they are all composed of technical or administrative staffs of some sort of engineering enterprises. Moreover, if a united front can be presented, it is likely that the organisation will gain the respect of the other parties in the Council the more readily, and it is obvious that cordial relations with fellow-members will be most important in obtaining sympathetic consideration of points directly affecting technical staffs. It is felt that the real motive behind the new unions has only to be carefully and fully explained to the other sections of the industry, already organised, by way of educating them up to an appreciation of the new conditions that have been created, to gain immediate and full sympathy.

A matter for settlement is how far the proposed unions should be associated with the scientific institutions connected with the various industries. Out of several associations already formed, or in process of formation, one, as has been publicly reported, has already agreed to discuss its rules with the Institution of Electrical Engineers, with a view to working not under the control of the Institution—which would probably be a position the Institution has no power to accept—but with the support of the Institution, which it already appears is likely to be a very valuable aid in establishing the status of the association amongst other kindred associations. Unless the various Institutions are prepared to federate for the purpose of recognising a union embracing all branches of engineering, the union, if a general one of this sort, would need to be sectionalised as has been already indicated, if it desired to act with the Institutions; but this is a matter which need not be further considered in these general notes. The only serious difficulty that occurs to one about establishing relations with the Institutions is that amongst their members, as also on their Councils, there are employers as well as employed, and it might prove to be undesirable to give a promiscuous body the opportunity of minutely considering the rules of an organisation purely of employed persons with whom certain members, being employers, might conceivably at some time or another find themselves at variance in opinion on important points. As members of the Institution, without the faintest trace of any ulterior motives, they would have the right to acquire certain confidential information which it might subsequently appear was a right disadvantageous to the best interests of all concerned. This difficulty is one for careful consideration, and, so far, one has not seen the way to a solution. It has already been publicly announced, with regard to the Institution of Electrical Engineers, that the Council has decided that the registration as a trade union of an association under its auspices should not be objected to. This recognition of the cardinal principle is of great importance and opens up the way to a friendly discussion of other, and perhaps minor, possible difficulties.

From the point of view of the technical and administrative staffs themselves, there are difficulties in the working of trade unions which will require patience and tact for their settlement. One of them is that the membership, if it is to be comprehensive, will include many grades of workers, judged from the standpoint of salary. While it will always be highly inadvisable, if not actually impossible, to deal with the salaries of the more highly paid officials, except as an individual and personal matter between themselves and their employers, one of the objects of the organisation will no doubt be the improvement of the financial position of its lowest paid members. Heads of departments, themselves employees, may find themselves in a difficulty between an attempt to work their departments as economically as possible and a desire to give better conditions to their junior assistants. This is an undoubted difficulty which must simply be faced, and will be best met by full and frank consideration of the whole subject between the representatives of the parties concerned, provided the trade unions by their general attitude indicate that, realising that they are, perhaps for the first time, seriously in a position to meet their employers on general questions, and that they are fairly and ably represented on their side, they will loyally abide by the decision, hoping that, even if they do not at once get all their points conceded, further education of employers will make them see that brains are worth as much in engineering as in medicine or law or elsewhere, and that if they accept the services of a man whom the community has thought fit to be allowed to live, it is for them to be the channel of the means to let the man live decently in return for his services, through them, to the community. Much can be done by careful selection of staffs by those responsible. An extraordinary example, taken from the workshop, is quoted in a recently published review of a book on "Present-day Applications of Psychology." "In a bicycle-ball factory, where only the most suitable workers were employed, 35 girls could do the work of the previous 120. Their hours were reduced. They had two days' holiday a month. Their wages were increased by nearly 100 per cent. In this way the accuracy of the work was increased by two-thirds, and there was a large decrease in the cost of production of the balls." And the same sort of thing could undoubtedly be done in the office.

Finally, this whole matter is but a small part of all that has to be done. It is reasonably certain, from hints which have been allowed to leak through, that Germany is alive to the possibilities of after-war trade, and if we are to hold our own against competition from our present enemies, and perhaps from unexpected as well as from expected quarters, we must manage to become fully awake, and never sink back into the sloth that was allowing Germany to gain the whole world so definitely that in a few years she would have had that supre-

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macy by penetration which she impatiently snatched at by war, and looks like losing now if we can but endure. What one advocates by all this is not mere self-seeking, for self-seeking is vain, except it be permeated with the desire to improve the whole through the improvement of the individual. As in so many other relations of life, now is the accepted time, and the object of these notes is to arouse the interest in a question, small but vital, of one and another, here and there, who may not yet have realised that to put off till to-morrow is to play the sluggard's part. As the door turneth upon its hinges so doth the sluggard upon his bed. Yet a little sleep, a little slumber, a little folding of the hands to sleep. So shall thy poverty come as a robber, and thy want as an armed man; and thy last state shall be even worse than thy first.

He that hath ears to hear let him hear. Take no risks, but do it now.

Science and the Future.*

Last year, in speaking to you of science and its functions, I endeavoured, by means of a rapid sketch of its origins and its progress in the past, and its scope and effects in the present, to show the value of science to mankind. This year I propose to consider some aspects of science and the future. A matter which we now see constantly referred to is what is known as reconstruction. Undoubtedly the war has been responsible for an enormous amount of destruction of capital; but capital does not merely consist of gold and silver, of bricks and mortar, of furniture and fitments, or even of railways, steamships and machinery—mostly things that in process of time fall into decay; but also of scientific knowledge. For thousands of years the manual labourer has been at work, and untold have been the products of his toil. How many of these products, however, have come down to the present day? But the products of the mind endure, and all our industries, all our arts and crafts, and all our sciences have their roots in the distant past. Little of the capital of the world is really due to mere handiwork, however skilled, and rather to the mental efforts and discoveries of exceptional men. Thus our greatest asset, the vast store of knowledge that Science has gathered together, for us the heirs of all the ages, is still intact.

The devastation due to the war will in time be repaired, but it is otherwise with the general future. It is stated in no less reliable a handbook than "Whitaker's Almanack," that "it has been estimated that the earth can maintain a population of 6,000,000,000 souls, a total which will be reached about A.D. 2100 at the present rate of increase." The shortage of the necessaries of life and of civilisation with the increase of the population of the world, can only be met by new achievements in the way of scientific discovery and invention, and by improved and more scientific organisation. As time goes on all industries tend to become more elaborate, and more dependent for success upon skilful management of the specially trained. The modern world has no room for antiquated and unscientific methods. Manufacturers should be able to look for assistance from the Government of the country. Much in this direction is already under way. The National Physical Laboratory and the Advisory Council are doing great work. Much has been said of the incredible things accomplished during the war in the munition factories and other works conducted by the State. But it should be remembered that the cost has been prodigious and also the waste. It has been suggested that the great key-industries should be placed under Government control. It is to be hoped that this will not be done. By all means let there be Government assistance, but the less Government control the better.

Now to turn to a different subject. Signs are now not wanting that at length the claims of Science in education are beginning to be recognised. By all means let us have a few great classicists, just as we have a few real poets. Nor do I deprecate the teaching of history or of foreign languages, and especially of our own. But the claims of science must not be neglected. What is necessary is the teaching of the groundwork, and then opportunity for expansion. We know instances of great scientists who were self-taught, but we know nothing of the others who might have been their equals had they ever, by a little rudimentary teaching, been started on the scientific road. As has been well said, "The literature of Science might have been quite different if Faraday had missed the unique opportunity afforded him by Davy at the Royal Institution. How many Faradays have remained mute and inglorious because doors were closed?"

There is one method of acquiring a scientific education to which not nearly enough attention is paid, the private reading of technical books and of periodic scientific literature. Many of our leading scientific men have owed their education almost entirely to this method. Yet most of the large scientific libraries such as are possessed by the various engineering institutions and other scientific societies are only accessible to their members; moreover, such libraries only exist in London and in a few large towns. These libraries should be kept open on Saturday afternoons and in the evenings. What I am anxious particularly to put forward is the desirability of the establishment of lending libraries from which all the latest scientific works could be obtained under suitable arrangements. It is impossible also to exaggerate the utility of public or semi-public lectures on scientific and technical subjects in spreading knowledge in these subjects and stimulating curiosity, thought, and also invention. The importance of provoking an interest in scientific subjects is paramount, and once the interest is created those interested can follow matters up in particular spheres by special reading. What is wanted is to awaken a taste for scientific literature, as a preliminary to the pursuit of the fairy tales of scientific discovery and invention.

There is a fallacious notion abroad that practically all great scientific work has been done by the poor. In the literature of industry we frequently come across accounts of the poor inventor who, though almost starving, by super-human endurance and perseverance eventually achieves success. We hear nothing, however, of the countless others in whose cases, "Chill penury repressed their noble rage, and froze the genial current of the soul."

Just as John Stuart Mill feared that the limited number of notes in the audible musical scale would in time lead to the exhaustion of all possible melodies, so there have been those who have thought that scientific discovery would before long come to a stop owing to the dearth of subject-matter and to the limitations of the human intellect. Nothing could be more erroneous than this idea in respect to science, for every new discovery and invention opens up the path for others, and thus the scientific horizon surely widens year by year. In the comparatively new fields of radio-activity, electromagnetic radiation, synthetic chemistry, chemical catalysis, electrical osmosis, photo-electricity, and corpuscular matter, to mention at random only a few of those that readily occur to one, the prospect seems practically illimitable. In regard to inventions and the science that is applied to utilitarian uses, is the case in any wise different. The petrol engine, originally invented for propelling boats and later adapted to driving land vehicles, has rendered possible the conquest of the air by the aeroplane, as also the depths of the sea by the deadly submarine. Bell's telephone, which, as originally produced, was intended for transmitting speech, is now used for receiving the inarticulate signals of wireless telegraphy. Photography and its sensitive plates and papers are now applied in radiography and in other directions of which the original photographic inventors never dreamed. The vacuum jacket, invented by Sir James Dewar for keeping liquid air cold, is used to-day for keeping things hot. Radium, originally only a scientific curiosity, has many applications in medicine, and is now used to illuminate watches and instrument dials so that they can be read in the dark. During the past five years the improvements made in wireless telegraphy, and also in wireless telephony, have been very important, but as yet it is not admissible to discuss them. One matter, however, is within public knowledge, and that is the increased and still increasing amount of news that we get in the papers that appears under the heading of "Per Wireless Press." In London tape and column-printing telegraph instruments operated by wire, that record sporting, parliamentary and general news, have long been familiar objects in clubs and hotels. There is no reason at all why similar printing instruments should not be operated by wireless means, not only in London and other large cities, but throughout the country, or even throughout the world. Some regulations would be necessary to prevent interference, and as wireless waves recognise no international boundaries, they would have to be universal. Thus arises a fitting opportunity for the League of Nations.

Great things are at present being foretold as to the marvels that we are to see in the way of the cheap electric distribution of energy throughout the whole country from a small number of giant gene-

* Abstract of the address of the chairman, Mr. A. A. Campbell Swinton, F.R.S., delivered before the Royal Society of Arts.

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rating stations. Great improvement over our present parochial methods is no doubt possible, but let us not be too sanguine. The limits of economical generation and distribution are already being reached, and there is also the question of material for the distribution conductors. Excepting silver, which of course is out of the question, pure copper is the best electrical conductor we know of, and the amount of copper in the world is limited. So far as we at present know, all alloys have a worse and not a better conductivity than their elementary constituents. No one, however, knows what improvement is yet to be obtained in the conductivity of metals by further purification, and especially by freeing them entirely from occluded gases. It would also be rash to deny too absolutely the possibility of the wireless transmission of electric energy in bulk.

By far the most important requirement of mankind is energy in its various forms. Nearly all our energy comes to us directly from the sun, though some portion is derived from the internal heat of the earth and from terrestrial and lunar rotations. The earth receives a total of some 200 billion horse-power, or on the average some 4,000,000 H.P. per square mile of that portion of the earth's surface that is exposed not too obliquely to the sun's rays. Apart from the direct heat we get daily from the sun, our main source of energy is, of course, coal. We must bear in mind that the amount of coal in the world is strictly limited. Many estimates have been made of its duration. Anyway it runs into 500 or 600 years for this country, and perhaps nearly 10 times as long for the whole earth. Sooner or later, however, it will be all used up, and mankind will have to depend on the sun's actual daily supply. Unfortunately we have discovered nothing better than the heat engine for turning coal and oil into mechanical work. Primary batteries and thermo-piles and similar devices for developing other sources of energy have proved disappointing in this respect, though there is room for research in regard to combinations of new alloys at low temperatures with the latter. Economy in the consumption of coal is therefore a matter of great importance.

The importance of utilising the water power on the earth as a means of saving the consumption of coal is now thoroughly recognised, and is receiving the attention of the Governments of this and other countries. The amount is, however, insufficient to take the place of coal. There is also the internal heat of the earth, which is actually at present being utilised near Volterra in Italy, where volcanic steam issuing from the ground is being successfully applied to work two 5,000-H.P. turbines. Apparently the older oil-fields of the United States already show signs of becoming exhausted.

When therefore the coal is exhausted it would seem that, in the main, resource will have to be had to the enormous flood of solar radiant energy that is continually falling on the earth, and the problem is how this can best be utilised. Here, then, in photo-chemistry, perhaps in photo-electric chemistry we have probably the most important problem that the science of the future has got to solve.

Transformer Oil.

By W. S. FLIGHT, A.M.I.E.E.

(*Continued from p.* 638.)

Summary.—Oils may be roughly divided into fixed oils and straight oils. The former give trouble through the formation of sludge. The latter are much more free from this defect. For use in transformers it is necessary to take into account viscosity, specific gravity, dielectric strength and other properties. Examples are given of the variation of specific gravity and viscosity, and the methods of determining the latter are stated. Flash point is also another important property that must be stated. In specifying dielectric strength, great care must be taken that the presence of moisture does not enter into the figure, and in practical use care must be taken that the oil does not take up moisture. The carrying out of dielectric strength tests is described, and the effect of dirt, air and circulation of the oil is considered on the results obtained. The author then discusses the formation of sludge and the practical methods of preventing it. Lastly, minor tests are described, such as the iodine value, acidity, evaporation, sulphur, &c.

Flash Point.

This is defined as the temperature to which the oil must be heated in order to give off vapours, which when mixed with air produce an explosive mixture. This does not mean that at this temperature the oil will take fire spontaneously, but that provided sufficient energy is supplied from an external source, the vapour will ignite but will not ignite the oil.

Fire Point.

Is the temperature at which sufficient vapour is given off by the oil to burn continuously when once the process has been started by energy from some external source, such as a flame or spark. A great deal of uncertainty exists as to what is the lowest limit of flash and fire point that can be permitted in an oil intended for use in a transformer. On the one hand it is found that certain manufactures of transformers supply an oil having a flash-point of only 135°C., and, on the other hand, customers' specifications often call for a flash point not less than 170°C. The reason for the latter high figure is probably due to the belief that the higher the flash point the less the danger of fire. In this connection it must be remembered that all oils will burn when placed in a flame, so should the building in which the transformers are located take fire it would not matter whether the flash point of the oil was 130°C. or 170°C. Obviously the flash point should be such that no vapours are given off by the oil at the operating temperature of the transformer. As the latter never exceed 100°C., there is no reason from this point of view why the flash point should be higher than, say, 110°C. It has been found, however, that in the course of time small quantities of vapour may accumulate above the surface of the oil at a temperature of 5 deg. or 10 deg. below the temperature at which the vapour first flashes on the comparatively rapidly conducted flash point test.

To make due allowance for this fact the flash point of the oil should not be less than 130°C. If the flash point was below this temperature and the transformer was run at its full output, there would be a danger of vapours accumulating inside the transformer tank, in the space between the surface of the oil and the cover. These vapours, if they happened to be mixed with the required quantity of air, could cause an explosion sufficient to burst the tank. The explosion might be started by arcing due to a bad contact or by a static discharge from the leads inside the tank above the surface of the oil.

The reason for the choice of an oil having a flash point as low as is consistent with safety is due to the fact that as a rule a low flash point is also accompanied by a low viscosity and also by a high dielectric strength.

These two latter characteristics are of such importance in the selection of an oil for transformer work that it has now become fairly standard practice to accept a flash point of 150°C. to 160°C. as being entirely satisfactory for all ordinary transformers

Table V. gives the flash point, viscosity and gravity of a number of transformer oils obtained from different parts of the world, and clearly illustrates the variations met with in the selection of the most suitable oil for use in a transformer.

Table V.

Sample.	Flash point, 0°C.	Viscosity at 15·5°C. (Redwood).	Specific gravity at 15·5°C.
A	152	26·7	0·859
B	153	35·0	0·867
C	160	19·0	0·854
D	166	26·2	0·848
E	167	83·0	0·882
F	169	88·0	0·884
G	171	30 0	0·855
H	175	31·0	0·850
I	176	152·0	0·889
J	178	31·0	0·856
K	182	35·4	0·856
L	186	51·5	0·861

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As in the case of viscometers, a number of instruments have been designed for testing the flash and fire point of oils. All of these can be classed as either open cup or closed cup. In the former the liquid to be tested is placed in an open vessel, and the flame passed over the surface at a definite distance from it. In the closed cup testing, the cup is about half filled with oil and the flame applied at intervals through a trap door in the lid.

Due to the small amount of air and consequently the smaller amount of gas required to produce a mixture that will ignite, the closed test invariably shows a lower flash point than an open cup test. Variations also occur in the use of the same instrument unless special attention is given to a number of precautions that have to be observed in making the test—*i.e.*,* such as correct length of flame, rate of heating, &c. Provided the tests are carried out in line with the conditions which have been standardised for each instrument, consistent results can be obtained. It is always necessary, however, in giving the results of flash tests to name the apparatus in which the test was made.

The flash point tester mostly used in this country and on the Continent for transformer and lubricating oils is the Pensky-Marten enclosed tester. In America the instruments mostly used are the New York State closed cup, the Cleveland open cup, and the Pensky-Marten closed cup. Due to the figures obtained in each tester depending on so many conditions it is not possible to accurately compare the results obtained in one tester with results obtained in another type of tester. For commercial work it is usually sufficiently accurate to compare flash points determined by any of the standard closed cup testers.

It will be noticed that in the above remarks, little reference has been made to fire point; the reason for this is due to the fact that in a pure straight oil the fire point is always found to be from 20°C. to 30°C. above the flash point. Thus by fixing the flash point, the fire point becomes fixed as well. For this reason, it is now usual in test results to state the flash point only.

Dielectric Strength.

In the early days of the oil-immersed transformer, attempts were made to use some of the fixed oils, such as resin oil, linseed oil, cotton-seed oil; because it was found that these oils had a higher dielectric strength than the straight oils at that time on the market. It was soon found, however, that the fixed oils gave trouble in the transformers due to the formation of carbonaceous deposits, and about the same time it was found that straight oils free from impurities and all traces of moisture, had as high dielectric strength as the fixed oils. As the latter are not so liable to form deposits and are cheaper, their use has continued ever since. It has been found that the voltage at which a definite thickness of oil will break down depends more upon the amount of moisture and other impurities in the oil than upon the type or nature of the oil. When tests are carried out on clean moisture-free oils, it is found that those having a low viscosity usually have a higher dielectric strength than those of higher viscosity. To illustrate this, results of tests on three samples of transformer oil are given in Table VI. :—

Table VI.

Sample.	Gravity at 15·5°C.	Flash, Pensky-Martin.	Viscosity (Redwood).	Dielectric strength (½ in. diam. spheres, 0·15 in. gap).
X	0·860	171°C.	26 at 20°C.	30,000
Y	0·833	134°C.	12 at 20°C.	35,000
Z	0·830	128°C.	10 at 20°C.	45,000

In order to obtain breakdown voltages as high as these given above, it is essential that all the moisture be removed from the oil; the presence of 0·025 per cent. moisture in the oil may cause a reduction in dielectric strength of as much as 100 per cent. Although oil and water cannot, as a rule, be mixed, there is every reason to believe that oil has the power of dissolving a definite quantity of moisture. If perfectly moisture-free oil be left exposed to the air of an ordinary room for two or three days, it is found that the dielectric strength will gradually drop until it reaches a fairly constant value. To ascertain how much of this reduction is due to moisture and how much due to dust, a similar vessel containing an equal quantity of the moisture-free oil should be placed in the same part of the room, and kept at a temperature of 70°C. to 80°C. When kept at this temperature it is found that the oil does not absorb any moisture from the atmosphere; the quantity of moisture taken up by the cold oil will depend upon the humidity of the atmosphere, the variation in temperature, and other factors. In a normal atmosphere the oil does not reach its moisture saturation point; if further moisture is added by shaking up with a few drops of water or blowing steam into the oil, and the oil and water allowed to separate, it is found that the dielectric strength of the oil is still further reduced. If the oil and water are shaken before test, and not allowed to separate a slightly lower figure is obtained. Plotting dielectric strength against moisture the curve is apparently of the shape shown in Fig. 5; no numerical values are given on account of the extreme difficulty of accurately determining the small quantities of moisture in the oil.

From the above it is seen that the dielectric strength of an oil depends largely upon the quantity of moisture in the oil,

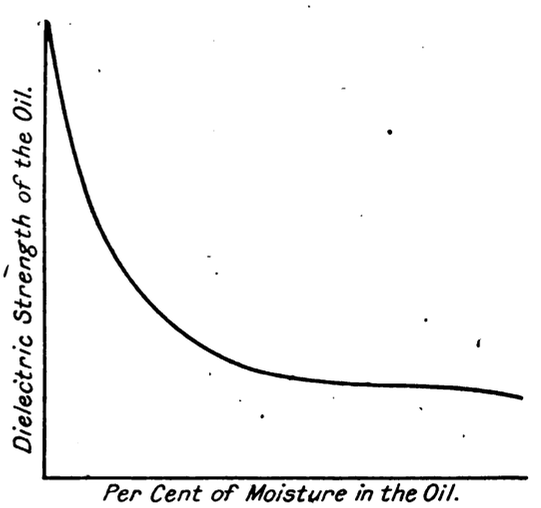

FIG. 5.—CURVE SHOWING EFFECT OF MOISTURE ON DIELECTRIC STRENGTH OF OIL.

and for this reason test results upon a sample of transformer oil often contain no dielectric strength test, since it is found that, provided the oil is a pure straight oil of the necessary flash point and viscosity, it will be a good insulator when freed from moisture. Dielectric strength tests are, however, most important when samples are taken from a consignment of the oil of a grade that has been approved for use in transformers. In order to ensure that oils supplied as transformer oils are as free from moisture as it is possible to obtain them on a commercial scale, the oil companies take special precautions to dry the oil, and also the steel drums. If this is properly carried out and the seal at the bung made with a lead washer, there is no danger of moisture entering the oil under reasonable treatment. There are two conditions that should be always guarded against as far as possible :—

(*a*) The drums of oil should be stored under cover, and not exposed to the sun, rain or snow.

(*b*) The storage should be made frost-proof. It has been found that moisture-free oil in properly sealed steel drums will absorb moisture if the temperature drops below 0°C. This is apparently due to a re-arrangement of the molecules of the metal, the same phenomena that causes metals to sweat when heated.

These elaborate and expensive drying requirements are not necessary if the oil is to be used for the purpose of lubrication, and consequently when sold for the latter purpose, they can be

* See "Oil Analysis," by A. H. Gill, page 12 of 6d. edition.

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marketed at a cheaper rate. The requirements of the two classes of oil in this respect is reflected in the drums, it being standard practice to put transformer oils into steel drums whilst wooden drums are satisfactory for most lubricating oils.

As moisture-free oil quickly takes up small quantities of moisture upon exposure to the atmosphere it is not reasonable to expect the dielectric strength of a bulk consignment of oil to show as high a figure as can be obtained upon a small sample specially dried in the laboratory. It is still the practice of certain firms to quote figures for the dielectric strength of a transformer oil which are so high that they have obviously been obtained upon specially prepared samples. As this special treatment can very seldom be given to the large quantity of oil required for filling the transformers, it is far better to fix on a reasonably high dielectric strength and specify that tests must be taken on samples drawn direct from the drums and tested without any previous drying or filtering. In taking these samples it is of the utmost importance that all vessels used for handling the oil be perfectly clean and free from moisture; as an extra precaution, each vessel should be well swilled round with the oil, and that lot discarded before the actual test sample is taken.

Unfortunately, there is not as yet in any country a definitely recognised standard test apparatus for determining the dielectric strength of oils. In some instruments for this purpose the gap is arranged horizontally, as (*a*), Fig. 6, and in

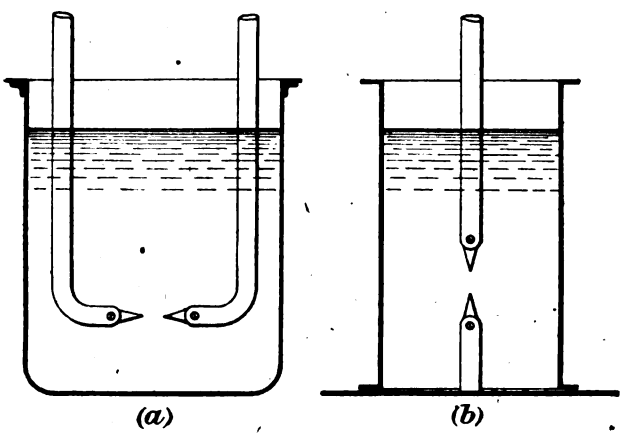

FIG. 6.—ARRANGEMENT OF ELECTRODES FOR DIELECTRIC STRENGTH TESTS.

others vertically (*b*). The latter arrangement has been found most satisfactory as it is easier to reset, and does not require such a large volume of oil. The chief difficulty with this type of tester has been the difficulty of cleaning the glass vessel and the bottom electrode after each test; an ingenious method of overcoming this defect, is to have a ground glass flange on the bottom of the glass oil container, and stand this on a smooth brass plate.

The electrodes mostly used for commercial oil tests are either needle points or ½ in. diameter spheres, and the gaps specified range from 0·040 in. to 0·20 in. When one realises that for each length of gap and for each shape of electrode, the same oil will give a different breakdown figure, the need for the adoption of some definite standard is at once clear.

It is suggested that probably the most suitable standard would be found to be electrodes of ½ in. diameter spheres (12·7 mm.) and a gap of 0·10 (2·5 mm.). To obtain breakdowns under these conditions a transformer giving a maximum voltage of 20,000 would be suitable and such a transformer could be built having a capacity of about 5 k.v.a.

In obtaining the dielectric strength of an oil, special precautions have to be taken in order that true and consistent results may be obtained; some of the factors not previously referred to, which influence the results obtained, are the following:—

(*a*) *Dirt, Dust, &c.*—Although the oil may be free from moisture it will show a low breakdown if it contains any quantity of solid matter in suspension. When an electrical stress is maintained between two points in the oil there is always a tendency for any foreign particles in the oil to line themselves up along the lines of stress, and thus bridge across the gap. This is often manifested during the test by a few single sparks passing between the electrodes when about three-quarters of the ultimate breakdown voltage has been applied. These pilot sparks, as they have been called, are never experienced when testing clean moisture-free oil, and may be caused by either dirt or moisture in the oil. As the presence of dirt is almost as detrimental as that of moisture, attention should be given to this in obtaining samples from a barrel, and the sample should always be taken by means of a small diameter vessel with a suitable handle, which can be lowered through the bung hole in the side of the barrel. Before taking the sample out, the barrel should be rolled over several times to thoroughly mix up any sediment which may have settled to the bottom.

(*b*) *Air.*—Air bubbles in the oil have a similar effect to dirt and moisture; on account of the specific inductive capacity being less than that of the oil, they are drawn into the strongest part of the field, and thus reduce the effective thickness of oil in the gap. To minimise the effect of air the following precautions should be taken:—

1. The test cup should be swilled round with some of the oil, to form a film of oil on the inside.
2. The test sample should be poured down a glass rod into the cup.
3. The electrode should be painted with a camel's-hair brush dipped in a sample of the oil.

(*c*) *Circulation of the Oil.*—Commercial transformer oil taken direct from the barrel always contains a certain quantity of moisture and dirt, and as previously mentioned the breakdown voltage largely depends upon the lining up of these impurities in the gap. The voltage at which this can take place depends not only upon the quantity of the impurities, but also upon the resistance which is offered to their forming into definite lines. Consider the case of voltage applied to a needle gap; most of the stress is concentrated on two small portions of the gap near the points, and this sets up a very vigorous circulation of the oil in a plane at right angles to the gap. The result is that many of the particles of foreign matter which are attracted into the gap are carried out again before they have time to arrange themselves along the lines of stress. The effect of this circulation causes the breakdown voltage of ordinary transformer oil to be greater when tested between needle points than between ½ in. diameter spheres, the circulation in the latter case being much less than in the former. From the shape of the electric field between spheres as compared with that between points, it would be expected that the maximum potential gradient for a given applied voltage would be greater for points than for spheres, or, in other words, that a gap of given length would break down at a lower voltage with points than with spheres. This is found to be the case with solid dielectrics and would probably be obtained on oil if perfectly free from all impurities. Table VII. gives test results which illustrate the above points:—

Table VII.

Material.	Thickness.	B.D.V. Points.	B.D.V. ½ in. diam. spheres.
Transformer oil	0·10 in.	16,000	9,200
Solid insulation	0·10 in.	16,000	24,300

In addition to masking the true effect of the shape of the electrodes, the circulation of the oil across the gap is probably the cause of oils of lower viscosity showing a higher dielectric strength than thicker oils. It may also offer an explanation of the fact that when tested hot, oils show a higher dielectric strength than when tested cold, the lowering of the viscosity at higher temperatures resulting in a more rapid circulation of the oil. In oil immersed transformers the circulation of the oil due to convection currents acts to advantage in preventing impurities from lining up. The stress between live parts and earthed parts is not usually high enough to cause any lining up.

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except when a large quantity of water has got into the transformer tank, or the oil has become heavily loaded with dust or carbonised oil.

(*d*) *Sparking through the Oil.*—If after taking one breakdown on a sample of oil, a second breakdown is taken on the same lot of oil, it will usually be found that the second breakdown is at a higher figure than the first. If a third breakdown is taken this may be higher still. This is probably due to a quantity of the moisture in the oil being drawn into the gap and decomposed by the heat of the arc; as the oxygen and hydrogen are carried off in the decomposed gases from the oil they have no chance to recombine. When the second breakdown took place there would be less moisture in the oil and consequently puncture would take place at a higher voltage. By specifying that the dielectric strength shall be taken as the average of 10 breakdowns all taken on the same lot of oil, it is possible to obtain a higher dielectric strength than if the first breakdown only was considered. This has often been done by those who wish for commercial reasons to obtain as high a dielectric strength as possible. The results obtained are, however, artificial, because in practice it is the minimum dielectric strength that determines the factor of safety of the apparatus.

The most delicate method of detecting the presence of moisture in transformer oil is by means of a dielectric strength test. When, however, there are not the necessary facilities for making this test, the simplest and most reliable test is to heat a 3 in. iron nail to a dull red, and to slowly immerse in a small sample of the oil. If there is any trace of moisture in the oil, a sharp crackling noise will be heard quite distinct from the spluttering of the oil. If, on making this test, there is any difficulty in deciding if the sound indicates moisture or not, a control test should be carried out with another sample of the oil which has been previously well shaken up with one or two drops of water. For the successful detection of moisture by this means it is essential that the test be carried out in a quiet place, as the crackling due to small percentages of moisture is easily masked by the sound of running machinery, &c.

The most usual method of removing moisture from oil is to maintain the oil at a temperature of 105 deg. to 110 deg. in an open vessel for 10 to 30 hours, the time depending upon the quantity of oil, the quantity of moisture to be removed and the area from which it can be evaporated. Of recent years, the heat method of removing moisture has to a large extent been replaced by the filter press method. It has been found that if oil is allowed to pass through a piece of porous paper that has previously been thoroughly dried in an oven, any moisture in the oil will be retained by the paper until the paper has taken up sufficient moisture to restore it to its normal condition. Papers under normal conditions contain from 10 to 20 per cent. moisture. This is probably due to the affinity between paper and moisture being stronger than the affinity between oil and moisture. Filter press oil drying sets are now on the market, consisting of a motor driven rotary pump supplying a press composed of a number of individual filtering compartments arranged in parallel.* The sheets of paper, resembling white blotting paper, after being dried in an electrically-heated oven, are immediately immersed in dry oil to prevent absorption of moisture from the atmosphere, and are then placed in the press. Probably the great success that has been obtained by the filter paper press system of drying oil is partly due to the fact that the filter paper also removes all the fine particles of dust, dirt, &c., which may be present in the oil, and which have been shown to exert a powerful influence upon the breakdown voltage. If dielectric strength tests are taken on the oil after passing through the filter it is usually found that the first few gallons have a dielectric strength from 70 to 100 per cent. higher than the inflowing oil. This large increase quickly drops to 40 or 50 per cent., and more gradually to about 10 per cent. On opening up the press after a run, it will be found that practically all the dirt has been trapped on the outside pieces of paper, and these should in all cases be scrapped. An economy in papers can, however, be effected by draining and re-drying the remaining sheets, and using them as outside sheets for other runs. One of the great advantages of this system of drying the oil is that it can be carried out on site, and when necessary without removing the transformer from its tank, or disturbing any of the electrical connections.

(To be concluded.)

* A detailed description, together with photographs of a press of this type was given in Vol. LXXIV., page 56 of THE ELECTRICIAN for October 16, 1914; *see also* THE ELECTRICIAN, August 21, 1914, Vol. LXXIII., page 798.

Natural Gas Fuel in America.

The San Joaquin Light & Power Corpn., of Fresno (Cal.), has recently constructed a 26-mile natural gas line to supply fuel to its Bakersfield steam-driven plant. The Midway Gas Company supplies the natural gas from the Midway (Cal.) oil fields.

The San Joaquin line consists of pipe 6 in. in diameter, the joints of which are butt-welded by the oxyacetylene process. No flanges or screw joints are used on the entire line. The "Electrical World" states that it is expected that approximately 6,800,000 cubic ft. of gas per 24 hours can be delivered at 250 lb. to 300 lb. pressure through the 6 in. main to Bakersfield. Using an equivalent figure of 6,000 cubic ft. of gas to one barrel of fuel oil, there is a saving of over 1,100 barrels of oil per 24 hours when the pipe line is working at its full capacity. The battery of boilers at the Bakersfield plant consists of four 325 B.H.P. and eight 603 B.H.P. units. The four smaller ones were originally provided with gas burners, but the eight larger units so far have been equipped only for burning fuel oil. A pressure governor at the plant steps down the pressure from the pipe line to about 50 lb. per square inch, but this pressure is again reduced at the burners to from 0·75 lb. to 2 lb. per square inch. The oil burners have been removed, but no change in the furnace is required for burning gas, as it is always possible to change back to oil firing on a half-hour's notice. Not only does the burning of gas at this plant furnish a good war saving measure, in that it allows a considerable quantity of oil to be used for war purposes, &c., but it also shows a substantial financial saving to the company. Two years ago fuel oil was purchased at 50 cents per barrel, but the price is now almost $2 per barrel.

Government Control of Industry.

The Minister of Reconstruction (Dr. Addison) has announced, on the advice of the Standing Council on Post War Priority, that the position as regards the supply of materials to manufacturers is such that domestic control can now be considerably relaxed. Orders have already been issued enabling manufacturers and others to utilise for their ordinary civil trade existing stocks of a number of raw materials hitherto controlled, and the ration of material allowed to trades for peace work has in many instances been largely increased. Restrictions on imports and exports have been relaxed in certain directions, and further concessions of a more comprehensive character are in contemplation.

It is, however, important that producing capacity should be utilised in such a manner as to provide for the re-establishment, at the earliest possible moment, of the industries and shipping of the United Kingdom. It is also imperative that adequate provision should be made for the full discharge of the obligations of this country to its Allies, particularly in regard to the reconstruction of devastated areas. Control by the Government of the normal relations of industry can only be brought to an end if manufacturers and traders will endeavour during the period of reconstruction to regulate their order of production and distribution in accordance with the national needs and obligations. In the meantime the Order as to Priority of March 8, 1917, will remain in operation. The following list indicates the classes of work to which materials and producing capacity set free from war work should, so far as possible, be devoted in the immediate future:—Maintenance, repair and replacement of existing machinery and plant; maintenance, repairs and renewals for railways, tramways, canals, roads, harbours and docks; shipbuilding and maintenance and repair of merchant ships and fishing vessels; manufacture of agricultural, milling, food producing, mining and textile machinery, machine tools, building materials, equipment used in the public utility services in the United Kingdom; manufacture of approved orders placed by the Governments of the United Kingdom, the Dominions or the Allies; manufacture of goods for export (subject to such Government regulations as may be found necessary).

The Departments responsible for the control of supplies during the war will continue to exercise such control as may be necessary, and applications for priority permits, export and import licences and other similar facilities should be forwarded to the same Department as hitherto. Applications should not be addressed to the Ministry of Reconstruction or to the Standing Council on Post War Priority.

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Trade Unions for Engineers.

The present is essentially a time for organisation. A strong impetus has been given to the movement by the Whitley Report, which may be regarded as an attempt to attain by general agreement that which will never be attained by antagonism. In the past there has been a disposition on the part of employers to refuse recognition to trade unions owing to the fear, by no means unfounded, that the strength of trade unions might be used to the detriment of industry. On the other hand, it has been fairly proved that industrial agreements between employers and employed (that is, between bodies of persons as distinct from individuals) have been less broken where there has been considerable organisation on both sides than where this organisation has been weak. Consequently, there is a good case in favour of organisation as a means of maintaining industrial peace. It is on these lines that we may expect employers and employed to form Joint Industrial Councils and Joint Works Committees.

When, however, we pass from general principles to the details of any such scheme, we may well ask: What is the employer and what is labour? From the point of view of the Whitley Report, employers may be considered as those bodies which together form an organisation for the protection of their interests. It is a union of bodies rather than a union of individuals, and these bodies are represented by their most responsible officials, such as directors; or, when we come down to works committees, by, very possibly, heads of departments. On the other hand, labour is more easily defined as consisting of those who carry out manual labour and those who immediately direct such operations. The trade union is an organisation of such individuals.

Between these extremes, however, there is an important body of men who are generally designated under the term "staff." They include all the technical engineers, from draughtsmen and juniors up to the most responsible positions, excluding, possibly, heads of departments. They carry out the greater part of the technical brain work of the undertaking. Yet what is their status? So far as can be gathered they have been completely forgotten in any scheme of joint organisation of employers and employed. It looks rather as if the technical engineer is regarded as neither fish, flesh, nor good red herring and is to be left out in the cold. Moreover, the technical man is, as a rule, notoriously under-paid. He may even receive less than the skilled worker he directs. It is, then, this general aspect of affairs that is leading to the trade unionism of engineers.

In this connection we would commend to our readers an article by a correspondent which appears in another column, and in which a number of points are considered. It is quite clear that the Whitley Report is leading to trade unionism of what may be styled the "professional classes." It must be remembered, however, that the formation of such a trade union does not in itself entitle such a union to representation upon any Joint Council or Joint Committee. As far as can be gathered, such representation is limited to labour trade unions on the one hand and to employers' organisations on the other. A trade union of engineers is neither one thing nor the other, but from the very nature of things its sentiments should be nearer those of the employer than to those of labour, for the upper grades may become virtually, if not actually, employers. The question has, of course, been raised as to whether engineers should join in such trade unions. There has recently been a broadening of the scope of trade unionism so as to embrace brain workers as well as manual workers, and we do not doubt that the A.S.E. would much prefer to see all engineers within its ranks rather than see separate unions. We feel, however, that the interests of the technical engineer cannot always be the same as those of labour, and there is also the serious disadvantage that if an engineer joins such a union he may be forced to take action of a kind which would be highly distasteful to him.

Then there is the further question whether, if unions are to be formed, there should be several unions dealing with various branches of engineering, or a single comprehensive union. As is well known the Council of the Institution of Electrical Engineers has taken steps to discourage, as far as possible, a multiplicity of unions, and has approved the E.P.E.A., which so far has been chiefly concerned with the staffs of power stations. As it is quite possible that different branches may not have identical interests, it would seem that the soundest policy would be to have a union for each branch with a federal union for the whole.

Having reached the conclusion that combination is desirable, let engineers accept the position and act without further delay. Nothing is to be gained by waiting; in fact quite the reverse. Our readers are aware that the Electrical Trades Union has already expressed the most active hostility to the formation of the E.P.E.A., and has threatened to make it impossible for any of their members who leave the former and join the latter to earn their living in the London area. Presumably this policy is to be adopted generally. Although we do not think it will prove effective, it is, nevertheless, well to bear in mind that any half-hearted action would only weaken the postion of engineers. The present is essentially a time for organisation, and if the present moment is neglected there will be little chance of representation upon Industrial Councils, even as an act of grace.

We think it must be recognised at the start that the strength of every trade union has been due ultimately to the right to strike. To the engineer this is a method which does not appeal This is probably due to the fact that the power of the strike has often been used in a way which has been felt not to be justifiable. In the case of engineers it should surely be possible to avoid extreme measures. Their dealings should be characterised by reasonableness and by an appreciation of the facts. Nevertheless, certain steps have already been taken which we feel are regrettable, and the recent letter addressed by the E.P.E.A. to electricity undertakings, demanding certain terms, was not couched in the language which we should have expected. It seems to us that the mailed fist was much too evident, and that the velvet glove was entirely absent. We feel that this is by no means a good beginning. There should in every case be negotiations with a view to seeing what is fair and reasonable. When, however, these have taken place, and when possibly a satisfactory result from the point of view of engineers has not been obtained, we think that engineers themselves will realise that the right to strike is the ultimate weapon and that in all probability their position will not be secured without having this weapon in reserve. Although we feel that this is the logical outcome of looking at the position, we trust it will never be necessary to employ a weapon which to every engineer must be repugnant.

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Some Developments in Industry During the War.

Mr. F. Kellaway, M.P., Parliamentary and Financial Secretary of the Ministry of Munitions, delivered an address on this subject at a meeting of the Industrial Reconstruction Council on Friday last, Sir Wilfred Stokes, K.B.E., presiding.

Mr. KELLAWAY said he intended to confine his remarks to certain developments that had taken place in industry during the war, as this was not the time to say anything as to Government policy in regard to what measures would have to be taken in the future. The war had revealed with pitiless accuracy the defects in our industrial equipment. Many of those defects had been overcome, and the United Kingdom was now first in almost every sphere of industrial effort. Dealing with raw materials, and commencing with mica, he said Germany previous to the war had established a predominant position in the electrical industry, which would not have been possible without the supplies of mica brought from India and other parts of the British Empire. Mica was essential to that industry, and the position of the British Empire in regard to mica supplies was, and is, the strongest of any country. India produced 50 per cent. of the world's supply and Canada 15 per cent., and Germany formerly produced 10 per cent. in German East Africa. But at the outbreak of the war the mica market of the world was at the point of being transferred from London to Hamburg, thanks to the skill with which Germany had obtained a large measure of control of the Indian mines, and the success with which she had captured the electrical industry. Germany took 47,000 cwt. of the Indian mica in 1913, 50 per cent. of our total imports of mica from India in that year being re-exported to Germany. Indian mica could now be exported to London only, and the mica in German East Africa was being worked for and obtained by the Ministry of Munitions. The British electrical industry had taken the place previously held by Germany and Austria, and was now the first in the world. The demands for mica were bound to increase, and the expected developments of commercial aircraft, wireless and motor traction made it essential that the Empire's supplies should be safeguarded.

With regard to tungsten, which was used principally in the production of high-speed steel, before the war the British Empire produced 40 per cent. of the wolfram ore from which the tungsten was made, but so successfully had the enemy captured the trade that no British manufacturer was able to establish the industry. At the outbreak of the war one of the two firms endeavouring to manufacture in this country was only able to keep going with difficulty, and the other by entering into a contract to supply the whole of its output to Messrs. Krupp, of Essen. We were now able to produce all the high-speed steel needed for our own industries, and to export at a reasonable price to our Allies. British manufacturers could, if necessary, convert the whole world's output into tungsten metal or ferro-tungsten. The quantity of ferro-chrome produced in the United Kingdom prior to the war was practically negligible, but a plant had now been established at Newcastle sufficient to meet our requirements for many years to come, the power being obtained from waste gases from coke ovens, and the industry would compete successfully with the cheap water power of Scandinavia. The world's consumption of spelter in 1913 was 1,012,000 tons, compared with copper 1,044,000 and lead 1,196,000. Amongst other uses it was milled into sheets for roofing and electrical purposes, and the oxide of zinc was indispensable in manufactured rubber. Australia had practically unlimited supplies of zinc ore. Germany obtained control of these ore supplies, and imported from Australia a large portion of her supplies of zinc ore. Previous to the war we used annually 240,000 tons of spelter, of which 77 per cent. was imported, practically all from Germany, Belgium and Holland, Germany sending us £1,500,000 worth of spelter, besides smaller values of sheet zinc, oxide and lithopone. These supplies ceased on the outbreak of war, and our immediate needs were principally met by imports from North America. The price rose from £23 to £120 per ton, but the U.S. smelters erected new works, and by the middle of 1917 the price had come down to £50. The zinc concentrates now flowed from Australia to this country, and zinc smelters' plants were doubled, and in some cases trebled. Before those extensions were completed the shipping position from Australia became so serious that all shipments of zinc ore from that quarter had to cease, but that difficulty should soon disappear, and the home production of spelter should reach 140,000 tons per annum, as against 32,000 tons before the war.

We formerly depended upon Germany for our supplies of 30,000 tons of potash per annum, entirely brought in from the Stassfurt mines. It had since been found that 50,000 tons of potash was going to waste every year in this country in the dust or fumes from blast furnace gases. The only known method of collecting those dusts was the Halberg-Beth system, a German invention. The design had been modified to ensure greater reliability and lower capital cost and to reduce the quantity of steel which it was necessary to use, and plants in hand, without these modifications, should produce 18,000 tons of potash per annum. Gas cleaning plants were being erected at two blast furnace works which should produce 1,600 tons of potash per annum. Other sources of potash—cement kiln gases and suint liquors (derived from washing raw wool)—were being investigated. We ought to reach complete independence in a comparatively short time. Germany had relied on her practical monopoly of natural deposits of potash in Europe to enable her to bargain for the recovery of her world market, but she would be disappointed. The cleaning of the flue gases also made the gas available as a source of power, and it was worth while to do the cleaning for that purpose alone. The machine tool industry had presented difficulties, but the position had been met with astonishing success. Restrictions had had to be put upon the use of machine tools for other than munition purposes, but the munitions supply had never been jeopardised by the lack of tools. The output prior to the war was valued at £4,000,000 per annum. For 1917 it was increased to £6,500,000 based on pre-war prices, or £10,000,000 at war prices. Our increased output was reached by concentrating upon the production of a limited number of types, and the economy consequent upon specialisation had been so fully demonstrated that it was probable manufacturers would continue to specialise. Our output showed an increase of 66 per cent. in 1917 over pre-war production, compared with the German increase of 23 per cent., and there was no reason why this country should not become independent of outside supplies. In engineering methods great advances had been made in the improvement of machinery, and economy of men and efficiency resulting from the necessity of organising for the production of interchangeable repetition work. Old machines had been found unsuitable for giving the accuracy which interchangeability necessitated, and fresh machines were put in which were more efficient. Increased efficiency had also been secured by increased use of milling machines, improvements in screw threads, development in drop stampings and increased use and delicacy of gauges and die castings. All this had led to a realisation of the importance of having an up-to-date tool room, and the importance of the use of jigs, which saved the time of the operator in setting the work on the machine. In shop transport, in addition to conveyors, there had come into universal use electric trucks and platforms or skids, which deposited their loads exactly where they were required, and the old idea that scientific knowledge was impracticable in the shop had been swept away. In August, 1914, a certain shop manager, with the aid of the works metallurgist, had halved the time previously occupied in machining articles of non-ferrous metal. Remarkable progress had been made in aeronautical work, the weight of the engines per horse-power being about one-third of what it was at the beginning of the war, and it was hoped that before long the power of the engines in horse-power would be the same as the weight in pounds. With regard to magnetos, only one firm—Messrs. Thomson-Bennett Magnetos, Ltd.—was producing these in 1914, the output for 1913-14 being 1,140 magnetos. We still depended to some extent on the United States and Japan for the fine copper enamelled wire and oiled silk required for magnetos, but wonderful progress had been made in providing the necessary materials, and we should soon be self-supporting. The greatest credit was due to the officials of the Admiralty, the Ministry of Munitions and to Mr. Peter F. Bennett, of Messrs. Thomson-Bennett Magnetos, Ltd. We had now some 14 firms producing 128,637 magnetos in a year. The output for October was 18,000, against a monthly output of 100 at the beginning of the war, and the quality was better than that of the Bosch magneto. The output of ignition plugs in 1914 was 5,000, and for the year ended October 31 last the output was 2,148,726, the October output being 303,449 against a monthly output of 420 in 1914. There was, however, room for improvement in the design of mica sparking plugs for aircraft work. Optical and scientific instruments sold in this country prior to the war were nearly all foreign, or made of foreign parts, but our output had increased 20 times and we were now self-supporting. Similar progress had been made in regard to optical glass, and the turnover of our scientific glassware industry was more than £600,000 per annum. Prior to the war all the glasses for miners' safety lamps were obtained from abroad, namely, from Germany and Austria, and 75 per cent. of the glass bulbs, tubing and rod for electric lamps also came from Germany and Austria. We now produced sufficient supplies of the right quality. Before the war our output of bulbs

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for electric lamps was about 12 millions per annum, and three out of every four in use were imported principally from Germany and Austria, but we were now making enough for our essential needs. At the outbreak of war a considerable part of our artillery was equipped with dial sight No. 7, patented in Germany and in this country by C. P. Goers, of Berlin. At the outbreak of war the War Office had approached Messrs. Ross and Messrs. Beck, and the deliveries to October, 1915, were 1,362. The total deliveries to date from home manufacturers were 21,000. Much more remained to be done by the provision of more efficient works and furnaces, the installation of the most modern machinery, the development of potash production, the training of labour, scientific research and Government organisation. Reorganisation for peace-time production would take some time, but there were already signs that employers and employed were facing the difficulties with skill, courage and faith, and even in the immediate future we need not fear anything like a dislocation or stoppage of industry, and when our industry was once more established on a peace basis he believed British production and the demand for British labour would reach a peak it had never attained in pre-war days.

Mr. A. P. M. Fleming's Address to the North-Western Centre of the Institution of Electrical Engineers.*

Much attention is being directed to reconstruction, and careful surveys are being made of conditions likely to affect industry in the future, such as increase in production, the elimination of wasteful competition, tariffs, supply of raw materials, demobilisation of military and naval forces, change in character of manufacture from war to peace conditions, women in industry, wages and many others. All are important problems, each bringing many subsidiary ones in its train. But the most important of all the problems with which we have to deal, and one which will be of increasing importance in the future, concerns the human element in industry. Fatigue deserves special consideration, not only in that it is clearly a governing factor in production, but because it has a considerable and possibly a predominating influence in forming the mental attitude adopted towards industry by workers. Its causes and effects are not generally appreciated, but it is a normal condition consequent on bodily or mental activity indicated by a diminished capacity for further exertion. Fatigue is almost entirely nervous in its origin, and it is doubtful whether the muscles themselves ever approach a condition of real fatigue. Nervous fatigue is, of course, the more insidious form, and much more difficult to treat when it becomes chronic. It is, therefore, essential to arrange a suitable alternation of working and rest periods, forming a natural working frequency or rhythm. The correlation existing between industrial fatigue and accidents is so marked that the occurrence of the latter may be utilised as a measure of the former. Statistics show that the number of accidents happening increases as the working period proceeds, with a diminution prior to the dinner interval. The number falls considerably on resumption of work, increases steadily throughout the afternoon, but again diminishes, due to the anticipation of freedom, before the day is ended. The influence of an emotion such as interest in or fondness for the job has a remarkable effect in staving off fatigue. Moreover, when industrial operations are complex and frequent, but irregular in their incidence, the worker becomes worried, as the frequency of occurrence is greater than his natural working rhythm.

There is no doubt, however, that the greater part of industrial fatigue is entirely unnecessary, partly owing to the enormous amount of wasted movement and wasted time on the majority of industrial operations, and partly owing to the difficulty arising in concentrating attention due to poor working environment. The former may be largely remedied by what has been termed "motion study," the latter by "welfare" work. The application of motion study has succeeded where its introducers have succeeded—and has failed where its introducers have failed—to take the human factor into the fullest consideration. Its application in Great Britain must be even more cautious than in America, and intensive methods should not be introduced into any works without the fullest knowledge and consent of the workers themselves. To ensure success, the change must be preceded by an educational campaign. It is often contended that motion study transforms a man into a machine; but this argument is based on a misconception. Any man working at any job gradually and unconsciously cuts down each motion involved to a minimum, and progress towards mastery inevitably results in the use of least effort. The obvious result of motion study is to increase production, with a diminished wear and tear of the human being. A consequence of the increased production will be decreased working hours.

The introduction of welfare work, as such, dates from the realisation on the part of employers that, under modern industrial conditions, work is best performed in good surroundings by contented, healthy human beings. It has been criticised by the workers on account of its tendency to weaken the so-called solidarity of the working classes and to render membership of trade unions a less pressing necessity. Workers also regard with suspicion anything which is promoted by a spirit of benevolence or philanthropy. They do not want paternalism or charity. The development of Joint Standing Industrial Councils and the tendency towards further organisation in industry are removing the causes of these objections; and in any case we can have no sympathy with those extremists who object to any improvement in industrial conditions because they reconcile workers to wage slavery.

In the past, selection for industrial occupations has been of a haphazard character. In the case of youths entering the engineering trades it has been frequently left to the unstable judgment or caprice of a foreman without qualification for such a vital matter. In other cases, academic qualifications have been a determining factor in spite of their acknowledged uncertainty as guides to industrial success. The least usual and, under present conditions, most satisfactory method, although costly in time, is that of practical trial. It is unlikely that psychological methods will be employed for some years to come, as psychologists have not yet formulated general lines of procedure with sufficient accuracy. This need not discourage us, however, from progressing along other lines. Educational qualifications have necessarily been an important guide. Subsequent progress depends largely on individual desire to succeed, and, in general, merit has to a considerable extent met with its reward. The process has been akin to the natural process of survival of the fittest, and may be termed "self-selection."

In connection with aviation, the essential characteristics of successful and unsuccessful aviators have been examined by medical men and psychologists, and in this country, in America and in France methods have been devised for effective selection according to men possessing the necessary psychological and physiological characteristics. As a result, it has been possible to set forth the characteristics required by successful aviators. In connection with gunnery, signalling and other special requirements similar measures have been taken.

The idea of training is a necessary complement to that of selection, for training renders the selected worker fully productive and efficient in a minimum of time. It is futile to endeavour to train workers engaged promiscuously; it is wasteful to leave carefully chosen workers to pick up their occupations for themselves.

The electrical industries are of a skilled character, and require a period of several years during which the learner may acquire practical experience; it is also necessary to have this period accompanied by some form of instruction. Further, the future workman must have his general intelligence developed—he must have considerable mental resilience. Those youths who will in all probability compose the rank and file of industry will enter works before the age of 16, and will be required under the new Education Act to have continued education until the age of 18. This, as well as their pre-works education, should embrace a knowledge of the principles of industrial economics and of industrial history, as well as the elementary principles of science underlying the trade in which they are engaged. The facilities for training in research are at present too few, but there are developments that will remedy the present defects. The universities are attempting to afford suitable training, but there is required, in addition, training in large industrial laboratories, such, for instance, as that afforded by the Mellon Institute of Industrial Research, or the National Physical Laboratory. This gap will be filled possibly when more of the large industrial concerns establish their own research organisations. Developments in commercial training are taking place in certain of the universities in providing business courses. The most urgent changes are required

* Abstract.

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in connection with the training of works managers. Modern management has a technique quite apart from the technology of the particular works managed. Managers require to be broad-minded men, capable of handling tactfully large numbers of workers, of appreciating their points of view, and of deciding justly between conflicting claims. In Manchester a directorship in industrial administration has been established jointly by a few leading firms and the university authorities for the purpose of providing a satisfactory course of training for present and future managers.

Attention may now be directed to those factors which influence relations between groups of workers in industry. In the past this co-operation between management and the rank and file has often been entirely lacking, and is always far from complete. The causes of this lie deep in the rise of the factory system itself. This can best be appreciated by studying the transition from the Guild system, when every worker felt a responsibility to his trade, to the later industrialised conditions, when the gap developed between master and man. The rise of the industrial system shows clearly that whenever the human factor has been ignored or opposed, consciously or unconsciously, dissatisfaction, strife and frequently open rebellion, have been the inevitable consequences. One dominating feature stands out—namely, the absence of a strong national permeating influence of what might be termed "industrial patriotism," replacing the mutual mistrust between employers and employees. There are, happily, many indications that the community at large is giving earnest attention to these problems. Bodies such as the National Alliance of Employers and Employed will enable workers and employers to meet on equal terms. The medium between the management and workers now developing rapidly is the Works Committee, a popularly elected body having one representative from each department or trade in the works, and electing its own chairman and secretary. For reconstructing industries as a whole, the Whitley Report suggests the formation of Joint Standing Industrial Councils. But the introduction of any modification into the industrial system postulates the co-operation of all grades of workers without reservation or qualification of any kind, and before this can be accomplished a long and painful educative process has to be pursued. Those who argue in favour of democratic control seldom remember that exercise of control involves responsibility, which in turn demands wide experience and knowledge. A plan which would remove a great deal of doubt and mistrust from the minds of workers would be a recognition of the principle of upward mobility, by which all those engaged in industry having special capacity or latent ability may rise to positions in which it may be utilised.

We have considered the various means which make for improvement in the material prosperity of those engaged in industry. It is useless, however, to provide the means unless the will is also present to employ them. In war time the morale of the fighting forces is maintained partly through patriotic sentiment, partly through fear of the consequences of defeat, and partly through pride of achievement. These must be replaced by an equivalent in time of peace. In the past, material prosperity has been considered as an aim and an end in itself. The material side cannot be neglected, but if developed without reference to the ethical side, industrial activities become devoid of purpose and meaning and humanly intolerable. Consideration of the ethical aspect of industry involves the development of a new industrial ideal which would include everything that makes for the more durable satisfactions in life; it will command that loyalty, that regard for the common good which we call citizenship, the concrete expression of man's duty to the State. It would promote the cultivation of a love of art and science and all the media of a broad and liberal culture and for the growth of a sane and balanced mental outlook. When the chief personal demands of the individual are satisfied, self-interest, the dominating factor in industry to-day, will give way to this ideal of service, which can then be stimulated, developed and maintained.

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"Industrial Electrical Measuring Instruments." By K. Edgcumbe, M.Inst.C.E. (London: Constable & Company.) Pp. xvi.+414. 2nd Edition. 16s.

"Report on the Relativity Theory of Gravitation." By A. S. Eddington, M.A., F.R.S. (London: Fleetway Press.) Pp. vii.+91.

"Payment of Wages: A Study in Payment by Results under the Wage System," by G. D. H. Cole. (London: Fabian Research Dept., and George Allen & Unwin.) Pp. 155. 6s. net.

"An Introduction to Trade Unionism," by G. D. H. Cole. (London: Fabian Research Dept., and George Allen & Unwin.) Pp. 128. 5s. net.

Correspondence.

SOME APPLICATIONS OF ELECTROMAGNETIC THEORY TO MATTER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have just been re-reading the recent articles by Crehore bearing the above title, and a proposition he describes as new struck me as familiar. I refer to the proposition on page 393 of your issue dated September 6th last, referring to the uniform value of the sum of the squares of perpendiculars dropped from a given point on to the medial lines of a regular tetrahedron, for all positions of the point equi-distant from the centre of the figure. This is described as a proposition new to the science of geometry.

The proposition is not new, and is capable of being stated in more general terms. In "Todhunter's Spherical Trigonometry," edition 5, page 132, we find the demonstration of the proposition that if a sphere of unit radius be described around a regular polyhedron, the sum of the squares of the cosines of the arcs which join any point on the surface to the solid angles of the polyhedron is one-third the number of the solid angles. Now from this it follows that the sum of the squares of the sines of those angles will be two-thirds of the number of the solid angles, and these sines are the direct measure of Crehore's perpendiculars.

You will note that the proposition is true for any polyhedron, not only for the tetrahedron. Now the medial lines of the tetrahedron with their extensions are the diagonals of the more familiar cube. The above proposition gives for the cube, with its eight solid angles, twice the sum for the tetrahedron; but this is only because the perpendiculars in the case of the cube are measured twice over, the arcs being struck from both ends of the diagonals.

Crehore's application to crystals with four axes for the atoms could be made equally well to systems having not only 3, 4, 6 and 10 axes, corresponding to the five regular solids, but to any combination of these, and therefore *to any number of axes above two*, provided they be grouped as required so that the termini form regular polyhedrons.

The particular axes cited by Crehore are the projections in three dimensions of four axes each at right angles to the other three, and projected so that all are equally foreshortened (foreshortened in the ratio $\sqrt{3}/2$). As an intuition, I venture to say that the proposition can be extended to "n" dimensions, so that if, through any point in a medium of "n" dimensions perpendiculars be dropped on to the axes of a regular hypersolid, the sum of the squares on the perpendiculars will be constant for all points equi-distant from the centre of the hypersolid.—I am, &c.,

London, Nov. 27. E. BASIL WEDMORE.

COAL ECONOMY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the appeal which my Committee made in the Press that electric supply stations should assist the Coal Controller in distributing circulars with a view to urging the public to economise in coal, I should like to say that the appeal met with a most gratifying response, and the following letter will be of interest to those who thus kindly assisted.—I am, &c.,

The Provincial Electric Supply Committee of the United Kingdom, London, Nov. 27. T. W. COLE.

The following is the letter to which reference is made:—

Board of Trade, Coal Mines Dept., Holborn Viaduct Hotel, November 20, 1918.

T. W. COLE, Esq.,
The Provincial Electric Supply Committee of the United Kingdom.

COAL ECONOMY CIRCULARS.

DEAR SIR: With reference to the assistance which has been given by member companies of your Committee and other undertakings in dis-

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tributing circulars on coal economy, would you kindly convey to these companies the thanks of the Coal Controller, and inform them that the Department very much appreciate their kind help, which we feel has been of material value.

May I point out that there is little promise of an alleviation of the serious coal shortage this winter, and that the utmost economy in the consumption of fuel and light is still necessary.

Yours faithfully,
(Signed) C. W. SANDEMAN,
Director of Publicity.

The Use of High-Pressure and High-Temperature Steam in Large Power Stations.

In our issue of Nov. 29 we gave an account of a recent discussion before the Institution of Electrical Engineers, of Mr. J. H. Shaw's Paper on the above subject (abstracted in our issue of Aug. 16). In what follows we give a summary of the further discussion before the Birmingham Local Section on Nov. 27 :—

Mr. L. S. CARR said the question of the most economical pressure and superheat could not be considered from the point of thermal efficiency only. With turbines a very high vacuum was required to obtain high efficiency, but this vacuum called for heavy capital expenditure for condensing plant, and, in inland stations, on cooling towers and pumping. At present there were very little data available on these points—at any rate as to extra high pressure. At 700° F. no trouble had been experienced as regards the erosion effect on blading. The effect on certain parts of the fittings supplied in gun-metal was overlooked, and these had to be replaced by steel or one of its alloys, otherwise the results had been most satisfactory. Glasgow's new station was designed for 250 lb. per square inch, 250 deg. superheat, and boiler plant at a new station on the N.E. Coast for a working pressure of 475 lb. per square inch and 700° F. was now being installed, which was a big advance. He hoped the figures of capital, running and maintenance costs and steam consumption would be published. The term "Pounds of coal per kilowatt generated" was misleading and should be abolished. It was obviously unfair to attempt to compare two districts on such a basis—*e.g.*, a station using coal of 12,000 or 13,000 B.Th.U. with one using between say, 8,000 and 9,000. The latter, though it may be burning more pounds per kilowatt may be the more highly efficient. A high vacuum could be obtained on a river or sea-side station due to the colder water, and to the fact that the use of syphonic action materially lowered the pumping costs. Eskil Berg, of the Turbine Engineering Department of the General Electric Company, of Schenectady, recently gave the decrease of water rate as approximately 1 per cent. gain for every 12·5 deg. of superheat, and also emphasised the saving in the size of auxiliaries due to superheat.

Mr. H. BENTHAM asked whether the author had any actual operating figures for comparison with the tables. A saving of 8 per cent. in fuel consumption was shown by raising the steam gauge pressure from 200 lb. with 200° F. superheat, to 300 lb. with 300°F. superheat. Most engineers in adopting very high pressures and temperatures feared the added possibility of breakdown, which would not only wipe out possible economies, but might dislocate the running of the station. Higher temperatures might lead to serious expansion troubles, particularly in turbines of the reaction type which depended on fine clearances for their efficiency. Could the author tell whether high pressure or temperature had anything to do with the recent breakdown of the two 35,000 kw. and one 25,000 kw. turbos in the States ? The "High Pressure and Superheat" B.T.H. and Babcock combination at Rugby after a long run, was in excellent condition. This set, however, was small. Expansion trouble might occur on sets of 5,000 kw. to 10,000 kw. He could not agree that the total works costs were not likely to be affected by the use of higher pressures and temperatures. Maintenance costs would wipe out fuel saving if one ventured to operate some existing plants at higher total temperatures than 600° F. Additional expansion would set up further "racking" strains on the pipework. At one large power station riveted pipes and flanges had been substituted for all welded steam piping on their main steam ranges, owing to troubles due to high temperatures.

Mr. R. A. CHATTOCK thought that some of the figures given were optimistic. The statement that cooling towers could not obtain a lower bottom temperature than 75° F. was hardly correct. In Birmingham they obtained an average temperature throughout the year of 71° F. and the vacuum corresponding to this was 28·3 in. Again, coal was taken at 10s. a ton—a figure that was likely to be exceeded for a good many years. Figures should have been worked out on the basis of about 15s. a ton. A vacuum of 28·5 in. was assumed with a circulating water temperature of 60° F. with the river water, whereas 29 in. should be easily obtained with such a temperature. The overall efficiency of boiler-house plant was assumed to be 77·5 per cent., which he considered, as an average, practically impossible to obtain, although on individual boiler tests, including economisers, efficiencies of 80 per cent. to 85 per cent. could be reached; the average efficiency of the whole of the boiler-house over a period of 12 months could not be expected to be higher than 70 per cent., and probably somewhat lower. The coal per unit was stated in pounds throughout the Paper. It was more useful to state this in British thermal units per unit. For comparison, pounds of coal per unit was quite misleading.

With the pure water that it was necessary to use in modern high duty boilers, the liability to internal corrosion of pipes and economisers was very great, and it was of the utmost importance that the carbon dioxide or the oxygen contained in the water should be removed. The closed circuit system of handling the water should be adopted, and the temperature should be raised to at least 180°F. to 200°F. In Birmingham they were proposing to press the boilers up to 325 lb. per square inch, and to superheat up to a total temperature of 700°F.

Mr. J. Y. MACKERSIE also inquired how the author arrived at the figure of 8 per cent. to be added to the standing losses of the power station, operating with a working pressure of 200 lb. per square inch, when the working pressure was 350 lb. per square inch. He knew of no formula, empirical or otherwise, giving the proportion of standing losses on the increased pressure. The author thought that the boilers used in the new stations would be of the flash type with no steam and water reserve. This hand to mouth system of steam raising would be dead against one of the principals of station running, *i.e.*, continuity of supply. A steam reserve should not be provided either by providing larger steam drums or other methods of storage.

Mr. R. J. KAULA discussed the limitation of pressure to 400 lb. per square inch. Such a pressure could not be adopted in existing stations. Increased pressure and steam temperatures involved increased risk of breakdowns and failures; but without taking such risks there would be little progress. As regards turbine construction, if the steam condition were raised either the number of stages or the disc diameters required to be increased; however, the blade lengths and overall diameters of the turbine varied with the total steam quantity passed. Thus there was not much to choose between the costs of the two designs. If makers were to produce highly efficient turbines for widely differing steam conditions they would have to carry two sets of patterns for each standard output, which was a serious drawback. It would be an advantage if users were to agree upon a standard steam pressure and temperatures for new installations.

Mr. F. FORREST said that with pressures as high as 350 lb. per square inch the type of economiser was of great importance. A pulsating pressure existed, which was greatly accentuated if reciprocating pumps were used. At first sight one would condemn the use of cast iron for economiser tubes under such conditions. The steel tube economiser appeared to be more suitable, but suffered under the disadvantage that the metal rapidly corroded unless means were adopted for completely de-aerating the feed water before it entered the economiser. For some time there would be differences of opinion among engineers as to which type to adopt. With feed water at 350 lb. per square inch, and at, say, 250°F., a burst tube would be a very serious matter, and boiler insurance companies, as well as engineers in charge of plant, would watch this matter very carefully.

Mr. J. P. KEMP asked whether the overall efficiency of 77·5 per cent. for the boiler-house plant was put forward as a practical figure. He had not met such a very high result, and thought that 67·5 per cent. would more closely represent the average efficiency obtained at the present day. The highest average result he had known was obtained in a power station in Brazil, where the average for one particular month was 72 per cent., but the conditions were extraordinary. The boilers were new and very clean; they were operated at a fairly high "boiler load factor"; all air leakages on standing boilers were carefully eliminated; the feed water was clean so that blowing down was seldom necessary; no boilers were emptied during the month; the boilers were hand fired by Indian stokers who were doing their utmost to earn their bonus; and the entire plant was very carefully supervised for the whole period by competent European engineers. These were conditions which were not ordinarily experienced in boiler-house practice. Unless a very marked improvement was effected in the various types of boilers, superheaters and economisers in use, he doubted whether the author's figure of 77·5per cent. average efficiency was practicable.

Mr. W. N. Y. KING agreed that Mr. Shaw's figures were optimistic. From the profits shown there must be deducted various losses attendant on the use of the increased pressures, *e.g.*, extra capital cost and maintenance charges due to special steam-piping fittings, joints, glands, lagging, &c. Further, auxiliary plant would be considerably affected in design. At high pressures pre-heating was especially necessary. Auxiliary piping would be a source of greater care and loss of heat due to radiations, and would cost more in upkeep of values and lagging. The power required to drive the auxiliaries was estimated at only 2·65 per cent. of the total output; 5 per cent. would be nearer the correct proportion, even with a highly efficient plant. It would have been more suitable to express the power required in kilowatts and not in brake-horse-power in connection with technical electrical matters.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters : Balderton-street, Grosvenor-square, W. 1.
Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Sunday, December 8th.—The competitions between the Companies will be held at Esher Bridge.
Monday, December 9th, to Saturday, December 14th.—Drills as usual.

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Electricity in Birmingham Industries.

In its issue of the 29th ult. the "Birmingham Daily Post" states that the great contribution which Birmingham made to the solution of the munitions problem was only possible by a great augmentation of its power supply. One or two big establishments had independent power plants, but most of the works relied on the municipal supplies of electricity and gas. The movement in the direction of electrification of industry has been hastened by war requirements. The scheme for the extension of the electricity works was arrested by the war, but the new station at Nechells is again being pushed forward towards completion, and when brought into service it will give an additional supply of about 30,000 kw., with means of increasing the output to 100,000 kw. as the demand arises. When the war began the number of consumers taking current from the municipal mains was 8,746, and the horse-power of motors 64,623. The total lamp and motor connections represented 65,510 kw. By the end of the war the number of consumers had increased to 11,101, the motors to 131,912 H.P., and the total connections 119,233 kw. The department has also had to refuse a very large amount of industrial power applied for, and for about two years no private houses have been put on the mains. Motors representing thousands of horse-power are waiting to be installed. A substantial part of the additional current now being arranged for is accordingly forestalled, assuming that those establishments which have been such large consumers hitherto for war purposes will continue equally active under peace conditions. The ascendancy of electricity over steam power has been emphasised by war conditions. Gas and suction gas have also been displaced, though gas engineers expect to recover some of the ground they have lost. Big motor-car builders, who started out with private generating plants, now prefer the alternating current supply of the Corporation. The metal-rolling mills have adopted the same policy. Other branches where electrification has advanced are the tube mills, brassfoundries and pen factories. During the war new works have been electrically equipped at Ward End, Bromford, Tyseley and Selly Oak, sub-stations which already existed being used for the purpose.

Electric current has, moreover, become an indispensable adjunct in some typical local industries, not only for driving heavy machinery, but for operating portable tools and instruments used in all sorts of crafts. Jewellers employ tools with motor attached for a considerable range of fine work, as well as superseding old-fashioned methods by electric soldering irons. The current is employed in brassfoundries for lathe work, cutting, sawing, polishing, plating, &c. It is also rendering invaluable service in the making of spectacles and opera and field glasses. Numerous small motors have been introduced for driving stitching machines and otherwise assisting the work of the boot-repairer. One firm has lately put down motors of 40 H.P. for making glass bottles Current is increasingly called for to operate dough-making machines.

The following table is given as an illustration of the latest experience in regard to representative Birmingham trades :—

	Units used per ann. per H.P. installed.		Units used per ann. per H.P. installed.
Bedstead manufacturers.	438	Lamp manufacturers ...	1,141
Brassfounders	824	Metal-workers	654
Electroplaters	695	Refiners	553
Engineers	895	Rolling-mills	691
Gunworkers	1,284	Stampers and piercers .	604
Ironfounders	806	Wire-workers	488

The electric furnace has occupied a growing field, and it is fulfilling a useful function in some local industries, the capacity ranging from 2 kw. or 3 kw. up to 500 kw. The former are used in melting precious metals in the jewellery trade, while the larger furnaces found their opening through the demand for munitions, proving very serviceable in the melting of iron and steel ingots. Between the two extremes there are a number of intermediate sizes in use in different metal-working trades in the district. Great economies of labour have been effected by the use of electrically-driven motors for tilting the furnaces, and electrically-driven overhead cranes for carrying the molten metal into the casting shops.

Parliamentary Notices.

In the following cases notices of intention to promote Bills in the 1919 Session for electric supply or electric traction powers have been given.

BLACKPOOL Corporation seeks powers to purchase the undertaking of the Blackpool & Fleetwood Tramroad Company, to construct tramways and street improvements, &c.

In the LEEDS CORPORATION Bill power is sought to construct tramways, tramroads and street improvements, to extend limits for supply of electricity and gas, &c.

MANCHESTER CORPORATION seek powers for further works in connection with the electric generating station at Davyhulme, to take water from Manchester Ship Canal, &c.

MIDDLESBROUGH CORPORATION seeks authority to construct tramways within and outside borough, to run trolley vehicles outside borough, to purchase tramways of the Imperial Tramways Company (either alone or jointly with Stockton-on-Tees and Thornaby-on-Tees Corporations), to acquire powers and undertaking of North Ormesby, Southband, Normanby and Grangetown Railless Traction Company, to employ trolley cars and trolley vehicles, to enter into agreements with Cleveland & Durham County Electric Power Company and Newcastle-upon-Tyne Electric Supply Company for the supply of electricity, &c.

The NEWARK GAS COMPANY seek powers to apply for provisional orders to supply electrical energy and to take transfers of undertakings of local authorities and others, &c.

NUNEATON CORPORATION desire to obtain further powers to purchase from, or supply to, any adjoining local authority, company or person electricity in bulk.

SHEFFIELD CORPORATION seeks powers to construct new tramways, to advertise the city, &c.

STOCKTON-ON-TEES CORPORATION desire to construct and work tramways; to purchase motor omnibus undertaking in the borough and neighbourhood of the Imperial Tramways Company, to run motor omnibuses within the borough, &c.

STRETFORD URBAN COUNCIL seek powers to purchase the undertaking of the Trafford Power & Light Supply (1902), Ltd., to extend area of supply of electricity to Davyhulme and part of Salford, to sell portion of undertaking in Salford to Salford Corporation, and further powers in regard to the supply of electricity, the provision and working of motor omnibuses, &c.

A Bill will be introduced to incorporate the THAMES OCEAN, WHARF & RAILWAY COMPANY for the construction of a wharf, quay or landing stage in Canvey Island, and for the construction of four lengths of railway and other works, to empower the company to generate and supply electrical energy in bulk or otherwise, to work the intended railways by electric or steam power, &c.

TYNEMOUTH CORPORATION desire power to run trolley vehicles in the borough, to construct overhead and other trolley electrical equipment to use trailer cars and omnibuses, to make regulations as to electrical power and safety of passengers, to enter into agreements with Newcastle-upon-Tyne Electric Supply and Northern Counties Electricity Supply Companies, to work tramways and light railways when completed, to purchase light railway in Whitley and Monkseaton, to alter dates for purchase of tramways and light railways of Tynemouth & District Electric Traction and Tyneside Tramways and Tramroads Companies, &c.

PROVISIONAL ELECTRIC LIGHTING ORDER.

CHEPSTOW Electric Lighting & Power Company, Ltd., is applying for an order to extend area of supply to parts of rural district of Lydney.

TRAMWAY PROVISIONAL ORDERS.

OLDHAM Corporation and Chadderton Urban Council, and THORNABY-ON-TEES Corporation are applying for Provisional Orders to construct tramways, to enter into working and other agreements, &c.

Legal Intelligence.

Battery Refills Action.

On Monday Mr. Justice Darling, sitting without a jury, had before him an action brought by the Electric & General Stores Company against the Anglo-Continental Sales Company to recover damages for alleged breach of contract. Defendants were not legally represented and did not appear at the trial. Plaintiffs' counsel said defendants contracted on May 15, 1916, to supply them with a large quantity of battery refills. The first instalment was to be a lot of 20,000, and payment was to be at the rate of £23 per thousand. When the goods were delivered they were examined and it was found that not a single refill came up to the specification. Plaintiffs therefore suffered damage, for they paid £460, and lost the profit which they otherwise would have made.

Mr. J. Wm. DODDS, partner in plaintiffs' firm, gave evidence, and said that the whole consignment, on being submitted to tests at his own works and those of a Sunderland firm were not up to the specification provided. He reckoned the loss of profit alone at £20 per thousand.

Mr. WM. T. MUNDELL and Mr. JOHN BRUCE BRANTING said they examined and tested the refills, which did not come up to the mark.

His LORDSHIP gave judgment for plaintiffs for £460 and for £400 damages.

Breaches of Mining Regulations.

At Mansfield last week Mr. Chas. H. Heathcote, manager, and Jas. C. Thompson, electrician at the Sherwood Colliery, were charged with contravening on Sept. 6 last No. 129 of the General Regulations made under the Coal Mines Act, 1911.

Capt. Robert Nelson, electrical engineer to the Home Office, said that in consequence of the report of a fire at the colliery on June 24 he made an inspection on Sept. 6, and in the motor-house he found a transformer with a cable leading to it, the insulation of which at the cable end had not been sealed as required by the regulation. The same thing applied to the cable leading from the transformer to the motor. Although that condition was not immediately dangerous, it invited danger in the course of time, for if the cable end was not properly sealed moisture collected and ultimately the reliability of the cable was destroyed.

Mr. Heathcote gave evidence and contended that the sealing of the cable was efficient, and evidence in support of this was given by Mr. Andrew B. Muirhead, consulting engineer and chief engineer of Messrs. D. Selby Bigge & Company, and Mr. William Maurice, M.Inst.E.E.

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The magistrates were of opinion that the cable was not sufficiently sealed and imposed a fine of two guineas.

A second charge against defendants was that certain electrical apparatus in the main switch-house at the shaft bottom was not installed so that the cable was mechanically protected by securely attaching the metallic covering to the switchgear, and the Bench imposed a fine of one guinea.

A third information that at the shaft bottom adequate precautions were not taken to prevent signal and telephone wires from touching cables or other apparatus was dismissed.

In the case of Mr. Thompson, the Bench stipulated that instead of paying fines he should pay the costs of the summonses.

Patent Record.

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

November 2, 1918.

17,932 READETT. Electrically treating and hardening steel, &c.
17,962 KAPLAN. Galvanic cells.
17,972 KAPLAN. Galvanic cells.

November 4, 1918.

17,985 BUNKITT. Securing electro-deposited tip on a propeller blade.
17,995 HUNT. Detection of varying magnetic field.
18,011 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Vacuum breakers for liquid condensers. (6/11/17, U.S.)
18,013 W. T. HENLEY'S TELEGRAPH WORKS CO. & NICHOLLS. Removable fuse carriers.
18,025 SCINTILLA. Magneto-electric ignition machines.
18,033 MCNALLY. Telephone transmitters.
18,046 DIXON. Telegraphy. (1/11/17, U.S.)
18,048 DE SEYSSEL. Frictionless electric switch.
18,051 JOEL. Dynamos.
18,054 EDISON SWAN ELECTRIC CO. & SHERGOLD. Snap switches.
18,059 STAMP. Electrical meter controllers.
18,070 18,071 & 18,072 ECKERSLEY. Electro-magnetic wave transmission and reception.
18,073 WHIDDINGTON. Electro-magnetic wave transmitting and receiving systems.
18,074 18,075 & 18,076 ROBINSON. Electro-magnetic wave navigational systems.
18,076 ERSKINE-MURRAY. Electro-magnetic wave navigational arrangements.
18,077 ROBINSON. Electro-magnetic wave reception arrangements.
18,078 LEA. Electro-magnetic wave signalling systems.
18,079 POOL. Electric socket connections.
18,080 WHIDDINGTON. Braided electrical conductors.
18,081 WHIDDINGTON. Electro-magnetic wave signalling systems.
18,082 WHIDDINGTON. Electro-magnetic transmission of sound.

November 5, 1918.

18,086 PICKARD. Electrical ignition for internal combustion engines.
18,088 MALLIK MOTOR SIGNAL CO. & OGDEN. Electric signalling systems for motor vehicles.
18,089 BRAMLEY. Magneto ignition machines.
18,101 HOLT. Electric concertina accordion.
18,115 LANE. Magnetic devices for drawing cog in mesh on electric machines.
18,135 NORSK ALKALI AKTIESELSKABET. Electrolysis of chlorides of alkaline metals. (13/12/17, Norway.)

November 6, 1918.

18,154 MORINAN & WHITEFIELD. Renewable filament and standard incandescent electric lamps.
18,178 SCHASCHKE. Machine for winding coils.
18,207 & 18,208 SCINTILLA. Rotating magnets of magneto-electric ignition apparatus. (6/10/17, Germany.)
18,209 ENCLOSED MOTOR CO. & MOSSAY. Dynamos.
18,212 MANSELL. Electric lamp holders.
18,216 MAGINI. Equitable cyclic distribution of monophase charge at phases of polyphase feed circuit.

November 7, 1918.

18,249 IRELAND & LUCAS. Ignition magnetos.
18,259 LATOUR. Radio-telephone apparatus.

November 8, 1918.

18,319 HARBEN. Indicating position of buttons of electric bells or switches.
18,338 COLLINS. Switch type incandescent lamp-holders.
18,339 GARBETT. Electrodes.

November 9, 1918.

18,358 WHITFIELD. X-ray photography.
18,370 COXON & WILLIAMS. Renewal of metal filaments in lamps.
18,396 ERSKINE-MURRAY. Electric welding. (9/11/17, U.S.)

November 11, 1918.

18,400 PRENTICE. Contact devices for ceiling roses, cut-outs, connectors, rosettes, &c.
18,424 MALLINS & BARKER. Trolley heads for electrically-propelled vehicles.
18,425 COLLIE. Spring contact clips for fuses.
18,431 JONES. Electric driving.
18,433 GRYLLS & HEAFE. Arc lamps.
18,435 SIEMENS & HEWITSON. Supporting electric cables, &c
18,454 WALKER. Controllers for motors.
18,464 SOC. ANON. DES ETAB. L. BLERIOT. Regulating devices for electrical machinery. (31/7/18, France.)
18,467 SEWARD. Electro deposition of magnesium. (19/11/17, U.S.)
18,468 TAVANI. Circuits instantaneously sensitive to photo-electric action.

November 12, 1918.

18,500 GREEN. Electric heaters.
18,502 PARK ROYAL ENGINEERING WORKS & JOYCE. Adapter or connector for electric wires.
18,507 SIEMENS BROS. & CO. Galvanic cells.
18,511 SKINDERVIKEN. Telephone transmitter. (7/11/17, U.S.)
18,534 HOLSGAG. Alternating current welding transformers.
18,539 GUSH. Mounting electrodes in boilers, &c.
18,543 MELLERS & JACKSON. (Waterhouse.) Contact shoes for train control systems.

November 13, 1918.

18,559 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO., MILLER & BROOME. Motor control.
18,576 CROSSLEY-HILL. Transformers.
18,585 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Dynamos. (23/11/17, U.S.)
18,594 SIEMENS BROS. & CO. & PETTIGREW. Registration of telephone calls.
18,601 DEAN-OSGOOD. Switches.
18,614 EWEN. Inductance coils.
18,622 COUPE & DOYLE. Carbon elements for radiators, &c.
18,625 BRAGG, DRYSDALE & HUNTER. Control and firing of mines, &c., by electricity.

Commercial Topics.

Anglo-Egyptian Trade.

The Egyptian Ministry of Finance has inaugurated a commercial service, and in order to foster closer relations between United Kingdom and Egyptian traders the Ministry desire to collect catalogues of United Kingdom manufacturers. Catalogues may be forwarded direct by British firms to the Commercial Secretary, Ministry of Finance, Cairo.

* * * *

Commercial Intelligence Officers.

It is announced that the question of the designation to be borne by the Commercial Intelligence Officers appointed in foreign countries in connection with the re-organisation of the Government system of commercial intelligence has been under consideration. It is felt that the title of Commercial Attaché is not the most suitable, and it has consequently been decided that the designation of these officers should be altered as follows: —

Commercial Attaché, 1st grade, to be called Commercial Counsellor of Embassy. Commercial Attaché, 2nd, 3rd and 4th grades to be called Commercial Secretary of Embassy (1st, 2nd and 3rd grades).

* * * *

Iron and Steel Prices.

The Minister of Munitions has fixed the export prices of pig and bar iron as from Dec. 2 until further notice. The existing maximum prices of pig iron for home delivery remain in force. The Minister is also fixing new maximum prices of steel for delivery in the United Kingdom on and after Feb. 1, 1919. Until that date the existing maximum prices remain in force.

During the war, while the Government was practically the sole purchaser of iron and steel products, the Ministry of Munitions adopted the policy of stabilising prices by paying direct to the makers certain increased costs due to war conditions. Now it is desirable to place the industry on an economic basis as early as possible, but the great increase in prices which would result from an immediate withdrawal of all subsidies would seriously prejudice the resumption of ordinary commercial work and induce dislocation not only in the iron and steel trades, but in the wide field of engineering and other activities dependent on iron and steel. The Government has, therefore, decided to remove the subsidies in two stages. Those applicable to steelmaking will be removed on Jan. 31, 1919, when a revised schedule of maximum prices for steel will take effect. Those applicable to pig iron will continue until April 30, when it is proposed that all subsidies should cease entirely. Arrangements have been made in consultation with the trades concerned to secure an equitable distribution of pig iron and steel so long as any subsidies continue. It is not, however, intended that Government subsidies should be used to enable exports to be made to overseas markets at less than the full cost. The Ministry have, therefore, issued lists of export prices for both iron and steel calculated to include the full amount of the subsidies. The Government will levy as a drawback on exported iron and steel the difference between home and export prices.

* * * *

Demobilisation Instructions.

It is announced that, though general demobilisation has not begun, priority of release will be given to officers and men who have definite employment awaiting them. An employer who has vacancies for individual officers and men now serving with the Forces should take the following steps to secure that they are noted for early release when general demobilisation begins.

Officers.—Employers should obtain Form R.C.V. from the local District Director, Appointments Department, Ministry of Labour, enter on it the required particulars and return it to him.

A university, scientific or technical institution, or employer expecting the return of an officer to enter on or complete a course of training, articles, &c., should obtain Form R.C.T.V. from the local District Director of the Appointments Department of the Ministry of Labour, and should complete and return it in the same way as Form R.C.V.

For Men other than Commissioned Officers.—Employers should obtain from the local Employment Exchange a specially printed postcard, E.D. 406, enter upon it the man's name, regimental number, and the name and number of his unit, with, if possible, his home address, and return it to the Employment Exchange. In the case of men of high educational attainments serving in the ranks, an employer who has a definite vacancy to offer such a man, or an institution or employer who expects the return of such a man to complete a course of training, should fill up the form R.C.V. or R.C.T.V. and return it to the local District Director, instead of sending the postcard E.D. 406 to the Employment Exchange.

Arrangements are being made for a limited number of "pivotal" men to be released in advance of general demobilisation for specified professions and industries, including the following: Civil, mechanical and mining engineers, officials of local authorities, agricultural machinery, building and construction, coal mines, glass, iron and steel manufacture (primary processes only, excluding stampings and forgings), railways, shipbuilding, iron and steel wire, shipowners and ship brokers, &c.

Firms or persons claiming exceptional treatment for an officer or man on the ground that he is "pivotal" should fill up Form D.F. 2, which can be obtained from the Ministry of Labour, Demobilisation and Resettlement Department (D.F. branch), 8, Richmond-terrace, London, S.W.1. Persons applying for Form D.F.2. must state: (i.) The precise nature of their business, industry or profession; (ii.) the capacity in which they propose to employ the man whom they claim as "pivotal"; and (iii.) his rank or rating in the forces.

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Electricity Supply.

The Bolton Electricity Committee has again increased the charges for electricity.

SOUTHWARK (LONDON) BOROUGH COUNCIL has applied for power to increase the maximum price of electric current from 8d. to 1s. per unit.

BURNLEY ELECTRICITY COMMITTEE recommends that the salary of the Borough Electrical Engineer (Mr. Starkie) be increased from £500 to £600.

Consumers' accounts in WILLESDEN are to be increased by 10 per cent. as from September, and for all supplies through slot meters the increase will be 2d. in the 1s.

STOKE-ON-TRENT Corporation has adopted a revised scale of charges for electricity, which will yield an increased annual revenue of from £800 to £1,000.

TIVERTON CORPORATION are considering an offer by Sir Ian Amory to erect hydro-electric works and to supply electricity for lighting and power in the district.

Last week GLASGOW CORPORATION agreed to increase the salary of Mr. W. W. Lackie, chief engineer of the electricity department, by £250 per annum. Mr. Lackie's present salary is £1,250.

The Board of Trade have now sanctioned the application of the Urban Electric Supply Company for leave to increase the charges for electricity at WEYBRIDGE to 8d. a unit. The increased rate is to be subject to further revision six months after the end of the war.

Owing to a dispute as to a wages award, a strike of about 50 stokers occurred at the Huddersfield electricity works on Saturday last, but clerks and other employees of the Corporation volunteered their services, and a supply of current was maintained, though a few factories were affected. The strike was settled on Monday, when the men's demand was conceded.

In pre-war days there were 15,605 stair lights in EDINBURGH, of which 14,440 were gas and 1,165 electric. The number removed on account of restrictions arising out of air raid precautions and not restored is approximately 4,140, of which 3,950 are gas and 190 electric. The Cleaning and Lighting Committee has authorised the inspector to restore the whole of the lights as soon as possible.

ACCRINGTON ELECTRICITY COMMITTEE have decided to increase the charges for electric current for lighting by another 10 per cent., making 20 per cent. above pre-war charges, and consume s supplied on the rateable value basis will be charged on the average net price paid by them during the corresponding quarter of the preceding year, plus 20 per cent. additional charge, with adjustments to prevent hardship in exceptional cases.

STEPNEY (LONDON) COUNCIL is recommended by the Electricity Supply Committee to accede to the request of the D.P. Battery Company, contractors for the maintenance of a battery of 244 cells at Limehouse station at £124 per annum, that the payment to them be increased 5 per cent. for every £1 by which the mean daily quotation of English lead during the year exceeds £18 per ton. At the time of the company's application the price of lead had increased to £30, compared with £15 at the time the agreement was entered into, and it has since risen to about £40.

The accounts of MARYLEBONE (LONDON) ELECTRICITY DEPT. for the yeas ended March 31 show gross capital expenditure £2,149,482 (increase £3,424), of which £1,662,428 is outstanding. Revenue was £216,846 (compared with £215,034 in previous year), and gross profit was £112,655 (£121,445). Interest, special charges and provision for repayment of loans required £112,594 (£114,481), and the net profit was £61 (£6,964). Units generated were 24,451,990 (compared with 24,159,759), and sold 18,387,268 (17,647,146). Maximum load on feeders was 10,817 kw. (9,737 kw.) and load-factor 19·4 (20·7) per cent.. The sales and publicity section shows a credit balance of £874 (£1,464).

At the meeting of BELFAST CORPORATION on Tuesday, Councillor White, chairman of the Electricity Committee, announced that many applications from prospective power consumers had been received, the demands varying from 100 H.P. to 500 H.P. In that connection, few could have failed to realise the important part which electric power was going to play in industry during the period of reconstruction. Belfast might feel assured that capital expended on electric power developments would bring a rich return in increasing prosperity to the city. At present the output of current used for power was double that for lighting. In 1901 they generated a million units, and in the present year 22 million units. In addition to that, they were under contract to supply something like 20 million more units, and he ventured to say that within a couple of years the output would not be far short of fifty million units annually.

Electric Traction.

YORK COUNCIL has decided to add a half-penny to the fare for each stage on the tramways.

Mr. W. Clough, general manager of the Bury Corporation tramways, has tendered his resignation.

The salary of the general manager of the ACCRINGTON tramways (Mr. H. Pilling) has been increased from £400 to £500 per annum.

LIVERPOOL Tramways Committee propose to order motor omnibuses, in order to relieve the present traffic congestion owing to the lack of tramcars.

BELFAST TRAMWAYS COMMITTEE has revised the tramway fares, and new penny stages have been introduced. Free passes on tramcars are being given to blind persons.

WALLASEY CORPORATION has decided to increase the tramway fares and to reorganise and reduce the length of the penny stages.

PRESTON TRAMWAYS COMMITTEE recommends the Corporation to purchase electric welding plant, at an estimated cost of £820.

The Board of Trade has extended by one year, from Aug. 18, 1919, the period limited by the HALIFAX CORPORATION ACT, 1911, for the completion of certain tramways.

WILLESDEN URBAN COUNCIL has accepted the tender of Ransomes, Sims & Jefferies for three 2-ton electric tipping wagons of British manufacture, at £1,151 each.

DOVER Borough surveyor, in a report on the condition of the local tramways, recommends the relaying of certain sections of the tramways and repairing others, at an estimated cost of £10,661.

The Board of Trade has extended by one year, from November 8, 1918, the time limited by the DEARNE VALLEY LIGHT RAILWAYS ORDER, 1915, for the compulsory purchase of lands and completion of works.

ST. HELENS CORPORATION recently appointed a new tramways committee with Councillor Rudd as chairman, and this committee has passed a resolution declining to extend the tramway lease, which lapses in October, 1919, and recommends the Corporation to make arrangements to work the tramways themselves.

The members of NEWCASTLE-ON-TYNE TRAMWAYS COMMITTEE have presented Councillor Jerrold Teago with a silver tea service in recognition of work done as an auxiliary tramcar driver during the early days of the war. The Chairman of the Committee (Mr. Mayne), who made the presentation, said that during 18 months Mr. Teago had turned out at 4 o'clock in the morning to drive the workmen to the shipyards and factories in the city.

A deputation from the King's Norton district waited upon the BIRMINGHAM TRAMWAYS COMMITTEE last week in order to urge the extension of the tramways system from Selly Oak to Northfield, Longbridge and Rednal. In reply, the chairman of the Committee, Mr. Lee, stated that they recognised the importance of the tramway being laid to the districts mentioned as soon as possible, but there was difficulty in obtaining materials. A sub-committee has been appointed to deal with the matter.

The Tramways Committee has decided not to give a tramcar service on Christmas Day.

The gross capital expenditure of BRADFORD tramways department at March 31 was £1,042,732, of which £521,676 has been repaid or provided for repayment. Year's revenue was £402,181 (compared with £356,025 in 1917), working expenses were £314,998 (£267,459), and after providing for insurances, interest, rent of leased lines and redemption of capital, net profit was £31,376 (£30,802), of which £10,000 (£3,400) has been devoted to relief of rates and £21,260 (£25,477) placed to reserve. Total revenue per car-mile was 16·345d. (14·037d.), and working expenses, including power, were 12·322d. (10·063d.) Passengers carried were 84,129,252 (77,074,546), car miles run 5,534,858 (5,728,982) and units used for traction and car lighting 12,410,819 (12,286,590). The railless trolley system realised £12,249 (increase £1,544), or 7·934d. (increase 0·753d.) per mile, and working expenses were £12,761 (£11,290) = 8·266d. (7·574d.) per mile.

Imperial and Foreign Notes.

The ONTARIO FIRE PREVENTION LEAGUE recommends the adoption of certain regulations and precautions against fire, including the inspection of all electric wiring throughout the Province.

The NEW ZEALAND hydro-electric scheme for the North Island, submitted to the House of Representatives, provides for three generating stations in the Auckland, Wellington and Hawkes Bay districts, which will have capacities of 96,000, 24,000 and 40,000 H.P. respectively. The total capital expenditure is estimated at £7,599,441.

In order to keep the wheels of industry turning in Canada during the period of transition from war to peace conditions, the Government has placed orders for 200,000 tons of 85 lb. steel rails, which will be used for the betterment and extension of Canadian railways. The Dominion Steel Corporation at Sydney has been given an order for 125,000 tons.

The Tasmanian State Premier, Mr. Lee, recently stated that the State's HYDRO-ELECTRIC SCHEME is being developed still further, and Parliament is to be asked for a further considerable sum of money for that purpose this year. It was hoped to launch a big scheme on the West Coast, and large contracts for the supply of power had already been entered into. It would be necessary to develop the Arthur Lake and link it with the Great Lake. The Minister of Lands (Mr. Hayes) said between the Great Lake and Waddamana there was a fall of 1,100 ft., but from Lake Arthur there was a fall of 2,200 ft.; 30,000 H.P. would be obtained at the Great Lake and 55,000 H.P. at Lake Arthur. They had spent £600,000, and the whole of the works would run to £2,000,000 or £3,000,000. The scheme would pay the interest on the outlay, and the State would not be asked to pay one penny.

"Indian Engineering" states, in an article on HYDRO-ELECTRIC DEVELOPMENTS in the Native States of India, that the Durbar of the State of Gwalior has sanctioned the estimates for the Parbati power scheme, which is to be designed to generate 8 million units per annum, that the State is laying out an industrial city under the direction of Prof. Stanley Jevons, economic adviser to Allahabad University, and that a trust has been formed to establish 25 factories. It is suggested that the iron ore smelting industry in Maghroni and Panihar could be

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revived by the application of electrical energy generated by power from the Sindh river, and that a paying aluminium industry could be established near Sipri if electrical energy were used. While other industries such as cotton ginning, weaving, glass making, cement manufacture, &c., could be worked by similar means. Mr. Gurtu, Revenue Member for Irrigation, says electrical energy might be obtained in the State of Gwalior from 18 sources and the total might equal 6,748,000,000 kw. annually. Mr. Alakh Dhari, Inspector General of Commerce and Industry of Gwalior State and Prof. Dunstan have expressed the opinion that electricity would probably be the most economical source of energy for iron smelting in the State.

Certain British firms are, according to the "Birmingham Daily Post," to be invited by the French Government to co-operate with engineers in France to carry out extensive public works in Algeria and Morocco.

In the ITALIAN CHAMBER OF DEPUTIES last week Signor Mitti, Minister for the Treasury, said that it was not possible to create a State monopoly of hydraulic forces, the development of which had to be left to private enterprise.

The United States Government has purchased from the Marconi Wireless Company of Ameirica the wireless equipment on more than 300 vessels under Government control, as well as the equipment for all small stations heretofore owned by the Marconi Company.

A Polish subsidiary company of the A.E.G., of Berlin, has been formed with a capital of one million marks, for the purpose of erecting electricity works, manufacturing electrical plant and machinery, &c. The head office of the new company is at Warsaw.

The proprietors of a shipyard in CADIZ, Spain (Echevarrieta y Larrinaga) propose to construct a dry dock in connection with their works capable of taking vessels up to and including 30,000 tons. Already new, up-to-date repair and construction shops have been erected; a large power-house is being constructed and electric cranes are being installed and a branch railway, connecting with the main line from Cadiz to Madrid, is under consideration. It is expected that with the completion of the dock Cadiz will become the most important port in southern Spain.

The "Board of Trade Journal" stated that in AUSTRIA an Order has been issued which authorises the State, and concerns in which the State participates financially, to expropriate existing plant for the production of aluminium sesquioxide and aluminium. The erection of new factories for the production of aluminium sesquioxide and aluminium, and the conversion of other plant into such factories, is made dependent upon special permission from the Minister of Trade. It appears that Austria has extensive deposits of bauxite, but hitherto only a small part of it has been worked up at home. It is hoped that the requisite increase of output can be profitably effected in connection with already existing concerns.

The "Norsk Marconi Kompagni" has been formed in Christiania, with a capital of 900,000 kroner, for the construction and sale of apparatus for wireless telegraphy and telephony. Marconi's Wireless Telegraph Company of London is to receive 300 shares in return for the exclusive right granted to the Norwegian company to construct and sell apparatus in accordance with the patents of the English company. The Belgian "Société anonyme internationale de télégraphie sans fil" had previously received the sole right for the sale and erection of wireless installations on Scandinavian merchant ships, but the Norwegian company has concluded an agreement with the Belgian company, under which the former obtains a monopoly of supplying all Norwegian merchant ships, which will be built in Norway, with Marconi wireless installations.

Miscellaneous.

The prices of petrol and paraffin have been reduced by 2d. per gallon.

The Society of Motor Manufacturers has decided to hold its annual touring car show at Olympia in November next.

In order to attract trade to the port, MANCHESTER SHIP CANAL facilities are to be improved by the erection of new warehouses and the installation of electric plant.

Recent additions to the STATUTORY LIST of firms and persons with whom trading by firms and persons in the United Kingdom is prohibited include the following: *Denmark*—A.E.G. Dansk Electricitäts A/S (Copenhagen).

MARCONI'S WIRELESS TELEGRAPH COMPANY, LTD., announces its transatlantic wireless service (Clifden-Glace Bay) was re-opened for the exchange of press telegrams between this country and North America at midnight on Monday.

At a meeting following a dinner at the Holborn Restauarant, London, on Friday last, the BATTI-WALLAHS' SOCIETY, of which about 50 members were present, passed a resolution pledging the Society to give its full support to the campaign of the Merchant Seamen's League to boycott German-made goods, and it was also decided to request the League to form an electrical section. This action was taken as the result of an appeal by Mr. Havelock Wilson on Oct. 15 last.

Sir Isambard Owen speaking at the TAUNTON MUNICIPAL TECHNICAL INSTITUTE last week, said he hoped the time had come when schools, colleges and universities were no longer looked on as luxuries, or of merely local importance, but that they were a primary national need. Had it not been for the men of science, who went on making and improving during the period of the war, we should now be in a very different position. Indeed, it was largely owing to the colleges and technical institutes that we were looking forward to a peaceful Christmas. We were to enter on another struggle now to sustain and extend our manufactures and commerce, and the labours of our scientific men would again have to come into play.

The "London Gazette" of Nov. 29 contains the following alterations to the list of PROHIBITED and RESTRICTED EXPORTS:—

Delete.—(A) Aluminium, (A) carbons suitable for searchlights, (A) cerium and alloys (except ferro-cerium), (A) mercury and compounds of same, (B) plumbago crucibles, (A) carbon electrodes for furnaces, (A) ferro-molybdenum, (B) ferro-chrome, (A) magnetos and parts, (B) mica waste and powder, micanite and articles and materials containing mica, (A) nickel and alloys and manufactures of same (except nickel-plated goods), (A) sparking plugs, (A) tantalum, (A) zirconium and its alloys.

Add.—(A) Aluminium and alloys of same, (B) magnetos and parts, (A) nickel, its ores and alloys, (B) sparking plugs.

At a meeting of employers and employees of the BIRMINGHAM brass and copper trades last week it was decided to form an INDERIM RECONSTRUCTION COUNCIL.

Mr. ERNEST J. P. BENN, Chief Commissioner of Trade Organisation, presided, and said that it was for industry to show that they were ready to deal with reconstruction problems. They had won the war, and it was now for them to win the peace. During the war industry and Government Departments had become so mixed up that it was difficult to know where industry ended and government began. Birmingham was the home of trade organisation, and he had no doubt that Birmingham would see a great deal to the advantage of industry and the State in the establishment of such a joint committee, which, of course, would act independently of existing employers' association and trade unions.

Mr. E. D. HARCOURT (Brassmasters' Association, and chairman of the committee presenting the report) said that employers' associations considered selling prices and trade unions chiefly considered the question of wages. Those matters were only incidents in connection with industry, and the many other problems could be considered by the Joint Committee.

Mr. W. J. DAVIS (Brassworkers' Association), who moved the adoption of the report, which approved the appointment of an Interim Industrial Reconstruction Committee, said they must do what they could to sustain capital and labour.

IMPORTS.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during October, 1918, and (*b*) the aggregate figures from Jan. 1, to Oct. 31, with increase or decrease compared with corresponding periods of 1917:—

Electrical machinery, (*a*) £26,614 (decrease £86,589), (*b*) £560,661 (decrease £599,842); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £17,659 (increase £2,441), (*b*) £145,094 (decrease £59,527); and electrical machinery unenumerated, (*a*) £8,955 (decrease £89,030), (*b*) £415,567 (decrease £540,315); telegraph and telephone cables other than submarine, (*a*) £755 (increase £690), (*b*) £4,167 (decrease £46,420); telegraph and telephone apparatus, (*a*) £1,741 (increase £616), (*b*) £41,347 (increase £5,361); other electrical wires and cables, rubber insulated, (*a*) £1,538 (as in October, 1917), (*b*) £2,195 (decrease £31,106); with other insulations, (*a*) £741 (increase £530), (*b*) £4,099 (decrease £4,762); carbons, (*a*) £799 (increase £3,701), (*b*) £28,016 (decrease £37,798); glow lamps, (*a*) £53,831 (increase £47,748), (*b*) £163,878 (increase £91,988); parts of arc lamps and searchlights (other than carbons), (*a*) £8,714 (decrease £1,966), (*b*) £85,285 (decrease £17,174); primary and secondary batteries, (*a*) £7,669 (decrease £23,438), (*b*) £121,527 (decrease £141,281); meters and measuring instruments, (*a*) £570 (decrease £4,018), (*b*) £19,771 (decrease £10,427); switchboards, (*a*) £483 (increase £403), (*b*) £2,756 (increase £2,195); electrical goods and apparatus unenumerated, (*a*) £40,447 (decrease £13,250), (*b*) £426,159 (decrease £33,389). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £117,288 (increase £6,016), (*b*) £899,200 (decrease £212,910).

EXPORTS.—The exports of electrical machinery, material, &c., (*a*) during October, 1918, and (*b*) from Jan. 1 to Oct. 31, with increase or decrease compared with corresponding periods of 1917, were as follows:—

Electrical machinery, (*a*) £92,300 (decrease £36,378), (*b*) £882,820 (decrease £354,410); including railway and tramway motors, (*a*) £5,143 (decrease £747), (*b*) £34,674 (increase £3,848), other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £60,919 (increase £10,965), (*b*) £542,829 (decrease £168,762); and electrical machinery unenumerated, (*a*) £26,238 (decrease £46,606), (*b*) £305,317 (decrease £189,496); telegraph and telephone cables, submarine, (*a*) £2,146 (decrease £40.291), (*b*) £447,116 (increase £275,591); other than submarine, (*a*) £45,395 (increase £22,909), (*b*) £281,049 (decrease £281,475); telegraph and telephone apparatus, (*a*) £21,785 (decrease £2,691), (*b*) £164,426 (decrease £64,387); other electrical wires and cables, rubber insulated, (*a*) £5,473 (increase £407), (*b*) £60,586 (decrease £112,658); with other insulation, (*a*) £19,144, (increase £12,816) (*b*) £99,125 (decrease £153,697); carbons, (*a*) £616 (increase £51), (*b*) £6,988 (decrease £14,430); glow lamps, (*a*) £5,269 (decrease £5,009), (*b*) £66,137 (decrease £46,777); arc lamps and searchlights, (*a*) £1,066 (increase £1,009), (*b*) £17,332 (decrease £5,266); parts of arc lamps and searchlights (other than carbons), (*a*) £86 (decrease £4,426), (*b*) £13,803 (decrease £57,940); primary and secondary batteries, (*a*) £15,647 (increase £5,166), (*b*) £103,932 (decrease £26,437); meters and measuring implements, (*a*) £8,436 (decrease £3,417), (*b*) £101,743 (decrease £13,771); transformers, (*a*) £1,234 (decrease £5,067), (*b*) £28,638 (decrease £33,231) switchboards, (*a*) £9,396 (increase £6,753), (*b*) £32,881 (increase £292); electrical goods and apparatus unenumerated (*a*) £35,508 (decrease £29,706), (*b*) £341,034 (decrease £257,489). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £171,201 (decrease £45,486), (*b*) £1,763,790 (decrease £791,895).

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Tenders Accepted.

SUNDERLAND COUNCIL has accepted the tender of Ferguson, Pailin & Company for switchgear and that of the British Thomson-Houston Company for a motor for coal conveyor.

HAMMERSMITH (LONDON) BOROUGH COUNCIL has accepted the tender of Erith's Engineering Company for the supply of a mechanical stoker at £1,350. E. Bennis & Company tendered at £1,980, the Stirling Boiler Company at £1,600 and the Underfeed Stoker Company at £1,555.

Appointments Vacant and Filled.

A large dynamo firm advertises for two assistant electrical designers.

An experienced designer of electric motors is required by an advertiser.

An electrician is required to take charge of small electric light installation. Applications to the Borough Surveyor, Douglas, I. of M.

An instructor is required for workshop classes in electric wiring and installation work at the Borough Polytechnic, Borough-road, S.E. 1.

A teacher for wireless telegraphy is required at the Merchant Venturers' Technical School, Bristol. Salary £250, rising by increments of £10 to £300. Applications to the Registrar.

A London firm of aircraft engineers, making metal fittings for aeroplanes, and desirous of changing over to production of metal work for domestic architecture, wants a capable works manager.

West Ham Education Committee invite applications for the post of Principal of the Municipal Technical Institute. Salary £600, rising to £700 per annum. Particulars from the Town Clerk.

A chief instructor of Government Technical Schools is required by the Government of Ceylon. Salary £450, rising by annual increments of £30 to £600 per annum. Applications to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1.

Applications are invited for the position of professor of physics in the University of Cape Town. Salary £800 per annum. Applications by Jan. 1 to the High Commissioner for the Union of South Africa (32, Victoria street, London, S.W.1), from whom particulars can be obtained.

A lecturer in natural philosophy is required at the University, Melbourne. Salary £450 per annum. £100 allowance for travelling expenses. Applications to Agent-General for Victoria, Melbourne-buildings, Strand, W.C. 2, by Feb. 1, 1919.

Mr. F. M. Fletcher, A.M.I.E.E., assistant electrical engineer at Rochdale, has been appointed borough electrical engineer at Darwen, in succession to the late Mr. Charles Garnett, at a commencing salary of £300 a year. He will commence his duties at Darwen on Jan. 1.

Business Items.

The Sheerness & District Electric Power & Traction Company, Ltd., has for sale a 110 kw, Browett-Lindley generating set.

The Stanton Ironworks Company, Ltd., has opened a branch office at Manchester at Grosvenor-chambers, Deansgate, which will be under the management of Mr. G. W. Turner. Telegrams "Spigot, Manchester," and telephone 4,945 City.

In their new pamphlet, "Notes on the Selection of Chain Gear," Messrs. Hans Renold, Ltd., Didsbury, Manchester, give information as to the cost and selection of chain drives, useful hints upon the erection and care of chain drives, &c.

The proprietor of letters patent No. 25,632 of 1906, relating to a simple construction of magneto giving four sparks per revolution, desires to sell the patent or to grant licences. Applications to Messrs. Boult, Wade & Tennant, 111 & 112, Hatton-garden, London, E.C. 1.

From the 9th inst. the address of the Electrical Contractors' Association (Inc.), the N.E.C.T.A., Ltd., and the National Federated Electrical Association will be 11 and 13, Southampton-row, W.C. 1. The new telephone number will be Museum 4088, and the telegraphic address "Nafecta Phone London." In future Mr. Leonard G. Tate will devote his whole time to the work of the three associations.

Mr. S. M. Hills, A.M.I.E.E., has resigned his position in the sales department of the West Ham Corporation Electric Supply to join the staff of Messrs. Greenly's, Ltd., the well-known specialists in business propaganda. Mr. Hills obtained his technical training at the Northampton Institute and his practical training with the British Westinghouse Company and the Mersey Electric Railway. Later he has been identified with the publicity side of engineering in the U.S.A., Australia, New Zealand, Japan and elsewhere.

In the 1918 Folder of the Bastian Electric Company, Ltd., particulars and prices are given of the various types of Bastian electric fires, stoves, heating apparatus, &c., supplied by them. The main claims made for Bastian fires are that they are reliable and operate at a higher temperature, that they give a better quality of heat—*i.e.*, the scorching heat, or real, red heat of the bright coal fire. The fires are guaranteed for four years, and the company claim that they can do this because of the design and of the high grade materials employed, particularly the quartz tubes and the very pure nickel chromium (Tabasco) wire.

Liquidations.

A meeting to receive an account of the winding-up of the Ilkeston Motor & Electrical Engineering Company, Ltd., will be held at Bromley House, Nottingham, on Jan. 1.

The British Electron Company, Ltd., is being wound up voluntarily for the purpose of reconstruction, and Mr. S. Lingard, 10, Marsden-street, Manchester, has been appointed liquidator, with authority to consent to the registration of a new company to be named British Electron, Ltd., and to enter into an agreement with such new company

Companies' Meetings and Reports, &c.

Western Telegraph Company, Ltd.

At the Annual General Meeting of shareholders on Wednesday, the Chairman (SIR JOHN DENISON-PENDER, K.C.M.G.) said: I think the Company is to be congratulated on having surmounted the many difficulties which necessarily arose in consequence of the War, causing at times considerable anxiety in maintaining communication which has proved so valuable to Britain and her Allies. Amongst the many difficulties with which we have had to contend may specially be mentioned the restriction of shipping, the supply of material and stores to our many stations, delays and danger to our repairing steamers in restoring interruptions to the cables, at times actually impossible to do, the transport of staff owing to regular liners being otherwise employed, &c., but communication has been maintained all over our system, although I regret with delay as regards the general public and the Press. The revenue from messages, &c., shows an increase, compared with the previous 12 months, of over £392,000, but the ordinary expenses and those connected with the maintenance of cables were also increased by nearly £131,000, and income tax and excess profits duty by £236,000, consequently the surplus over the corresponding period is brought down to the sum of £25,000. Commodities of all kinds used in the service, freight and insurance were only procurable at greatly enhanced prices, and extra payments to staff were necessary in consequence of the increased cost of living at home and abroad. I think it right to refer to two letters which have been received from shareholders, suggesting that some part of the reserve funds should be distributed to the proprietors in the form of "Bonus Shares." As we foreshadowed at the last meeting, the Company has now been granted a concession by the Brazilian Government to lay a submarine cable from Rio de Janeiro to the Island of Ascension, where it will join our other cables which land at that Island; also we have secured a concession to lay a cable from North Brazil to the Island of Barbadoes. The length of these new lines together will be considerably over 3,000 nautical miles and will entail an expenditure of many hundreds of thousands of pounds. Furthermore, since war was declared it has been impossible to carry out renewals to the several existing sections which are now urgently in need of renovation, proved by the constant interruptions to which they are subject. These renewals had to be suspended over the last four years, and time has shown the necessity of resuming this work at once, in spite of the high prices which at present prevail for cables. We are also threatened with further competition—the Western Union Telegraph Company has secured a concession to lay cables between various ports from the north to the south of Brazil, thus making another communication between Brazil and the United States. The Central & South America Cable Company, which for many years past has owned cables and land-lines from the United States to the Argentine, has also obtained a decree from Brazil sanctioning the laying of two cables to the River Plate. One from Rio de Janeiro and the other from Santos. These cables will connect that Company's existing system at Buenos Aires with its lines serving Chili, Peru, Central and North America. We are also advised that a few weeks ago a concession for a submarine cabe from Rio de Janeiro to Cuba has been granted to an American citizen. The necessary steps are being taken by our legal advisers to protect this Company's interests where this proposed competition is considered to affect them.

In July last at a meeting of a Wireless Company the Chairman stated that an eminent authority in the United States had expressed to him the opinion that no long-distance cables will ever again be laid and that, in his view, wireless telegraphy is thoroughly efficient for all telegraphic purposes. This opinion is evidently not shared by North American cable companies, as is proved by the efforts they are making to lay new submarine cables over a distance of many thousands of miles, entailing an expenditure of close upon, if not over, £2,000,000. Your Directors have, however, no fear that we shall be able to hold our own in the future as in the past, but what I have just told you furnishes another reason for maintaining the strong financial position in which the Company stands at the present time. Under these circumstances I feel sure the shareholders will support the Board in declining to consider in any form the issue of Bonus Shares.

As you are aware a large proportion of our staff are young men, and when war broke out in 1914, on behalf of our Associated Cable Companies, I communicated with the authorities, knowing well that these young men were anxious to enlist and asked what action our Companies were to take to let the trained staff go or to keep them to maintain cable communications. We received a definite instruction that our trained men should remain at their posts, and by so doing were, equally with those at the Front, doing their duty to their Country and the Allies, in maintaining cable communication, an absolute necessity for the Army, Navy and Commerce. With reluctance this order was respected by the combined staffs with but few exceptions. Twice during the war one of the Islands where we have a cable station was bombarded by an enemy submarine. The Company's buildings were particularly aimed at, but on the first attack no damage was caused, although several houses close to our office were struck. On the second occasion a shell severely damaged a church facing our station, and splinters penetrated the staff quarters, going through the floor and ceiling of two rooms which fortunately were unoccupied at the time. Several people were killed and wounded, but I am glad to say no member of our staff or their families were amongst the number. At another Island, where the Company's office is also close to the sea, an enemy submarine appeared actually in the harbour and did considerable damage

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to shipping, but no bombardment of the town took place. The staff throughout remained cool and resourceful, and I may add that communication would have been maintained even if our buildings here or abroad had been wrecked. The delay in transmission is regrettable, especially at a time when expedition in Press and commercial telegrams is of even more importance than in normal times, but this is a matter which has been beyond our power to rectify. I, however, now look forward, if we can only get favourable weather for our ships, which are all at their posts ready to effect repairs, to reduce this delay very materially before the close of the present year. Three interim dividends of 1½ per cent. each, and a final dividend of 1½ per cent., also a bonus of 2 per cent., have been paid, amounting together to £166,344, making a total distribution of 8 per cent., free of income tax, for the year ended June 30, 1918, thus leaving £33,129 18s. 11d. to be carried forward.

The report and accounts were adopted, and the retiring directors and auditors were re-elected.

A quarterly interim dividend of 2s. per share has been declared on the ordinary shares of the GLOBE TELEGRAPH & TRUST COMPANY, LTD.

The directors of Edgar Allen & Company, Ltd., have declared an interim dividend of 1s. per share, tax free, on the ordinary shares.

A quarterly dividend of 1½ per cent. on the cumulative preference shares has been declared by the BRAZILIAN TRACTION, LIGHT & POWER COMPANY, LTD.

The directors of the ZINC CORPORATION, LTD., have declared a dividend of 2s. per share on the preference shares, being the second half of the fixed preferential dividend of 20 per cent. for 1918.

The half-yearly interest on the ELECTRIC LIGHT & POWER COMPANY OF COCHABAMBA (Bolivia) 6 per cent. Government guaranteed loan will be paid on Dec. 16 by Messrs. Erlangers, 8, Crosby-square, E.C. 3.

The directors of the WESTERN TELEGRAPH COMPANY, LTD., have declared the first quarterly interim dividend of 3s. per share, tax free, for the year ending June 30, 1919, being at the rate of 6 per cent. per annum. The transfer books will be closed from Dec. 12 to 19 inclusive, and the dividend will be payable on the 20th inst.

Meetings of the holders of the prior lien debenture stock, notes, 5 per cent. debenture stock, and of the unsecured creditors of the PARAQUAY CENTRAL RAILWAY COMPANY, LTD., were held last week, when a scheme of reorganisation was approved. The chairman (Mr. B. H. Binder) stated that in July last the company's subsidiary undertaking, the Ascunsion Tramways, which had only been a burden to the parent concern, had been sold.

At the recent meeting of the BURMA CORPORATION the chairman (Sir Trevredyn R. Wynne, K.C.S.I.) stated that in order to provide the necessary power the construction of the Mansam hydro-electric power scheme had been put in hand, and contracts had been entered into for the required plant. When those works were completed they would have a plant capable of producing 31,500 tons of refined lead, 2,475,000 oz. of silver and about 25,000 tons of zinc concentrates. The installation of the additional plant to deal with the ore on a big scale had been deferred until after the war. It was not possible to say what the exact method of the treatment of the bulk of their ore would be.

The report of the WESTERN POWER COMPANY OF CANADA for 1917, states that the company, which was organised in 1916, has issued first mortgage 5 per cent. bonds to the extent $6,000,000 ($20,000,000 authorised); 10-year 7 per cent. debentures, $500,000 ($500,000 authorised); 7 per cent. preferred stock (cumulative from Jan. 1, 1918), $850,000 ($5,000,000 authorised); and common stock, $5,000,000 ($5,000,000 authorised). For 1917 operating revenues were $450,160, against $375,244; operating expenses, $130,559, against $116,150; net operating revenues, $319,601, against $259,094; non-operating revenues, $12,192, against $156; gross income, $331,793, against $259,250.

For the year ended June 30 the total revenue of the AUCKLAND ELECTRIC TRAMWAYS COMPANY, LTD., was £301,434. Traffic receipts were £294,564, an increase of £11,867. After providing for all expenses, including £22,511 for debenture and other interest, rental and percentage of profits payable to Auckland City Council (£5,431) and setting aside £25,000 to renewals and depreciation account, the surplus is £53,430, and with £5,293 forward, the total is £58,723. The directors recommend that £10,000 be transferred to reserve, and that a further dividend be paid on the ordinary shares of 1s. per share (less tax) for the half-year ended June 30, making 1s. 6d., per share for the year, carrying forward £5,973.

The directors of FULLER ACCUMULATOR COMPANY, LTD., are unable to submit the accounts at present owing to the amount of taxation under the Finance Acts and the Munitions Acts still being unsettled. They are, however, satisfied that the profits admit payment of 15 per cent. on the ordinary shares for year ended Oct. 31 (against 10 per cent. last year), after making liberal allowance for depreciation. At the meeting on Tuesday it was stated that further additions had been made to the Company's equipment in machinery, plant, buildings, &c., to cope with the continuing increase of business. The turnover for the year was considerably more than that of the previous year, and the prospects continue to look most promising. Mr. Leonard Fuller and Mr. D. A. Palmer were re-appointed directors.

Mr. L. Breitmeyer, who presided over the meeting of the CAPE ELECTRIC TRAMWAYS, LTD., last week said that during the past year 26,444,465 passengers were carried on the Cape Town and Port Elizabeth systems, earning £264,137. 18s. 6d., or an increase of 2,692,449 passengers and of £33,032. 0s. 5d. in traffic receipts. The figures created a record, but the working expenditure was again higher than in the preceding year. The ratio of expenditure to receipts (61·16 per cent.) was very little higher than last year, when it worked out at 60·91 per cent. The traffic over all lines had been run at full pressure, which meant a considerable wear and tear of the track and rolling stock. Of the amount available for appropriation (£42,391. 15s. 8d.), the sum of £12,000 had been placed to reserve, and a dividend at rate of 5 per cent. was declared, leaving £5,830. 13s. 8d. to be carried forward. South Africa, from a business and agricultural point of view, had been going through a period of unprecedented prosperity. New industries had been started and work everywhere was in full swing and at high pressure.

The net profit of FERRANTI, LTD., for the year to June 30 last was £35,174 after making provision for general establishment charges, bad debts, repairs and renewals, income-tax, debenture interest, &c., and the usual allocation to depreciation reserve. No provision has been made for excess profits duty, which has not yet been ascertained. Net profit for the previous year was £7,650. The outlook for the company's ordinary manufactures shows signs of improvement, although facilities for export trade are meantime limited. Substantial reductions have been made in the amounts outstanding in respect of debenture stock and loans from bankers, and arrangements were made for the renewal of the five-year notes until 1922. The directors have carefully considered the position and prospects of the company, and feel justified in recommending a dividend of 6 per cent. (less tax) on account of arrears of dividend accrued on preference shares. They hope at the conclusion of the war to bring forward a scheme for funding the arrears and to readjust the capital.

At the statutory meeting of the PLATINUM & GOLD CORPORATION, LTD., last week, the chairman, Mr. Thos. J. Ive, stated that there was no precious metal in such demand for scientific manufacturing processes as platinum. It was absolutely necessary and vital to many of the Empire's greatest industries. There were only two known sources of platinum in payable quantities—the Urals in Russia and the coastal regions traversed by certain rivers flowing from the western slopes of the Cordilleras or Andes Mountains and their affluents in the Republic of Colombia. The Chocó district, in which the Corporation was operating, was the chief centre of platinum production in Colombia, and the Corporation had secured and controlled large and extensive alluvial deposits of exceptional value. Previous to the war 90 per cent. of the world's output of platinum was purchased in Russia, but the yield from that country had fallen off in recent years. In 1912 the Chocó yield was 12,000 oz. and last year about 50,000 oz. Surveys had proved the existence of platinum and gold in payable quantities over many square miles of territory, and with modern up-to-date machinery the yield would be still further increased.

New Companies, &c.

ACME SALES AGENCY, LTD. (152,057).—Private company. Reg. Nov. 28, capital £500 in £1 shares, general agents, manufacturers of and dealers in machinery, rolling stock and hardware, &c. Reg. office: 57-9, Long Acre, W.C.

ASBESTOS ASSOCIATION, LTD.—Registered as a company limited by guarantee, with not more than 50 members, each liable for £1 in event of winding up, to protect the interests of asbestos manufacturers and traders in allied industries in the United Kingdom. The general committee (consisting of all the members) is to be divided first into two sections, viz.: Section A, manufacturing textile and general asbestos goods; and, Section B, manufacturing asbestos-cement building, sheets and tiles. Additional sections may be formed. No member may import manufactured asbestos goods from abroad, apart from specialities not at the time made by members, without first obtaining a resolution of the sectional committee of which he is a member.

LORIVAL MANUFACTURING COMPANY, LTD. (152,035).—Private company. Reg. Nov. 26, capital £100,000 in £1 shares, manufacturers of chemcials, electrical appliances and accessories, &c. Agreement with M. Lormier, P. M. de Vallambrosa and W. Petersen. First directors are: W. Petersen (chairman) and M. Lormier. Reg. office: 6, Lloyd's-avenue, E.C.

J. H. TUCKER & COMPANY, LTD. (152,031).—Reg. as a private company capital £150,000, in £1 shares, to take over the business of a manufacturer of electric lighting and power accessories carried on by J. B. Tucker, as J. H. Tucker & Company.

Thirty-Seven Years Ago.

[From THE ELECRICIAN, December 3, 1881.]

ENTERTAINMENTS BY TELEPHONE.—The latest news from France says that a company is to be started to give telephonic concerts. A hall is to be obtained where persons can listen by telephone to either play or opera.

ELECTRIC LIGHT FOR TRAINS.—Mr. Joseph Pease, M.P., is reported to have stated recently than an offer had been made to light the carriages on the North-Eastern Railway by means of electricity at half the cost of the present oil lamps.

ELECTRO-PHOTOGRAPHY.—An exhibition of Muybridge's electro-photographic apparatus, by means of which any particular motion of an animal or man can be photographed instantaneously, was given by M. Meissonier, the painter, in his studio at Paris the other day. By means of these photographs the separate and various movements made by a horse in walking, trotting, galloping, &c., can be reproduced, and painters will no longer have to imagine what they were like.

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CONTENTS.

NOTES 679
Arrangements for the Week 681
The Supply of Single-Phase Power from Three-Phase Systems. By Prof. Miles Walker, D.Sc. Illustrated 682
A New Standard of Current and Potential. By Chester T. Allcutt. Illustrated 684
Industrial Development in India. Illustrated 685
Transformer Oil. By W. S. Flight, A.M.I.E.E.—*Concluded* 686
A New Graphic Method for Winding Schemes. By Dr. L. Fleischmann. Illustrated 689
Salaries of Australian P.O. Engineers 690
Tests on a Joint in the Stator Windings of a 12,000 k.v.a. Generator. Illustrated 691
ADMINISTRATIVE ABILITY 692
REVIEWS 693
The Economics of Works Costs. By J. R. Dick, B.Sc.—*Continued.* 694
CORRESPONDENCE 696
Volunteer Notices 697
Electric Power Supply 698
Profit and Output 698
Working Capital for Municipal Electricity Works 699
The "Easifix" Lamlok Shade Carrier. Illustrated 699
Lincoln Electricity Works 699
The Electric Supply Industry and the Election 700
LEGAL INTELLIGENCE 700
Patent Record 701
Commercial Topics 701
Electricity Supply 702
Educational 703
Tenders Invited and Accepted 703
Companies' Meetings and Reports 704

Notes.

Industrial Research and Trained Workers.

AMONG the national deficiencies which must be removed during the years of reconstruction and thereafter must be classed the creation of an adequate supply of trained scientific workers. In this connection there is a timely report on this subject issued by the Education Committee of the British Science Guild. The report presents a statistical comparison of the position of universities and technical institutions in the United Kingdom, the United States and Germany. In view of the great amount of discussion on technical education since the war, and the development of such bodies as the Department of Scientific and Industrial Research, people are apt to assume that we have already made up much of the lee-way in this field. That there has been a gratifying movement in this direction, and that public opinion has been largely awakened to the urgency of the problem will be generally admitted. But this is merely promise; we still look to the future for fulfilment. As evidence of the ground to be made up we may quote the following instructive facts from this report: There are only 5,000 full-time students of science and technology in the United Kingdom in comparison with nearly 12,000 in Germany and 34,000 in the United States; the total income of universities in the United States is about £20,000,000, in this country £2,000,000 (or, excluding Oxford and Cambridge, £1,000,000); the University of Berlin receives annually from State funds a grant nearly equal to the total Parliamentary grant to the universities and colleges of England and Wales; private benefactions to universities and colleges in the United States exceed £5,000,000 annually—20 times that in the United Kingdom. Many other instructive facts are mentioned. For example, the block grant of £1,000,000 to the Department of Scientific and Industrial Research was considered a great step, yet the amount is much surpassed by the endowment of the Carnegie Institute (£4,400,000), the Rockefeller Institute (£3,000,000) and other institutions in the United States. Thus, while something has been done, much remains to be done to put this country on the same footing as the United States and Germany. Now, if ever, is the time to make this deficiency good.

Working Capital for Local Authorities.

FOR several years past the Incorporated Municipal Electrical Association have placed in their draft Supply of Electricity Bill a clause giving local authorities the power to borrow money for trading capital as may be required for their electricity undertakings. This seems to be a reasonable provision. It is interesting to note, however, that so far as Ireland is concerned this power has been given by the Public Health (Borrowing Powers) Ireland Act, 1918, so that Irish local authorities are now at an advantage. The first application under this Act, so far as we are aware, was made recently by the Dublin Corporation, so that the Corporation might have authority to borrow money for this purpose from the Bank of Ireland and to pay interest at the rate of 5 per cent. on the overdraft out of the profits of the electricity undertaking. The application was granted by the Local Government Board. So far, local authorities have relied upon the balance of their current account being sufficiently large to provide money for working capital. This fact, however, should be no legitimate reason for objecting to the more commercial method of paying interest on the capital that is required, and it would be well for corresponding legislation to be carried through Parliament for this country.

The Demand for Technical Education.

ONE of the most disturbing features of technical education in this country previous to the war was the relatively weak demand for technical education, both on the part of youths entering industry and the manufacturing firms whose service they proposed to enter. It has often been said that our national resources for technical and higher scientific education are inadequate, but it is admittedly a fact that in the past even those institutions we possess did not receive, in many cases, nearly as many students as they were prepared to train. This was naturally a discouraging factor to those desirous of extending facilities for technical education. We are not yet in a position to judge to what degree this demand for education has been stimulated since the outbreak of war. There is gratifying evidence of a fuller recognition of the benefits of education by industry, and it is essentially to this quarter that we must look for a stimulus. We can only expect a large influx of youths into technical colleges and institutions if they know that their subsequent position will depend on the training they receive. Since August, 1914, any growing demand due to these conditions has been largely masked by the great numbers of youths enter-

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ing the Army, which has tended to deplete attendance at classes. Nevertheless in certain areas, especially those which have been busy with munitions and engineering work, attendance seems to be quite exceptionally large. South Wales is a case in point. It is stated that in Cardiff the demand is so keen that the committee has established a waiting list, vacancies being filled as they occur. There are at present 1,500 students attending the college, while at the Newport Technical Institute the evening classes for mechanical engineering and boiler making has also reached an unprecedented figure. In the present circumstances this is a gratifying state of affairs, the more so as the college in South Wales has in the past rather been in the position of a Cinderella among technical institutions, admittedly not receiving the support which the important local industries would justify. There seems every reason to expect an era of greater prosperity for our scientific and technical institutions now that the demands for the army are ceasing and the stream of prospective students begins to flow again.

The E.P.E.A.

IT appears that the E.P.E.A. has reached the stage of its existence at which the appointment of a general secretary is desirable, and we gather from a resolution of the Western Section of this Association that there is some difference of opinion as to the appointment. Some of the members evidently feel that the position should be occupied by a member of the Association; in other words, by an engineer. Others take the view that the choice should not be limited in this way. As to whether a particular course is desirable must, we think, depend upon the aims of the Association. A position of this kind requires some administrative ability, great tact in negotiations, and realisation that there are somwehat wide interests to represent, from those of chief engineers downwards. Such a position is not easily filled in a satisfactory way, and we doubt if £500 per annum, which is the amount offered, is sufficient to attract the class of man that is really desirable. As a matter of fact, the technical knowledge that is necessary need be very small, and may be easily acquired second hand. The conditions of work, rather than the technical character of the work, are what are really important. It appears to us, therefore, that it would be a mistake to restrict the selection to members of the Association, and that it would be far better to go beyond its ranks in order to secure a secretary who will be able to fill this rather difficult position in a completely satisfactory way.

The Allocation of Plant by the M.M.

A FEW weeks ago we drew attention to a resolution which had been passed by the Incorporated Municipal Electrical Association criticising the way in which plant had been allocated by the Director of Electric Supply at the Ministry of Munitions. It was suggested by this resolution that such allocaton had been carried out unfairly, and that private enterprise had been unduly favoured. This view has not been supported by figures issued by the Ministry of Munitions, and which we published recently. The sequel is now seen in a letter from the I.M.E.A. to the Ministry of Munitions, in which the resolution is withdrawn, and regret is expressed that the resolution had been submitted. For the sake of our public services we are glad that the allegations have been disproved, and we trust that the whole matter will now be speedily forgotten. During the last couple of years it is easy to understand how misunderstandings may have arisen when we have all been suffering from numerous restrictions, which, although essential, were at times most irritating.

Industrial Reconstruction Council.—A Conference on "Restriction of Output" will be held under the auspices of the Industrial Reconstruction Council on Tuesday, Dec. 17, at 6 p.m., in the Hall of the Institute of Journalists, 2 & 4, Tudor-street, E.C. 4. The subject will be introduced by Mr. Wilfrid Hill, of Birmingham, a member of the Whitley Committee, after which the discussion will be open. No tickets are necessary.

"Australia's Greatest Tramway System."—The "Electric Railway Journal" thus describes the tramway system serving a large area round Sydney, comprising 350 miles of track and 1,387 motor cars, 11 trailers and 105 service cars. About 4,000 to 5,000 cars pass the centre of the city between 6 a.m. and midnight. More than 295 million passengers are carried per annum, and the car-mileage exceeds 25 million miles. An interesting feature of the system is the very severe gradients which prevail at some points where the lines rise from sea level to the top of the cliffs.

Women in Industry.—On behalf of the Women's Industrial League, Lady Rhondda has addressed a memorial to the Prime Minister setting forth the claims of women to receive the same pay as men for equal output and to be trained efficiently for industry; and also setting forth the view that the claims of women to work in their own interest must be respected and safeguarded. A sympathetic reply was received from the Premier, admitting that new industries do not come under the Treasury agreement and supporting the basis of equal pay for equal output.

Device for the Elimination of Atmospherics.—An announcement appeared recently in the daily Press to the effect that Mr. R. A. Weagant, chief engineer of the Wireless Telegraph Company of America, had discovered means of overcoming atmospheric disturbances in wireless telegraphy. A statement has now been issued by the Company to the effect that this device has been generally adopted in various parts of the world, and has been placed at the disposal of the Allies, as well as of the United States Government. Through this new discovery the large steel towers hitherto used become unnecessary, the receiving antenna being stretched merely a few feet above the ground. Interference between stations is also eliminated.

Electrical Power Engineers' Association.—At the monthly meeting of the Western Section, Southern Division, E.P.E.A., the following resolution was unanimously agreed:—

That the members of the Western Section, Southern Division, Electrical Power Engineers' Association, are of opinion that it is unfortunate that any recommendation for a nominee for the post of general secretary should have been made by the National Executive Council, as their action may have a quite unfair and unwarranted influence: and they feel that due consideration has not been given to the qualifications which such a position demands. They desire that, so far as is practicable, each member shall be acquainted with the real situation and the vital importance of the appointment before a final decision is arrived at. Further, they take exception to the inadequate salary offered, and suggest that the whole matter be reviewed before nominations are considered. In the opinion of members of the Western Section, it is essential that the future policy of the Association should first be definitely formulated, as the qualifications necessary in a secretary are inevitably linked thereto. They consider that the post should be thrown widely open to competition.

Fuses for 2,500 Volt Circuits.—A useful summary of the various steps that have led to the development of reliable fuses for circuits up to 2,500 volts, is given by Mr. R. C. Cole in a recent issue of the "Electrical World." The design of an enclosed fuse for such circuits involves careful attention to a number of details. Amongst these considerable importance is attached to the choice of a metal, the vapour of which will not support arcing; the filling material must also be such as to endure high temperatures without fusing or otherwise disintegrating. In early forms of fuses there was an insufficient amount of filling material to condense the metallic vapour before the melting temperature was attained. Thus the circuit might be broken and yet a conducting film might remain between the severed ends of the metal strip. A certain volume-ratio between metal and filling material is needed, and by dividing the metal into a number of strips the quenching of the arc has been greatly facilitated. Finally a double

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filling material was used, a substance specially well adapted to quench the arc being placed in contact with the metal, and a calcium carbonate-sulphate combination at either end. New fluxes have also been developed to prevent corrosion of strips in soldering and a special low melting point alloy has been used for connecting the strips to the terminals. Enclosed fuses for the protection of 2,500 volt circuits have been on the market since 1900, but the continual development of generators of increasing capacity, and the conveyance of larger amounts of power, has made new demands on the design of such fuses.

National Council of Women of Great Britain and Ireland.—An Engineering Committee, with Miss R. Parsons (1, Upper Brook-street, London, W. 1) as Secretary, has been formed by the National Council of Women. The object is that "technical women" should have some central organisation. By "technical women" is meant :—

1. Women with technical or mechanical training in engineering and allied industries.
2. Women responsible for the organisation of women's work in the shops.

The aims of the Committee are as follows :—

1. To work for the admission of women into all suitable institutes of engineers, iron and steel, motals, gas and illuminating institutes, naval architects, and on to the boards of the universities and technical colleges of university rank, to the technical branches of the higher civil service, such as H.M. Patent Office, technical inspectors on the Board of Education.
2. To secure opportunities for women equally with men to all technical schools and classes, colleges and universities.
3. To secure the co-operation of all women doing technical and mechanical work in Government factories, controlled factories and private firms, with a view to utilising their skill in all reconstruction work in the immediate future.

The Committee invite all branches of the National Council of Women who are situated near any centres of the Engineering Industries to form an Engineering sub-committee, who would be the nucleus of a large women's engineering alliance in their district.

The I.M.E.A. and the Ministry of Munitions.—In our issue of Nov. 8 we gave a resolution of the Council of the I.M.E.A. asking for impartiality in the granting of permits by the Ministry of Munitions for extensions to power stations. This was circulated to Members of Parliament. The following letter has now been written to the Ministry of Munitions withdrawing this resolution.

Incorporated Municipal Electrical Association,
28, Bedford-square, W.C.1, December 4, 1918.

The Secretary, Ministry of Munitions of War, S.W.1.

Reference Estab. Cent. 8/301.

SIR: In reply to your letter of November 13th (received on November 15th), the Council of the I.M.E.A., at its meetings held on the 14th and 29th inst. [? ult.], had this matter under further consideration.

A letter dated November 12th has been received from the Town Clerk, Sheffield, containing the following statement :—

"The Committee desire me to state that the statements made by Mr. Fedden at your meeting of October 17th, to which you refer in your letter to the Ministry of Munitions of the 2nd inst., were made on his own responsibility and without previous consultation with any members of the City Council, and the Committee, therefore, must disclaim responsibility therefor.

If it should transpire that any inquiry is made into the allegations on which your Council's resolution is based, Mr. Fedden will be prepared to submit such facts as are within his knowledge, and the Corporation will also furnish any information they may possess."

I am desired to inform you that, having regard to the statements of the Corporation of Sheffield, the resolution of October 22nd is withdrawn, and regret is expressed that the same has been submitted.

A copy of this letter is being sent to everyone to whom the original resolution was communicated.

I am, Sir, yours obediently,
(Signed) C. MCARTHUR BUTLER, Secretary.

Fuel Economy in Cooking Apparatus.—We have received a reprint of a series of three lectures on the above subject recently delivered at University College, London, by Mr. A. H. Barker. We understand that the lectures were originally reprinted verbatim in "The Builder." The three lectures cover a great deal of ground and are very opportune. In an introductory preface the author explains that his object is to illustrate general principles, not to single out particular apparatus for censure or approval. The first lecture is mainly introductory, the need for economy, the conditions of hiring and purchase, and the nature of heat being explained. Useful diagrams relating to the number of heat units purchaseable for one penny, oven temperature, &c., are presented. On one suggestion, the Government control of design with a view to efficiency, we can hardly agree with the author, though he is conscious of the difficulties, and suggests that many years would be necessary to reconcile public opinion to the step. Lecture II. deals with causes of waste of heat, including radiator losses, losses in burning fuel and waste of heat and material in roasting, boiling and steaming. Some useful hints are given on the design of kitchen ranges, and both gas and electrical apparatus are described. Stress is laid on care in manipulation, education of the cook and the prevention of waste due to carelessness in manipulation. Lecture III., however, is really the sequel to Lecture II., and here the methods of correcting the errors alluded to in Lecture II. are explained, incidental reference being made to the hay-box. We cannot recall any series of lectures on fuel economy that contains more useful information, and they deserve to be widely studied. The householder, restaurant proprietor and maker of heating and cooking appliances could obtain many useful hints from their perusal, and the references to electric cooking contain much of interest to the electrical engineer.

Obituary.

LIEUT. F. J. KEAN.—We regret to learn that Lieut. Francis John Kean (A.S.C., M.T.), B.Sc. (Lond.), late of the Polytechnic School of Engineering, London, and the McGill University, Montreal, died on Nov. 25 of pneumonia following influenza in the 2nd London General Hospital.

Arrangements for the Week.

FRIDAY, Dec. 13th (to-day).

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. General Meeting.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria street, London, S.W. 1. Lecturette on "Air Compressing," by Mr. H. P. Anderson.

SATURDAY, Dec. 14th.

MANCHESTER ASSOCIATION OF ENGINEERS.

6.30 p.m. The Grand Hotel, Manchester. Quarterly Meeting. Paper on "Wood Testing," by Mr. J. E. Hurst.

MONDAY, Dec. 16th.

ROYAL SOCIETY OF ARTS.

5 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Physical Chemistry and its Bearing on the Chemical and Allied Industries," by Prof. J. C. Philip, O.B.E. (Lecture III.)

INSTITUTION OF ELECTRICAL ENGINEERS, SCOTTISH CENTRE.

7.30 p.m. At the Rooms, 207, Bath-street, Glasgow. Address by the President, Mr. C. H. Wordingham.

WEDNESDAY, Dec. 18th.

INSTITUTION OF ELECTRICAL ENGINEERS, SOUTH MIDLAND CENTRE.

7 p.m. At the University, Edmund-street, Birmingham. Paper on "Carbon Brushes," by Mr. P. Hunter-Brown, A.M.I.E.E.

LIVERPOOL ENGINEERING SOCIETY.

8 p.m. At the Royal Institution, Colquitt-street, Liverpool. Paper on "The Growth and Arrangement of Industrial Boiler Plants," by Mr. H. S. Rowe, B.Sc. Joint Meeting with the Society of Chemical Industry.

THURSDAY, Dec. 19th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. Paper on "Carbon Brushes: Considered in Relation to the Design and Operation of Electrical Machinery," by Mr. P. Hunter-Brown.

ELECTRICAL POWER ENGINEERS' ASSOCIATION, LONDON AND SOUTHERN DIVISION.

6.30 p.m. At Anderton's Hotel, Fleet-street, London, E.C., Smoking Concert.

ILLUMINATING ENGINEERING SOCIETY.

8 p.m. At the Royal Society of Arts, John-street, London, W.C. A Summary of Progress in Photometry with "Special Reference to War Problems," will be presented, the discussion being opened by the President.

FRIDAY, Dec. 20th.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At the Royal Society of Arts, John-street, London, W.C. Presidential Address by Col R. E B. Crompton, C.B.

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The Supply of Single-Phase Power from Three-Phase Systems.*

By Prof. MILES WALKER, D.Sc.

Summary.—The various methods of supplying single-phase power are considered. The correct method of balancing the phases in the case of an electric furnace working at 0·7 power factor is developed for both choke-coil balancer and condenser balancer. Running balancers are classified under five sub-headings, and the merits and drawbacks of these balancers discussed. A new type of balancing transformer is described, and a calculation of a balancing transformer for feeding a 400 kw. electric furnace is worked out.

Present Demand for Single-phase Power.

The advantages of three-phase power distribution over the single-phase systems in vogue 25 years ago are generally acknowledged; but for some purposes single-phase current is to be preferred, as, or instance, in high-voltage alternating-current traction systems and for the operation of electric furnaces. From the metallurgical point of view, the single-phase furnace has much to recommend it; but owing to objections raised by suppliers of electric power to the unbalancing effect of a single-phase load upon their three-phase systems, the polyphase furnace is in much more extensive use in this country than the single-phase furnace.

In view of the very extensive use that will be made of electric furnaces for steel manufacture in the future, it is important to see what can be done to minimise the objection of the suppliers of electric power to a single-phase load.

Methods of Obtaining Single-phase Power.

Where single-phase power must be supplied for any specific purpose, we have a considerable choice of methods of obtaining it.

1. Single-phase generators driven by prime movers.
2. Three-phase generators constructed so as to give single-phase power.
3. Motor-generator sets.
4. The taking of single-phase current direct from one of the phases of a three-phase supply system, and the use of a balancer for balancing the phases.
5. A rotating balancing transformer, which absorbs the balanced three-phase power in one winding and supplies a single-phase load from an independent winding.

1. Single-phase Generators Driven by Prime Movers.

Where the single-phase load is near some source of mechanical power it is comparatively a simple matter to install single-phase generators that can be run independently of any other generators in the station. This has been done in the case of several single-phase traction systems. The main objections to the single-phase generator are: The cost for a given output is higher than for a three-phase generator; *e.g.*, a 25-cycle single-phase generator of 5,000 kw capacity, running at 1,500 revs. per min., is about 30 per cent. higher than that of a corresponding three-phase generator. Secondly, the efficiency of a single-phase generator is considerably lower than that of a three-phase generator of the same rating, owing to the higher iron losses due to the single-phase armature reaction and the loss in the amortisseur and the metal surrounding it. It is not uncommon for the guaranteed efficiency of a large single-phase generator to be 1½ to 2 per cent. lower than that of a three-phase generator of the same general characteristics. It is in general inconvenient to provide special single-phase generators to supply the load, especially when the load is some distance away from the power station.

2. Three-phase Generators Constructed so as to Give Single-phase Power.

Where the load is divided between a number of locomotives or a number of furnaces which are not started simultaneously, it is possible to divide the whole into two parts, putting one part on to one phase of a two-phase generator and the other part on to the other phase. It may be that such an arrangement gives a balance of load that is good enough for practical purposes; and if the generator is constructed with an amortisseur so as to take a single-phase load without injury, this arrangement is perfectly satisfactory. Similarly, three independent loads can be taken from a three-phase system. In this connection it is interesting to inquire how far the voltage of a three-phase generator is disturbed when a single-phase load is thrown on one phase, and in the original Paper this problem is fully treated in an Appendix.

3. Motor-Generator Sets.

In some cases where power companies have refused to connect a single-phase load on to their systems motor-generators have been installed. A motor-generator for this purpose may consist of an induction motor direct connected to a single-phase generator; or a synchronous motor may be used to drive the single-phase generator, and in this case the set may be used for improving the power factor of the system by over-exciting the synchronous motor. For general convenience of operation this method is entirely satisfactory: the consumer has complete control over his own voltage, the power factor on the three-phase side can be adjusted at will, and the maximum demand can be kept within bounds, notwithstanding the heavy currents that may be drawn from the single-phase generator at times of short-circuit. The main drawbacks to this plant are the high first cost and the poor efficiency. Owing to the low efficiency of the single-phase generator, especially when built with heavy armature conductors for large currents, the efficiency of the whole set is usually very poor. A 500 k.v.a. size has an efficiency of about 85 per cent.

4. Single-phase Current from Three-phase Supply with Balancer.

In order to secure a higher efficiency than can be obtained from a motor-generator, and a better specific use of the material employed, a number of different types of balancers have been proposed for balancing a three-phase system that would otherwise be thrown out of balance by a heavy single-phase load. These may consist either of stationary apparatus, such as choke coils or condensers, or of running machines, which may be either synchronous or asynchronous.

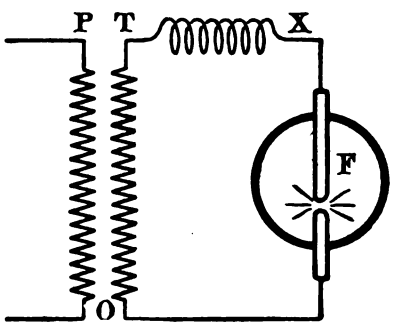

Fig. 1.

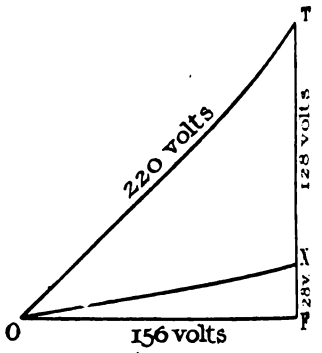

Fig. 2.

In the original Paper the author then proceeds to analyse the circumstances corresponding with a condition of "out of balance," a distinction being drawn between unbalanced currents and unbalanced voltages. The explanation of what occurs in a three-phase system is aided by vectorial diagrams; and in an Appendix in the original Paper an example, in which the power is balanced according to Steinmetz's definition, although the current and voltage are out of balance, is worked out. Balancers are next considered under the respective headings of stationary apparatus and mining machines. Thus, when a polyphase load is unbalanced by the addition of a single-phase load, it may be balanced by the addition of the wattless load taken by a choke coil or condenser. (This problem was also treated analytically by the author in appendices.)

By using a condenser the power factor might also be improved. There is, however, the drawback that such an arrangement has to be switched in and out, according to the furnace load.

Similarly, a running machine, such as a synchronous or asynchronous motor may be used to neutralise an alternating component of a system, and, if the impedance of the armature is low, the system may be very nearly balanced; if the impedance is not negligibly small, some kind of boosting appliance in series with the balancer may be used to compensate for this impedance. In the original Paper the author discusses five methods of boosting applied in different kinds of balancers, namely:—

(*a*) Unsymmetrical numbers of turns in the balancer winding.
(*b*) Booster transformer in series with the winding.
(*c*) Addition of choke coils or condensers to some of the phases.
(*d*) Booster generator in series with the winding.
(*e*) The generation of an oppositely rotating magnetic field of double the frequency.

* Abstract of a Paper read before the Institution of Electrical Engineers. Little more than the scope can be indicated.

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The fifth method is of special importance, and the treatment of this leads to an expression for the resultant magnetic field of a polyphase armature, which is shown to consist of two uniform fields of different amplitudes rotating in different directions. It is shown, further, that a system may be balanced by building a synchronous motor having a special rotor winding, through which currents can be sent which impress a backward rotating magnetomotive force. Various methods of achieving this result are mentioned. All these methods involve the use of several auxiliary machines in addition to the main translating apparatus required to furnish the single-phase load at its right voltage; and in the single-phase furnace

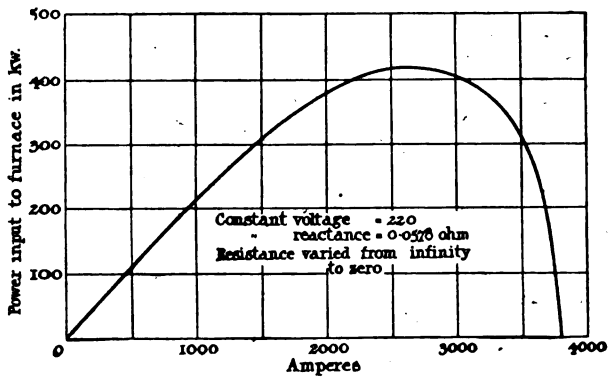

FIG. 3.

projects with which the author was concerned they did not give the characteristics that were required, and were ruled out in favour of the type of balancer falling under heading (5).

5. A ROTATING BALANCING TRANSFORMER,

which absorbs the balanced three-phase power in one winding and supplies a single-phase load from an independent winding, is of special interest in connection with single-phase electric furnaces.

The main advantages claimed for the single-phase furnace are as follows: Firstly, only two electrodes are required instead of three; as these can be brought into the furnace at two diametrically opposite points, the liability of the arc to cause a short-circuit through the hot semi-conducting lining is much reduced. This enables the voltage between the terminals to be raised to a value almost double that practicable for a polyphase furnace. The increase in the voltage leads to a corresponding reduction in current for the same power

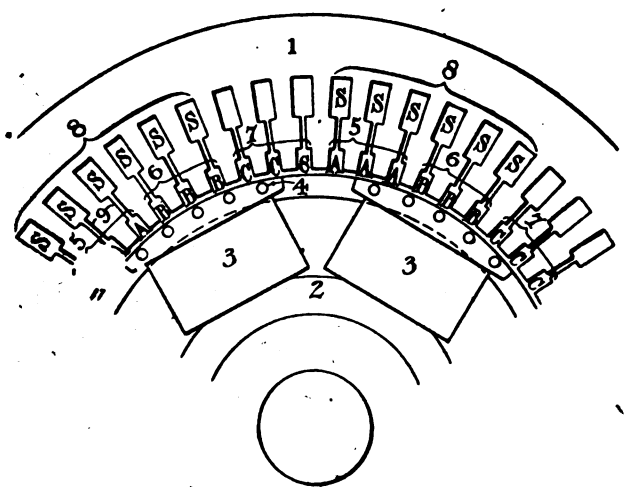

FIG. 4.

input; the smaller current leads to economy in conducting cables and contacts, and enables a much smaller electrode to be used than is possible in the polyphase furnace. As the electrode losses are dependent upon the surface of carbon exposed, and also upon the amount of air-leakage through the furnace, the reduction in the number and size of the electrodes and in the number and size of leakage holes results in a great saving in electrode consumption. Secondly, the single-phase furnace has an exterior shape which approaches a spherical form; the radiation losses are thus reduced to the smallest possible for a given content.

Requirements in Balancer for Single-phase Furnace Work.—When the purpose is to supply a single-phase current to an electric furnace, the source of supply being an ordinary three-phase system, there is an advantage in using a special kind of balancer which shall fulfil the functions of (1) voltage transformer, (2) balancer, (3) reactance, and (4) power-factor corrector. These functions can be performed by a motor-generator set designed with suitable characteristics; but the first cost of such a set is higher than that of a balancer of the same output, and the efficiency is lower. The advantages (from the user's point of view) of working a single-phase furnace with an inductance in circuit sufficient to make the current lag by 45 deg. behind the voltage may be pointed out.

Consider the circuit shown in Fig. 1, where OP is the primary winding of a transformer, OT its secondary winding, TX a choking coil, and F a single-phase furnace. In the vector diagram, Fig. 2, let OT represent the voltage generated by the secondary, XT the reactive drop in the choke coil (with which may be included any reactive drop in the transformer). Let FX represent the reactive drop in the furnace, and OF the resistance drop in the furnace and the rest of the circuit. If this diagram represents the full-load working conditions, then the full-load current is lagging 45 deg. behind the voltage, and is represented to some scale by the line OF. When the inductance and resistance are adjusted to give these conditions on full load, and the inductance is maintained constant, the voltage OT being constant, the input to the furnace cannot exceed the full-load value, however the resistance of the circuit may be varied. In fact, if we change the resistance of the furnace from infinity to zero, the current will increase from 0 to 1·41 times full-load current, and the power at various values of the current will be given by the curve in Fig. 3. The full-load value of the current gives the highest point of the curve.

The Importance of Stability.—These conditions give stability in operation, and are of great importance in preserving the lining of the furnace. If by any unfortunate chance part of the lining reaches a temperature above its melting point, it begins to blend with the contents of the furnace. Now the maintaining of the furnace at its

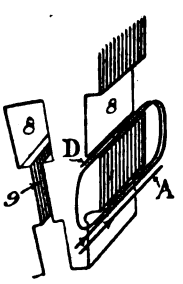

FIG. 5.

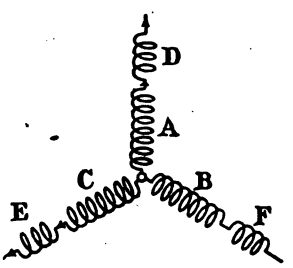

FIG. 6.

proper temperature depends upon the maintaining of the balance between the electrical input and the energy absorbed and radiated. If the characteristics of the circuit are such that an increase in the current is accompanied by an increase in the electrical input, the greatest care must be exercised, when the furnace is at full load, to keep the current near its full-load value; and this is difficult by reason of the unstable nature of the arc.

Where sufficient inductance is put in series with the furnace, the circuit becomes automatically stable and no regulators are required. The ideal condition for steady running is attained when the inductive drop at full load is equal to the resistance drop, as shown in Fig. 3. In designing transformers for this purpose, care must be taken to see that the cross-section of any iron added to the leakage paths is sufficiently great to give a fairly straight-line law for the increase of the leakage flux with the current, right up to the point 1·41 times full-load current; otherwise it may be found that when the furnace is short-circuited the current taken is much more than 1·41 times full-load current.

From the power company's point of view, the inductance is not an unmixed blessing. By reducing the power factor it calls for more copper in the mains for a given load, and reduces the output of the generators. Sudden heavy calls for low power-factor current have a bad effect upon the regulation of the whole system. But so greatly does the stability given by the inductance help towards economy in furnace linings that large numbers of furnaces in this country and in America are run at 0·7 power factor.

Design of Balancer for Single-phase Furnace Work.—It will be seen, then, that it is desirable that the single-phase winding should have such a high inductance that the current will lag 45 deg. at full load, and that the three-phase winding should be operated at unity power factor. These conditions can be met by building a three-phase synchronous motor having an ordinary three-phase armature winding lying in slots near the working face of the stator (*see* Fig. 4), and provided with a single-phase winding lying in slots further removed

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from the rotor than the three-phase slots, and arranged so that very considerable magnetic leakage occurs between the two windings at full load.

In the case of the 400 kw. balancer here described, the following were the particulars of the conditions to be met :—

Three-phase supply. Line voltage	6,000 at 50 cycles
Input to furnace	350 kw. to 400 kw.
Voltage on arc and connecting cables in phase with the current	156
Effective inductive drop in furnace and cables	25 to 50 volts
Single-phase voltage at terminals of balancer	160
Inductive drop in windings of balancer	110 to 130
No-load voltage	220 to 247, say 234
Single-phase amperes	2,400 to 2,700
Temperature rise of balancer after full load for three hours	45°C.

Compensating Winding.—One of the special features of this type of balancer is a compensating winding designed to inject a boosting voltage into the two phases of the three-phase winding that lie adjacent to the single-phase winding, in order to prevent those windings from taking more than their share of the load. The arrangement adopted is to inject into phases *A* and *C* an E.M.F. which shall at all times be exactly equal and opposite to the E.M.F. generated in the three-phase winding by the interlinked flux from the single-phase magnetomotive force. The most direct way of doing this is to wind a few turns of wire interlinked with the main leakage path of the single-phase winding, and electrically connect these to phases *A* and *C* so that the E.M.F. generated in the turns by the main leakage shall oppose the E.M.F. generated in the three-phase winding by the small leakage across the three-phase slots. The manner of winding and connecting the compensating conductors can be seen from Figs. 5 and 6. Apart from the special features above mentioned, the design of the balancer follows very closely the design of an alternating-current generator or synchronous motor. The full details are given in the original Paper and appendices, and the results of a full-load test are summarised. The efficiency worked out to 90·4 per cent.

A New Standard of Current and Potential.*

By CHESTER T. ALLCUTT.

The increasing use of potentiometers makes it desirable to secure a substitute for the standard cell usually required by these instruments. The serious shortage of standard cells caused by the war has emphasised this need, and it is poor economy to use a costly precision standard in a commercial potentiometer which reads to three significant figures at the most. It has accordingly become common practice to use a calibrated current-measuring instrument for setting the current. A long-scale galvanometer, with a suitable shunt, is used as a deflection instrument. After setting the current, the same galvanometer is used as a null instrument for balancing the thermocouple E.M.F. against the potentiometer.

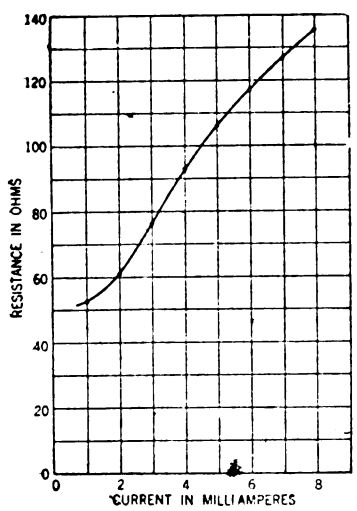

FIG. 1.—CURRENT RESISTANCE CURVE—BULB G.

This necessitates the use of a very high-grade galvanometer, which is costly and more delicate than a short-scale instrument of the same sensitivity. It is, therefore, desirable to provide a means for setting the current which will not both eliminate the standard cell and remove the necessity for a deflection instrument.

The new standard, proposed as a substitute for the standard cell in a certain classes of direct-current measurements, is essentially a Wheatstone bridge which will balance for but one value of current. The device comprises three constant resistances, *A*, *C* and *D*, and a fourth element *B*, whose resistance is a function of the current flowing through it. The resistance element *B* consists of a fine filament enclosed in an evacuated glass bulb, and of a material with a relatively high temperature coefficient. If the resistances *C* and *D* are equal the bridge will balance when the resistance of *B* is equal to the resistance of *A*. We thus provide a simple null method for setting the current in a circuit at a predetermined value.

The practicability of the device depends on securing a variable resistance having the desired current-resistance characteristics, together with a high degree of permanence. For use with portable potentiometers the bridge should balance at about 20 milliamperes.

* Abstract of a Paper read before the American Institute of Electrical Engineers.

A fine filament in a vacuum bulb answers requirements. Bulbs have been made which would more than double in resistance when heated by the passage of 0·005 ampere Fig. 1 shows a typical current-resistance curve of such a bulb. For currents of more than 2 milliamperes the resistance increases very rapidly with the current.

Most of the bulbs used had platinum filaments approximately 0·0005 cm. in diameter and from 1 cm. to 3 cm. in length. Silver coated platinum wire (Wollaston wire) was used, in order to facilitate the handling incident to the mounting the filament in place. After mounting the filament the silver coating was removed by means of nitric acid, leaving the platinum core exposed. The bulbs were evacuated to from 10^{-4} to 10^{-5} mm. of mercury. Even with pressures as low as 10^{-5} mm., a high degree of permanence may be obtained. Furthermore, at pressures as low as 10^{-4} mm. the change in heat conduction from the filament with changes in pressure is extremely small. In order to secure the permanence of vacuum, referred to above, it is necessary to observe the usual precautions, such as heat treatment of the glass, &c., during the process of evacuation. It is necessary to "season" the filament by passing enough current to heat the filament to a bright red heat for 24 hrs. The filament should be heated to a temperature considerably above that at which it is to operate Fig. 2 shows the effect of seasoning the filament on the characteristics of a bulb. Curve *A* shows the current-resistance characteristics of a new bulb. Curve *B* is plotted from data taken 24 hrs. later, while Curve *C* was taken after 24 hr. seasoning Further tests at a later date followed Curve *C* with great exactitude. There is also the possibility of a gradual change in the resistance of the filaments due to evaporation, but if one operates the filaments below red heat, no trouble from this source need be feared. Fig. 3 shows that for the larger values of current the effect

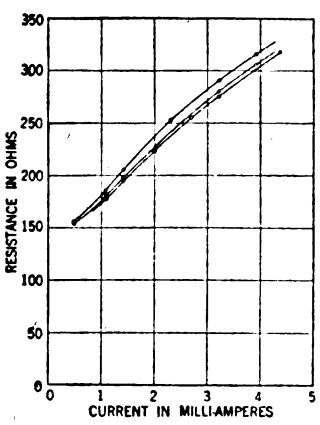

FIG. 2.—CURRENT RESISTANCE CURVES.
a. New Bulb.
b. 24 hours later.
c. After 24 hours' seasoning.

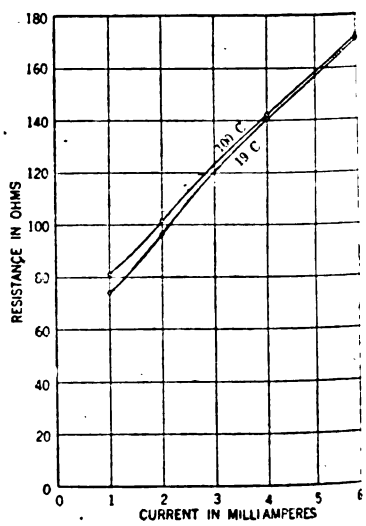

FIG. 3.—CURRENT RESISTANCE CURVES—BULB H.—SHOWING EFFECT OF AMBIENT TEMPERATURE.

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of ambient temperature is very small. For example, at 6 milliamperes the temperature coefficient is about 0·007 per cent. per deg. cent. change in ambient temperature For some classes of service this temperature coefficient is negligible. In any case it may be compensated for by giving one of the fixed resistances of the bridge with which the bulb is used a proper temperature coefficient, thus making the current for which the bridge will balance entirely independent of room temperature.

The degree of permanence possible is shown by data, given in Table I, representing the results of observations on a bulb during several weeks.

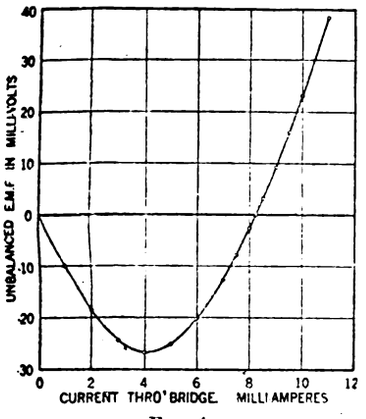

FIG. 4.

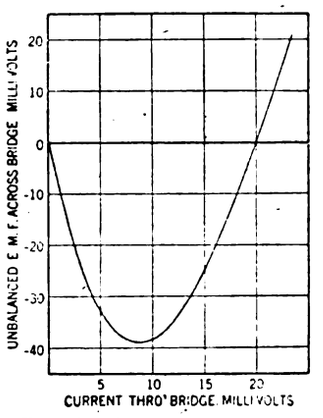

FIG. 5.—CHARACTERISTICS OF BRIDGE USING BULB H.

For the smaller values of current there are differences in the values of the resistance, possibly due to differences in room temperature; for larger values of current the effect of room temperature is apparently negligible. Figs. 4 and 5 show the sharpness of balance that can be obtained in a bridge using a bulb of the type described. These curves give the unbalanced voltage of the bridge (*i.e.*, the voltage tending to send current through the galvanometer) as a function of the current flowing through the bridge. The sharpness of balance may be increased by using two bulbs connected in opposite arms of the bridge, but it has been found that a sufficient degree of sensibility may be secured with but one bulb.

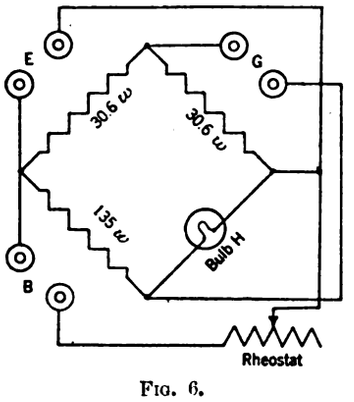

FIG. 6.

Fig. 6 is a diagram of connections of the device. A dry cell is connected to the binding posts marked *B* and a galvanometer at *G*. The rheostat is adjusted until the galvanometer shows no deflection and there is then 1 volt between the terminals marked *E*. The instrument is thus a very simple standard of both current and E.M.F. For use with potentiometers the current-setting bridge is permanently connected in series with the potentiometer circuit. Means are provided for throwing the galvanometer either across the bridge or in the circuit leading to the unknown E.M.F. This new standard may be relied upon to maintain an accuracy of ±0·1 per cent. The sensibility to current changes is ample, as it is very easy to set the current to within 0·1 per cent. with the type of galvanometer usually supplied with portable potentiometers. The device may, therefore, be regarded as a suitable substitute for the standard cell for practically all classes of service outside of precision laboratory work.

Table I.—RECORD OF TESTS ON BULB *G*.

Observation No.	Room temp.	Resistance at different values of current (amps.)				
		0·001	0·002	0·004	0·006	0·008
1	26·5	52·6	60·7	92·6	116·9	134·9
2	25·0	52·5	60·6	92·5	116·8	134·9
3	23·5	52·2	60·4	92·5	116·9	134·9
4	24·0	52·4	60·5	92·5	116·9	134·8
5	25·0	52·5	60·7	92·7	116·9	134·9
6	24·0	52·4	60·5	92·5	116·8	134·9
7	24·5	52·2	60·4	92·5	116·8	134·9
8	27·0	52·4	60·5	92·6	116·9	134·9
9	27·0	52·5	60·6	92·6	116·9	134·9

Industrial Development in India.

We have received an interesting illustrated pamphlet giving an address by Mr. Alfred Dickinson, M.Inst.C.E., to the members of the Eighty Club, on "The Industrial Development of India—an Object Lesson to Great Britain." Some details are given of the Tata hydro-electric scheme. In dealing with the question of power generally, Mr. Dickinson remarked that the production of electric

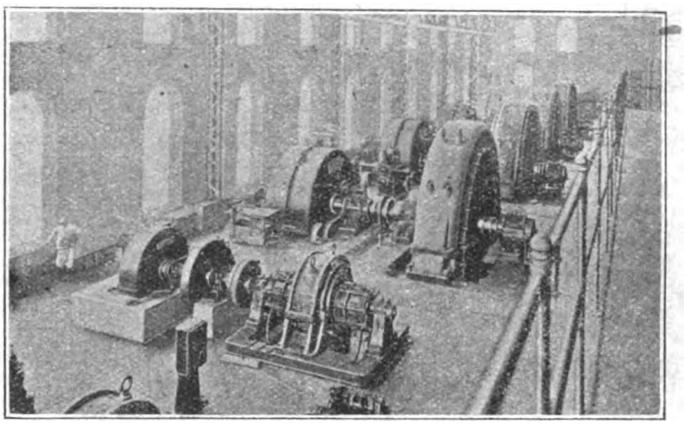

FIG. 1.—TURBINE AND GENERATOR ROOM OF THE TATA POWER STATION; FROM BOTTOM TO TOP OF GENERATOR THE HEIGHT IS OVER 19 FT. THE WEIGHT OF THE REVOLVING PARTS OF EACH LARGE SET APPROXIMATES TO 100 TONS.

energy in the future would have to be more in the nature of a by-product than a main product. In order to secure this, the producer of the future would have to become a general manufacturer, producing many chemical combinations, such as fertilisers, dyes, disinfectants, medicines, oils, &c., &c. He might even become a producer

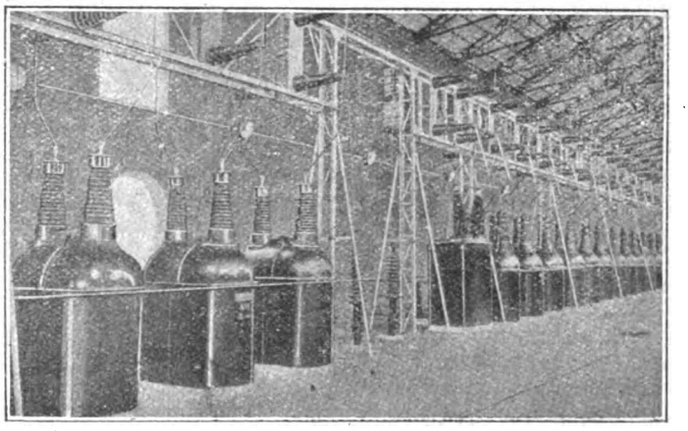

FIG. 2.—HIGH-TENSION REMOTE-CONTROLLED SWITCHES THROUGH WHICH THE SUPPLY TO THE TRANSMISSION LINE PASSES.

of steel and other metals; in fact, there was no limit to the scope of the manufacturing enterprises into which he could enter. So far as India was concerned, Mr. Dickinson's view was that the Government should undertake a complete investigation of the possible sources of water power in that country, and make the information available for public use. Private enterprise had already done much

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and was doing more. Messrs. Tata, Sons & Company, of Bombay, were the pioneers, and they continued to lead the van. As a result of investigations, made at their expense, it had been demonstrated that, by constructing a dam across a valley in the Western Ghats, water from the Koynao River could be harnessed so as to provide approximately 300,000 H.P. continuously. The preliminary estimates of cost showed this scheme to be a thoroughly sound commercial proposition. In Mr. Dickinson's opinion this was a discovery of the highest importance to the whole of the East. When the possibility of supplying 300,000 H.P. for every hour in the year was appreciated, it would be seen that it was equivalent to supplying to industries during the normal working hours of 3,600 per annum no less than 730,000 H.P. for each and every working hour of the year. He emphasised the possibilities this would create. 730,000 H.P. for 10 hours each day each year, supplied at, say, one-third of a penny per horse-power hour. This would give to India the greatest industrial fillip she was ever likely to receive from any single discovery. The price of coal, not only in India, but throughout the world, was rising faster than the interest on capital was rising. Therefore the disparity in the capital cost between water-power development and steam power development was rather tending in favour of water power.

Hitherto, in Great Britain, as a whole, there had been a great want of appreciation of the possibilities of industrial development in India. Figures recently published by the Department of Statistics in India showed that in the year 1915 there were in that country 4,053 industrial establishments, employing in the aggregate about 1,135,000 persons. Of the total establishments, 171 were owned by Government, local bodies or State durbars; and 3,882 by companies or individuals. In November last Messrs. Tata, Sons & Company, of Bombay, issued a private and confidential circular to their friends in India, in which attention was drawn to the desirability of establishing a strong industrial bank in India, and proposing a start if about two millions sterling could be secured. The responses to the suggestion were nothing short of marvellous, for applications from private friends for shares were lodged to the value of about five million pounds sterling. The bank was established with an authorised capital of roughly £8,000,000. Its main object was to finance and assist the development of existing and new industries. It would institute an up-to-date intelligence section which would include a competent staff of scientific and commercial experts, who would investigate and advise upon industrial schemes; so while we in this country had been talking the Indian had been accomplishing.

Transformer Oil.

By W. S. FLIGHT, A.M.I.E.E.

(*Concluded from p.* 667.)

Summary.—Oils may be roughly divided into fixed oils and straight oils. The former give trouble through the formation of sludge. The latter are much more free from this defect. For use in transformers it is necessary to take into account viscosity, specific-gravity, dielectric strength and other properties. Examples are given of the variation of specific gravity and viscosity, and the methods of determining the latter are stated. Flash point is also another important property that must be stated. In specifying dielectric strength, great care must be taken that the presence of moisture does not enter into the figure, and in practical use care must be taken that the oil does not take up moisture. The carrying out of dielectric strength tests is described, and the effect of dirt, air and circulation of the oil is considered on the results obtained. The author then discusses the formation of sludge and the practical methods of preventing it. Lastly, minor tests are described, such as the iodine value, acidity, evaporation, sulphur, &c.

SLUDGE.

Several references have already been made to trouble being experienced in the early days of the oil-immersed transformer, due to the formation of deposits when fixed oils were employed. Although the adoption of straight oils has very considerably lessened the liability of deposits from the oil, it has not entirely solved this problem.

Straight oils used in oil-immersed transformers are composed of hydrogen and carbon chemically united in various combinations. Some of these combinations are more unstable than others, and will readily unite with oxygen. If oils of this type are heated in contact with substances from which they can take oxygen, they do so, and thereby cause a chemical change to take place in the oil.

The hydro-carbon oxides formed by this chemical change are mostly solids which are only slightly soluble in the oil, and are precipitated as a slimy deposit on the insulation and metal parts of the transformer. The dielectric strength of this sludge, unless incorporated with dust or rust, is only slightly less than the dielectric strength of the oil, and there are no cases on record of transformer sludge having caused trouble by lining up or bridging across parts at different potential so as to cause a breakdown. The coating of sludge on the coils and iron acts as a heat lagging, and also seriously reduces the area of the ventilation ducts. In this way a comparatively thin coating of sludge may raise the maximum operating temperature of the coils to a sufficiently high temperature to char the fibrous insulating materials used in the construction of the transformer. The presence of solid hydro-carbon oxides also renders the oil more sluggish and thus further affects its cooling action. If the load on the transformer is not reduced after sludging has commenced the oil will locally be raised to a higher temperature than previously. This higher temperature will tend to hasten the oxidation of the oil, and result in further precipitation of sludge. If these conditions are permitted to continue, the transformer will ultimately attain to such a temperature as to completely carbonise the insulation, and a breakdown will then be liable to take place.

The time taken for the above conditions to be reached depends on the quality of the oil used and upon the temperature at which the transformer has been run. From the results of observations on transformers that have been in service a number of years, it would appear that with an ordinary transformer oil of good quality, sludge is produced very slowly if the maximum temperature of the oil is kept below 70°C., and increased rapidly with increase of temperature above this value.

In cases where the temperature has been kept low, very little sludge has been found after 10 years' service, whilst other transformers operating at a higher temperature with oil of the same quality have sludged badly in two or three years.

To meet the requirements of those conditions where an ordinary transformer oil is liable to sludge, so-called non-sludging transformer oils have been put on the market. The majority of these special oils certainly do not produce any quantity of sludge under the most exacting conditions of modern transformer service; they can, however, be made to sludge in varying degrees by laboratory treatment.

The liability of an oil to sludge is directly proportional to its power of combining with oxygen, and the problem has been attacked in two different ways: (*a*) By keeping oxygen from the oil, (*b*) by employing oils whose chemical arrangement is such that they have no power to unite with oxygen.

The first of these methods is usually carried out in practice by the employment of an oil expansion chamber, consisting of a small tank mounted on the top of the transformer tank, and connected to the latter by means of a single pipe. Thus, a very small surface of oil is exposed to the air, the oil temperature in the expansion chamber is considerably lower than the temperature of the oil in the transformer tank, and by slightly raising the connecting pipe above the bottom of the expansion chamber, any sludge produced in the expansion chamber does not get into the transformer tank. Considerable difficulty has been experienced in the commercial application of this idea, and by some makers it has been discarded in favour of open tanks when supplies of non-sludging oil can be obtained.

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Amongst the troubles experienced with oil expansion chambers, the following may be mentioned :—

The oil level of the expansion chamber being above the level of the transformer cover, it is necessary to make an oil-tight joint between the cover and the tank, and also around the terminal bushings. While this can be effected satisfactorily in the factory (although sometimes at considerable trouble) before the transformer leaves the works, it is a more difficult matter to do this on site, when the transformer is erected, or when opened for inspection, as must occur sometimes during running. There may also be leakage troubles due to the packing of the terminal bushings shrinking and becoming no longer oil-tight.

The oil-expansion chamber has also been proposed as a remedy for troubles due to condensation of moisture, where the surrounding temperature varies between wide limits. For this the oil expansion chamber is not an absolute remedy, as there is always the possibility of moisture condensing in the oil-expansion chamber and then getting into the oil in the main transformer tank.

Turning to the other method of eliminating sludge, it was discovered some years ago that the oils obtained from Russian petroleum, found chiefly in the neighbourhood ot Baku on the Caspian Sea, were far less liable to sludge in transformers than the oils obtained from the Pennsylvania products, or those obtained from Scotch shale oil. A distillate of given boiling point of the Russian oil has a higher density than a similar distillate of American or Scotch oil, and the viscosity is more readily decreased by heat. From chemical analysis it would appear that the superiority of the Russian oils is due to a difference in molecular composition of the two oils, the American oils containing a higher percentage of carbon than the Russian oils. As the result of the discovery of the non-sludging properties of the Russian oils, attempts were made to improve the existing grades of American oils, and it has been found possible to change the chemical arrangement of these oils so as to obtain a non-sludging oil, without seriously changing the physical characteristics of the oil. The methods of refining by which these oils are rendered non-sludging are naturally kept secret by the various firms who employ them, and there appears to be practically no available literature on this subject. With certain crudes a non-sludging transformer oil can be obtained by exposing the oil out of doors to the action of strong sunlight. When subjected to this treatment the unsaturated hydro-carbons take up oxygen, and are precipitated to the bottom of the vessel, where they are taken up by a layer of water, and are afterwards removed by draining off the bottom of the liquid.

Before an oil can be recommended for use as a transformer oil, it is necessary that some idea of its sludging tendency be determined. One way of doing this consists in attempting to reproduce in the laboratory a set of conditions which shall have the same effect upon the oil in a few hours as service conditions extending over many years. The usual method of test consists in blowing oxygen through the oil whilst at a temperature of 150°C.

* A piece of copper foil in the form of a plate or spiral is also placed in the oil, because it has been discovered that the copper assists the oil to take up oxygen at a quicker rate. Arrangements are also provided for condensing the vapour from the hot oil and returning to the sample.

If an oil is subjected to the above test for a period of about 50 hours, a weighable quantity of sludge is produced and the sludging tendency can be expressed as the percentage sludge, produced on the standard test, calculated on the weight ot oil from which the sludge was produced.

It has been contended that the above test is not a fair one because different oils differ as to the temperature at which a deposit will appear, and the sludging tendency would be better expressed as the maximum temperature an oil can be run at before sludge is produced. Apart from the length of time required to carry out a test on the above lines, there is no reason to believe that oils do not sludge at ordinary air temperature, provided they are exposed to oxygen for a sufficient length of time. In common with most other chemical changes the rate of oxidation of the oil is accelerated by heat, and provided the sludge test is carried out at a temperature not more than 20°C. above the flash point of the oil, it has been found that laboratory tests agree with the results obtained with the same grade of oil under service conditions in a transformer.

The sludge produced in a transformer varies in colour from a light yellow, through various shades of brown to almost black. The colour of the sludge is to a large extent controlled by the ten perature at which it has been produced ; the lower the temperature the lighter the colour. It is also influenced to some extent by the presence of dust particles when these are allowed to get into the oil.

Sludge taken from transformers working in porcelain works, &c., has been found to be a dirty white colour, and to contain a large percentage of silicious matter.

It has been found that the presence of dirt, dust, &c.. in the oil acts as a nucleus on which sludge forms, and that more sludge is produced if the oil contains these impurities. Every care should be taken to prevent dirt and dust from entering an oil-immersed transformer by making sure the lids and lead bushings are perfectly dust-tight.

If it is assumed that the sludging properties of an oil are due to oxidation of some of the unsaturated constituents, it is logical to assume that once an oil has sludged it will not be so liable to sludge again. In other words, if on opening out a transformer that has been in service a number of years, heavy sludging is found, should the old be replaced by new oil, or is it worth while spending time and money on filtering out the sludge and returning the old oil to the transformer ? Some authorities have even claimed it is worth while deliberately sludging new transformer oil before filling it into the transformer ; such treatment, it is said, results in far less sludge in the transformer after a definite period of service. From laboratory tests it would appear that for certain oils the percentage sludge produced in a given time decreases with increase in time of heating.

As a general rule it can be said that only in the case of very inferior oils is it worth while sludging the oil before use. With the modern refined transformer oils more harm than good will probably be done, and the expense is a serious item when the heating has to be continued for several days. Old oil that has sludged in a transformer may often be successfully used again after filtering out the sludge, provided the acidity of the oil is not too high. The best policy to adopt depends upon the individual conditions, and is largely influenced by the market price of new oil. Each case should be considered on its merits after careful tests have been made on the old oil.

Iodine Value.

There are a number of standard chemical tests for the determination of the percentage quantity of iodine that an oil will take up. As the iodine value is largely a measure of the degree to which an oil is unsaturated, it was anticipated that a relationship might exist between the iodine value and the quantity of sludge produced. Such a relationship has been found by some experiments but no close numerical agreement between the two tests has been obtained. This is probably due to the difficulty of conducting an exact quantitative sludge test. It has also been found that the iodine value of some oils decreases as the period of sludging is continued, tending to show that the unsaturated constituents are being converted into a stable condition and consequently reducing the liability of the oil to sludge further. Unfortunately, iodine value tests are almost as difficult and long to carry out as a sludge test, and little would be gained in time by substituting the former for the latter. An iodine value test does, however, act as a check upon the sludge test, and should always be made, if time permits, in comparing various samples of oil.

Acidity.

If new transformer oil be titrated with a standard alkali, it is usually found that it has an acidity from 0·008 to 0·010

* *See* "Journal" I.E.E., Vol. LI., 1913, Paper by Dr. A. C. Michie.

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per cent. in terms of SO_3 (sulphuric anhydride). Such low figures are generally considered by chemists to indicate that the oil is free from acid.

The presence of these very fine traces of acid are probably due to the sulphuric acid which is sometimes used by oil manufacturers in refining the oil. Any percentage below 0·03 per cent. are perfectly harmless, both to the insulation and to the metal parts of the transformer.

After an oil has been in use for some time, and particularly if any sludge has formed, a number of organic acids are produced as the result of oxidation. These acids do not so readily attack the insulation and metals as the same percentage of sulphuric acid. It is no uncommon thing to find transformers working successfully in oil which shows an acidity of 1 per cent. SO_3, and without sign of any detrimental effect of this relatively high acidity. It is not advisable to use any oil again if the acidity is over 1 per cent., for before the transformer is next cleaned out the percentage acid may have risen to such a value that it will attack and render brittle the insulation. Its effect upon the metal parts will be very small, as the petroleum acids do not attack the metals ordinarily used in the construction of transformers, but they slowly dissolve zinc or alloys consisting largely of that metal.

If the acidity of some of the solid sludge be tested, it will often be found to be as high as 3 to 4 per cent. SO_3, whilst the acidity of the oil from which the sludge has been removed will probably be under 1 per cent.

It is a well known fact that the presence of a very small percentage of acid added to distilled water will lower its insulation resistance many hundred times, and it has been stated that on this account there is a danger of an electrical breakdown if a transformer is run in an oil with a perceptible acidity. Tests made to determine this point showed that there was practically no falling off in dielectric strength up to an acidity of 2 per cent., which was the highest acid value obtained in these tests. The acidity of the oil before sludging was 0·0004 per cent., and the dielectric strength remained practically constant throughout.

As most of these petroleum acids are volatile at temperatures between 100°C. and 150°C. arrangements have to be provided during a laboratory sludge test to condense them along with the lighter fractions of the oil and return them to the sample under test.

Evaporation.

The question of the evaporation of transformer oil under service conditions is a relatively minor one. Different oils do possess somewhat different characteristics as to the degree of evaporation in open vessels. Transformer tanks, although not ordinarily air-tight, are sufficiently tight to prevent serious loss of the oil by evaporation. In many instances the lid of the tank acts as a condenser for the oil vapour, and returns the distillates to the oil. General experience of transformers in service has confirmed the view that, with properly designed tanks, trouble from oil evaporation is not to be expected with commercial grades of transformer oils. As a matter of fact more serious sources of oil loss are liable to occur through leaks from damaged tanks, or syphoning of oil through the transformer leads, when these features are not properly considered.

Colour.

The colour of transformer oil is of relatively small importance, but a light colour is desirable, so that the transformer may be inspected when under the oil. It is also sometimes necessary to make changes on the terminal boards submerged below the oil level, and the lighter coloured oil may permit doing this without removing the transformer or lowering the oil level.

Sulphur.

Oils obtained from certain crudes are liable to contain sulphur compounds. The presence of these in an oil-immersed transformer would result in corrosion of the copper by the formation of copper sulphide; and consequently all oils intended for use in transformers must be entirely free from all traces of sulphur and sulphur compounds.

Cold Test.

The freezing point of oils does not occur at any definite temperature as in the case of water, but is distributed over a range of temperature, during which the oil passes from a liquid to a plastic and then from a plastic to a solid state. This transformation is illustrated by the setting of paraffin wax. The usual method of determining the setting point of a transformer oil is to place a small quantity in a test tube, immerse the tube in a freezing mixture, and examine at definite temperature intervals. The temperature at which the oil just will not flow when the tube is held vertically is taken as the setting point of the oil. Table VIII. gives figures obtained in this way on a number of samples of transformer oils:—

Table VIII.

Sample.	Setting point.	Sample.	Setting point.
A	−15°C.	E	−11°C.
B	−10°C.	F	− 9°C.
C	− 2°C.	G	− 6°C.
D	−14°C.	H	− 3°C.

The oil does not become solid until a temperature 5°C. to 10°C. lower is reached, so that practically all of these oils would be suitable for use in outdoor transformers in any part of this country. As long as the transformers are switched on to the line, the slight heat from the magnetising current is sufficient to prevent the oil from freezing, and it is extremely uncommon to find any trouble in transformers due to excessive cold. In this connection it must be remembered that, unlike water, oils do not expand after solidifying, and consequently there is no tendency to burst the tank, pipes, &c.

Handling Transformer Oil.

Even if the best possible grade of oil is obtained, its purpose may be wholly or partly defeated if it is not handled properly. In this country the general practice is to ship the oil separate from the transformer, and to fill in on site. In the case of the oil arriving before the transformer, and whenever it is necessary to store oil, the drums should always be placed on their sides and never turned up on end, as the latter position allows water to collect in the head around the bung. If at all possible, it is always advisable to store drums in a closed room; if stored out of doors protection from the weather should be provided. A drum of cold oil when taken into a warm room is liable to cause the moisture in the warm air to condense on it, a process which is erroneously called "sweating," and it should never be emptied when there is any danger of this moisture becoming mixed with the oil. The drum should therefore be allowed to stand long enough to reach room temperature before breaking the seal. All vessels used for transferring the oil should be carefully inspected to see that they are absolutely dry and free from metallic or carbonaceous particles.

Immediately before placing the oil in the transformer tanks care must be taken to remove thoroughly any particles of foreign matter, scale, &c., which may adhere to the interior of the drum too firmly to be removed by the washing and drying which the drums receive at the oil refinery before filling, but which may become loosened by the continual swashing of the oil during transit. This can be conveniently carried out by using a funnel of large size, completely covering the top with two layers of any ordinary finely-woven cotton cambric, which has previously been washed and dryed to remove the sizing, and passing the oil through this as a filter. The funnel should be arranged to discharge directly into the transformer, and if this cannot be arranged, the oil must not be returned to an empty drum unless it is known to be thoroughly clean and dry. Advantage may be taken of the decrease of viscosity with heat and the oil passed more rapidly through the filter if slightly warmed.

Life of a Transformer Oil.

Under proper treatment the life of a modern transformer, provided it has been designed to meet the particular load it

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has to supply, may be taken as from 10 to 20 years. As there are no running parts requiring periodic attention, and usually a large number of connections on both the high-tension and low-tension side, it is very desirable that the oil should not deteriorate any quicker than the transformer, so that the complete unit may remain undisturbed until the natural ageing of the insulation rendered inspection desirable. This can be accomplished by selecting a transformer oil which will *not* precipitate any serious quantity of sludge during this period of years. Provided the maximum temperature of the oil during service conditions does not exceed 70°C., it has been found that most of the ordinary grades of transformer oil can meet the above sludge conditions. If the maximum temperature of the oil is liable to exceed 70°C., even for short periods, one of the special non-sludging grades of transformer oil should be used. These latter have in practice been found to produce only slight deposits of sludge after operating for four or five years at a maximum temperature of 85°C., and would apparently not sludge sufficiently to interfere with the successful operation of the transformer after running for 10 years at the above temperature. No cases have yet been examined of transformers operating in non-sludging oil at this temperature for so long a time as 10 years, and consequently no definite conclusions can be drawn. If the maximum permissible temperature of transformers is raised in the future by the employment of class " B " insulating materials (*see* Appendix 1 of British Standardisation Rules for Electrical Machinery) better grades of non-sludging oil will be required if non-airtight tanks are to be employed, and the oil is to have the same length of life as the transformer.

A New Graphic Method for Winding Schemes.*

By Dr. L. FLEISCHMANN.

There are two ordinary methods of graphic representations of winding schemes. In the one, the conductors are arranged in the drawing exactly as they lie on the armature; in other words, the conductors are numbered consecutively; the various conductors are connected together in accordance with the pitch. But in such a case it is not easy to form any conception of the electrical conditions. The method, due to Arnold, is better in this respect. But Arnold's plan is not always very easy to work; the scheme has to be prepared from the winding formula; there is the change from the actual number of poles to the number which corresponds to that of the circuits; there are questions of drum windings and ring windings. The new method, proposed by the author, is similar to

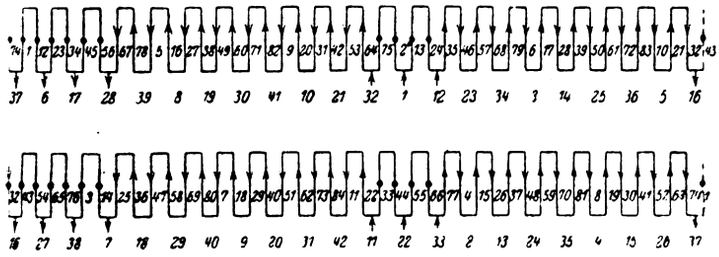

FIG. 1

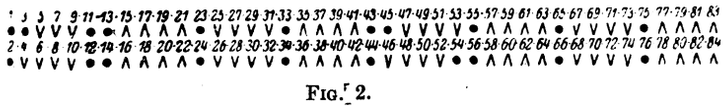

FIG. 2.

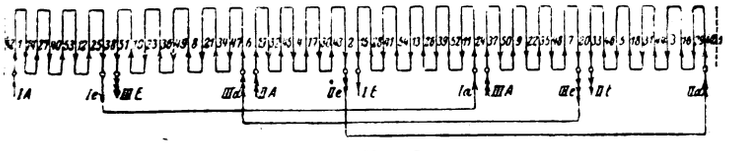

FIG. 3.

Arnold's, but avoids the change in the number of poles, and the passage from drum to ring. The winding, whether of the lap or wave type, is represented by a continuous line; vertical lines represent the conductors; horizontal lines show the end connections and the connections to the commutator. According to the pitch on the commutator, we write the corresponding numbers on the lower horizontal lines. We connect conductor 2 to the commutator segment 1, conductor 4 to commutator segment 2, and, in general, conductor $2n$ to segment n. According to the pitches on the commutator and on the end connections, the conductors with uneven numbers are suitably connected; in the case in which the pitches are equal they will be connected to that commutator segment which is half the number of the next even-numbered conductor. Now it is a question of determining the directions of the flow of current. For this purpose, we must fix the position of the brushes.

If there are k commutator segments and if the number of the poles is $2p$, then the number of the segments between two neighbouring brushes is $\frac{k}{2p}$. Let us suppose the width of a brush to be equal to that of a segment; and let us imagine brush 1 to be on segment 1 Generally speaking, $\frac{k}{2p}$ will not be an integer; then the nth brush will touch the two segments, whose numbers lie on either side of $1+(n-1)\frac{k}{2p}$. Let us suppose there are 42 commutator segments and 8 poles. Then $\frac{k}{2p}=5\frac{1}{4}$. The fourth brush therefore touches the segments 16 and 17. Let us suppose the current to enter by the segments 1, $1+\frac{k}{p}$, ..., $1+\frac{nk}{p}$, and to pass out by the segments

$$1+\frac{k}{2p},\ 1+\frac{3k}{2p},\ \ldots\ 1+\frac{(2n-1)k}{2p}.$$

If brushes of the same polarity lie next one another on the scheme, then the conductors, which lie between, are short-circuited by the brushes and by the connections between the brushes. Starting from the brushes, let us determine the direction of the current in the separate conductors; between two neighbouring brushes on the scheme of unlike polarity there is always a circuit. An instance will make this more clear. In Fig. 1 the number of conductors is 84; the number of pairs of poles is 8; the number of circuits is 4; the number of segments on the commutator is 42; the pitch on the commutator is 11. The lower horizontal lines are numbered 1, 12, 23, &c., corresponding to the conductors 2, 24, 46, &c.; and since in the present case the pitches on the commutator and end connections are the same, the uneven conductors are numbered 13, 35, 57, &c.

Tip of brush.	Rests on segment.	Covers segments.	Direction of current.
1	1	1	+
2	$6\frac{1}{4}$	6 & 7	—
3	$11\frac{1}{2}$	11 & 12	+
4	$16\frac{3}{4}$	16 & 17	—
5	22	22	+
6	$27\frac{1}{4}$	27 & 28	—
7	$32\frac{1}{2}$	32 & 33	+
8	$37\frac{3}{4}$	37 & 38	—

If we consider the current as entering by segments 32, 1, 12, . ., then the arrows must be in the same direction on segments 11, 22, 33, and in the opposite direction on segments 6, 7, 16, 17, 27, 28, 37, 38. If these arrows are inserted we see at once that the winding splits up into four circuits, with short-circuited conductors 1, 12-23, 34-45, 56-75, 2-13, 24-43, 54-65, 76-3, 14-33, 44-55, 66. We can also see that a brush which touches two neighbouring segments, like 11 and 12, does not short-circuit any winding. The pitch for the equipotential connection can be determined from the scheme. There are 21 conductors to a circuit; therefore, we reach an equipotential point after travelling over 42 conductors. There are 21 commutator segments, corresponding to 42 conductors; reckoning things out, we get $21\times11=5\times42+21$; and

* Abstract of an article in the " Elektrotechnische Zeitschrift," No. 7, 1918.

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we notice that 21 is also the ratio of the number of commutator segments to half the number of circuits. Fig. 2 is deduced from Fig. 1, and shows the actual positions of the current-carrying and short-circuited conductors.

This method can also be employed advantageously for alternate current. Let us take a four-pole winding for 54 conductors; and let it be required to determine where the connections are to be made on a six-phase winding, if it is a condition that all the connections are to be on the same side. There are 18 conductors for each phase; they must, therefore, be divided into two groups of 8 and 10. It is only necessary to count alternately 8 and 10 conductors in order to find the points of connection. The direction of the currents can easily be deduced from the consideration of the fact that the winding is not affected by the external connections. If one considers all the conductors to form a closed winding, then at the points of connection the currents in the neighbouring conductors must flow in the same directions. If we start from the connection between 42 and 1, and remember that at the following connecting points the directions of the current change, it is impossible to make a mistake.

Salaries of Australian P.O. Engineers.

Mr. Justice Higgins recently delivered an important judgment in the Australian Commonwealth Court of Conciliation and Arbitration in regard to the salaries of men in the professional division of the Commonwealth Service, the majority of whom are in the engineering branch of the Post Office. The Judge said (according to the "Post Office Electrical Engineers' Journal") that the professional division was divided into six classes. Youths in training constituted the sixth or F Class; the main body of the officers being in the E Class and only 29 in Classes A to D. The officers in the professional division, as distinguished from the administrative, clerical and general divisions of the public service, embraced those whose duties require special skill or technical knowledge usually acquired only in some profession or occupation different from the ordinary routine of the public service.

In the electrical engineering branch especially, his Honour stated that he had been surprised to find how far the officer must advance in mathematics, physics, electricity, &c., if he was to be properly qualified for his work. But it cannot be said of these men that they attain full responsible and professional status as they nearly all act under some direction or supervision, and acquire their experience under shelter, not in open competition. The work is constant and there is no risk of practice and income falling off. Full professional remuneration was, therefore, not warranted. As it was impossible for one who has not himself the knowledge which these vocations involve to gauge their position adequately, assistance was obtained from the professor of natural philosophy in the University of Melbourne, who was asked to investigate and report as to "the necessary educational, scientific and other attainments, qualifications and responsibilities of the officers concerned, and how, comparing the functions in the several departments, to place the said persons in approximately equivalent positions." Speaking generally, the E Class, which is the staple class, consists of men who have passed through the ordeal of training, and reached a position analogous to journeymen in a trade as distinguished from apprentices. Classes D, C and B consist of men who have attained more or less leadership and control of their fellow professionals; and Class A consists of the professional heads. Treating Class E as the staple class, he said that he found dissatisfaction, that severe application to science and technique did not produce an adequate reward. There had been a lack of applicants for the engineering branch. It was admitted that in the Postmaster-General's Department the supply of junior assistant engineers and assistant engineers had never equalled demands. The Commissioner, as to the professional division, had practically adopted the same classes and salaries as for the clerical division, but added a new class at the head, although the education and training for the ordinary routine for the public service must be much lower than for professional officers. He could not regard this treatment of professional officers as being either fair or wise. It was dangerous to efficiency to keep the margin between skilled and unskilled labour too low.

Clerical labour is practically unskilled as compared with the average professional of Class E. There is a tendency to make the rewards of skilled and unskilled labour too nearly equal. The Australian communities had earned for themselves a good name in the world by insisting that every labourer shall have enough wages wherewith to provide for himself and a family the essentials for a healthful existence; but the fact that a man has secured enough for these essentials is not an adequate reason for refusing to him the extra award which induces men to face the drudgery of study and close application. A perpetual flow of highly-trained men for the King's service, which involves laborious training, cannot be hoped for without reasonable reward for that training. In the stress of the present war he had generally refused to increase the margin of remuneration for special skill on the ground of the increase in prices and the depreciation in the value of money; and this course he proposed to follow here. He would endeavour to prescribe what was just and reasonable. Regarding the necessary qualifications and attainments of the different classes of professional officers in the various departments, the system of organisation adopted resembles a telescope, in which the cylinders of less radius slip into the cylinders of greater radius; for the officers of the higher classes have responsibilities for the work of the officers of lower classes, and the latter officers for the work of officers in classes still lower. Taking for example the Post Office Electrical Engineers, responsible for the construction and maintenance of telegraphs and telephones, we find that these 223 officers control property of the public valued, in the balance-sheet of June 30, 1917, at £10,000,000; that the new constructions in the year before the war amounted to £1,180,000; and that the annual cost of maintenance is £333,000. The number of telephone instruments has increased from 8,834 in 1901 to 52,180 in 1917. Taking the Class E engineers, it appears that they make inspections, prepare plans, engineering proposals and estimates for the construction of aerial and underground lines or telephone equipment; issue detailed instructions to mechanics carrying out maintenance and other works; inspect works in progress and upon completion certify to the condition of the completed work; generally assist the engineer in charge (Class D) in all matters; deal with the estimates of line inspectors and others, and with progress reports from the line foremen. As to the qualifications of these officers. If—as is normally the case—the Class E engineer pass through the Class F stage, it is necessary for him before entering Class F, to undergo a competitive examination in English, Algebra, Geometry, Trigonometry, Physics, Engineering Drawing and one optional subject—History, Geography, French, German, Latin. Then there is another and stiffer examination for Class E. The candidate has to undergo a training which is equivalent to nearly three years of the four years' course in mechanical or electrical engineering in the University, taking pure mathematics, applied mathematics, physics, inorganic chemistry, graphics, geometrical and mechanical drawing, an elementary course as to elasticity and strength of materials, building construction, aerial line construction, cable conduit construction, mechanical engineering (elementary), electrical engineering, telephone and telegraph engineering. Such are the qualifications for the E engineer. The D engineer must have acquired still higher qualifications, and engineers of classes C, B and A differ from those of the lower classes principally in the degree of responsibility and experience.

There is another consideration. The standard of qualifications required for men in the professional division was not nearly so high in 1903, when the existing scales of pay were fixed, as the standard of to-day. On these grounds, therefore, I propose to increase the minimum of the E Class from £216 to £300. Having fixed the minimum for the E Class, the superior classes will be raised in what he regarded as due proportions. He treated the men of the superior classes as analogous to leading hands or foremen or managers. The present minimum for the F Class is £84, and if he fixed the minimum below what is reasonably necessary for a lad of 18 to pay for board and lodging, clothes, books, technical classes, &c., the career in the professional division would be practically closed to the sons of poor men, hence he fixed £96.

Regarding increments to salaries, there has been much heart-burning. The Commissioner and his inspector do not know how the officer carries out his daily duties, do not even understand what his duties involve The superior officers of the professional branch do know. His Honour, proposed to make the increments annual and automatic unless the professional head of the department reported adversely in writing as to the conduct, diligence, or efficiency of the officer.

As to Acting Appointments, claims were put forward by the Association. It seemed to have been a common practice to get men to act in higher positions, to perform the functions of a higher class than their own, to call them acting in the higher positions, and yet to pay them no higher remuneration, unless the period was for six months. The Commissioner suggested three months, but his Honour saw no sufficient reason for departing from his rule of one month, which he had previously laid down, after careful thought, in relation to mechanics and to linemen. If the superior officers select him for the higher position and keep him in it he is presumably fit for it.

The ordinary hours of duty shall be from 9 a.m. to 4.30 p.m. Monday to Friday, and on Saturday from 9 a.m. to noon; but any officer may be required to work overtime without payment for any hours after 8 a.m. and before 6 p.m. provided that 81 hours per fortnight be not exceeded. In the case of officers in Classes D, E and F, payment shall be made at the double rate for work on holidays, and at the rate of time and a half for work on Sundays or holidays, or in excess of the time per day or per fortnight aforesaid provided that the work be done under supervision or by the previous direction of a superior officer. Any officer of Class D, E or F on duty away from his usual station shall be entitled to have the time necessarily spent in travelling in excess of his usual time of duty for the day (if the excess exceed half an hour) counted as time of duty for which he is to be paid at ordinary rate, but not more than one day's pay for the excess in any 24 hours. The minimum rates of wages to be paid to employees who are members of the Claimant Association shall be as follows:—Class F, £96 per annum; E, £300; D, £408; C, £516; B, 606; and Class A2, £700.

The following officers of the Postmaster-General's Department are included in the various classes:—Class F.—Engineers and draughtsmen in training; Class E.—Engineers (telegraph and telephone), draughtsmen (telegraph and telephone) in N.S.W., Victoria, Queensland, W.A.; Class D.—Deputy State Engineers in S.A., W.A. and Tasmania, State sectional engineer, sectional engineer (Central Office), chief draughtsman (engineering); Class C.—State engineer, Tasmania, deputy State engineer, Queensland, supervising engineers (Central Office) and State supervising engineers, N.S.W. and Victoria; Class B.—State engineers S.A. and W.A., deputy State engineers N.S.W. and Victoria; Class A2.—State engineer, N.S.W., Victoria and Queenslamd, and deputy chief electrical engineer.

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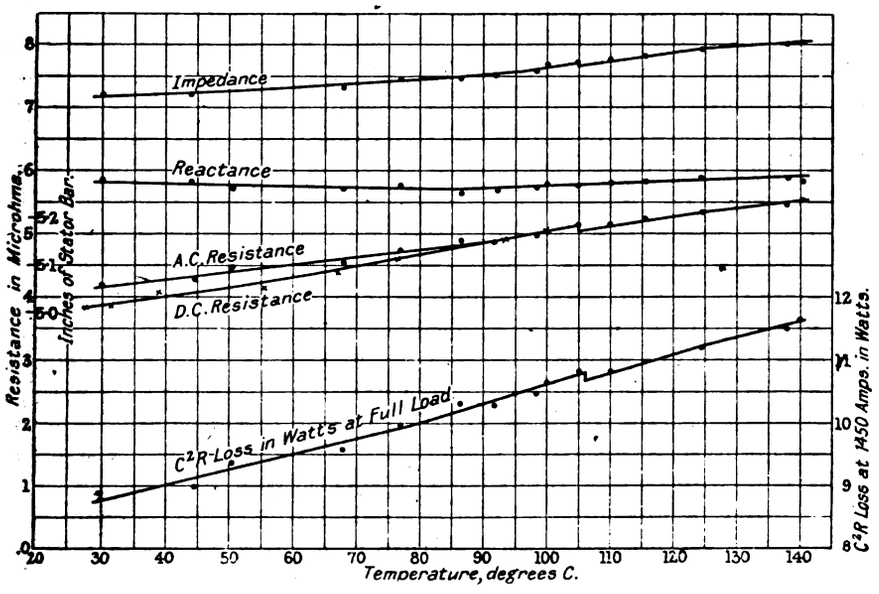
Officers in Classes C, D, E and F shall be entitled to increments as follows, unless the professional head of the branch determine previously in writing that the officer's conduct or diligence or efficiency is unsatisfactory: Class C, £18 per annum until salary reach £588; D, £18 until £498; E, £18 until £390; and Class F, £18 until salary reach £294. Increments already granted under the old scales shall be allowed under the new; *i.e.*, if an officer has been already granted two increments, he shall receive the corresponding minimum of his class at the new scale plus two increments. Officers in Class B may be awarded three increments of £24 each at the discretion of the permanent head. Officers in Class A2 may be awarded two increments of £106 each at the discretion of the permanent head. Any determination of the professional head to the effect that an officer's conduct or efficiency is unsatisfactory shall be produced to the officer affected on his request at any reasonable time.

The judgment gave definitions of the terms "Deputy Chief Electrical Engineer," "State Engineer," &c. A Board shall determine any difficulties or disputes arising under the award. The Board shall consist of one person representing the Postmaster-General, one person representing the Commissioner and two persons representing the Association, with the addition of the Registrar or some person nominated by him in case the votes are equally divided, or if the members or any two of them invoke the assistance of the Registrar.

Tests on a Joint in the Stator Windings of a 12,000 k.v.a. Generator.

We are indebted to the Victoria Falls and Transvaal Power Co., Ltd, for an account of some interesting tests recently carried out on a sample sweated joint from the stator windings of a 12,000 k.v.a. generator, the object being to ascertain the reason for these having melted out. It was important to ascertain whether there was any great difference in the resistance on alternating and direct current respectively, a Drysdale alternating current potentiometer being conveniently utilised for the tests, and giving very satisfactory results. The impedance and reactance curves are merely of academic interest, as no iron core was used in the test, but in view of the low impedance (only a few microhms) the good agreement with anticipated results is of some interest. Temperature measurements were made by the aid of copper-constanton thermocouples (about the most sensitive combination available in South Africa), the reading being very easily obtained by simply switching over the potentiometer used to direct current.



RESISTANCE OF STATOR JOINT. TYPE F.A.L. 1,200 NEW TYPE SWEATED JOINT. MEAN DISTANCE BETWEEN TERMINALS = 7½ IN.

Alternating Current Resistance.—Small terminals were tapped through the insulation into the copper immediately on either side of the joint, the mean distance between the terminals being, approximately, 7½ in. About 1,800 amperes alternating current was passed through the whole joint by means of step-up current transformers. This current and also the P.D. across the small terminals, was measured on the alternating current potentiometer, by which means the phase angle θ between the two, as well as their magnitude, is obtained. From these readings the following values are obtained by direct calculation:—

Impedance = Volts ÷ Amps.
Reactance = Impedance × cos θ
Resistance = Impedance × sin θ

The impedance, reactance and resistance in microhms are plotted against temperature in the diagram, where a second scale is also given showing resistance, expressed in inches, of solid bar. The procedure was to switch on the full current and take readings at frequent intervals as the temperature rose, these including readings on the thermo-couple laid against the joint under the insulation which was taken as giving the temperature of the joint. To obtain the higher points on the curves, *i.e.*, above 105° C., a current of about 2,050 amperes had to be used. This has caused a slight knee on the impedance and resistance curves, possibly due to increase of eddy current effects, or, possibly, to slight errors in the method of measuring, the elimination of all errors when measuring such a very low alternating current impedance being difficult.

Direct Current Resistance.—As a check on the above method, the resistance of the joint was also measured with direct current, and the result is shown in the bottom curve on the diagram. As there were no means in the test house for passing a sufficient direct current through the joint to heat it up, the joint was heated up in this case by means of blow lamps on the end of the stator bar. The temperature over the joint was therefore not so uniform as in the alternating current test, but the thermo-couple was in a position to register, approximately, the average temperature.

Resistance of Stator Bar.—As a further check, the direct current resistance between points 9¾ in. apart on the stator bar itself was measured and found to be:—

Resistance at 26°C. ..... 7·37 microhms.

From Matthiessen's standard resistance for annealed commercial copper conductors, *i.e.*, 0·668 microhms per cubic inch, the maintenance department data of the bar (588 sq. mm. cross section) and temperature coefficient of 0·0042 per °C., we have:—

Calculated resistance of 9¾ in. of bar at 26°C. ..... 7·45 microhms.

Conclusions.—These figures show a very satisfactory agreement between the tests and theory considering the very low resistance dealt with, and it should be noted that the resistance of the joint is actually only about 70 per cent. of the resistance of an equivalent length of solid stator bar. In other words the 7½ in. of joint is of equivalent resistance to about 5 in. of solid stator bar. The temperature coefficient of the joint, as obtained, from the direct-current resistance curve, is 0·00422. This, incidentally, proves that when measuring copper temperature by resistance method no appreciable error is introduced on account of good sweated joints in the circuit, since the tenperature coefficient we use for this purpose is 0·0042.

Tables I. and II. are a summary of the data on which the diagram is based, only the initial and final figures in each column being given:—

Table I.—*Alternating Current Resistance.*

Temp. °C.	Volts.	Amps.	Angle.	Impedance. m'ohms.	Reactance. m'ohms.	Resistance. m'ohms.	C^2R Loss at 1,450 amps. watts.
30·0	0·0128	1,782	54·5	7·18	5·84	4·17	8·77
140·5	0·1664	2·066	46·5	8·05	5·83	5·54	11·65

Table II.—*Direct Current Resistance.*

Temp. °C.	P.D. microvolts.	Amps.	Resistance microhms.
27·5	157	41·0	3·83
100·0	203	40·3	5·04

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Administrative Ability.

Peace has come suddenly upon us; are we prepared for it? The devastating and depressing competition in destruction called war is about to be replaced by the fertilising and uplifting competition in construction called commerce. Is Great Britain ready and able to resume her position as leader of the world in commerce?

Leaders are born, but before they can lead they have to be trained. Have we made adequate provision for the training of leaders in commerce?

In a desultory way this question has exercised the minds of educational authorities for some years past, and in several universities faculties of commerce have been created; but we see no signs that the urgent importance of the matter in its immediate bearing upon the nation's prosperity is being realised.

What we have particularly in mind is commercial training as an adjunct to the technical training of the young engineer, The standard curriculum of the British technical school gives no place to essentially commercial subjects. The result is that the technical graduate enters commercial work without even a smattering of the principles of commerce. The impression he is able to make upon the leading men of his firm is unworthy of his real attainments. It is seldom that these men are able to judge by any standard but their own, and that is commercial. The prospects of the technical student are thus blighted at the outset of his career, and opportunities are withheld for the development of the possibly great latent talents for commerce which he may possess. The student is baulked from his career, and the firm misses the prosperity it might have won.

Can we afford to omit from our engineering curricula such subjects as industrial organisation and economics when these subjects have long been reckoned as standard in the colleges of America?

We feel strongly that this omission can ill be afforded. The matter should receive the immediate and very thoughtful consideration of every technical school in the country. It is too late now to wait for the evolution and application of a new standard curriculum, into which commercial subjects shall have been fitted so as to harmonise perfectly with the rest of the structure. That must come in time, but something must be done immediately.

The standard course in the American schools of engineering lasts four years; one year longer than the standard course over here. One thing is certain: No reduction of the amount of time given to technical and scientific work in the British three-year curriculum can be allowed. This simplifies the problem of the immediate introduction of commercial subjects. They must be introduced as a special course at the end of the present curriculum. No nominal change need be made in the three years' curriculum, but teachers should in all subjects put new and special emphasis upon the commercial value of the materials, methods, processes, phenomena or principles with which they deal.

The meaning of commerce should be taken very broadly. Commerce is world service, and anything which satisfies a common want finds at once commercial application. That is commerce from the user's point of view. From the manufacturer's or merchant's point of view commerce means making money. There is a narrow and bad sense in this idea of commerce. Germany found it and idolised it. We have confidence that the idolators have made clear to all the world the ugliness of their idol. The modern manufacturer whose aim is money-making in the good sense, includes in his scheme of money-making that great new branch of commerce called welfare work, embracing the training of young apprentices and the preparation of technical school graduates for practical engineering and commercial work by a period of probation and development in the shops, and by courses of lectures on such subjects as salesmanship, industrial organisation and business method. Under welfare work comes also the care of all employees, from highest to lowest, in matters social and recreative, for it is now realised that expenditure on such matters is demanded, without any thought of philanthropy, in order that the overall commercial efficiency of the firm shall be high.

This being the modern spirit, it follows that, in looking for young trained men, the employer thinks, not only of technical attainment, but also of the important though less definable qualities which perhaps may be classed as "administrative ability."

If the technical schools can do something more than is done at present, to develop the student's administrative ability, giving him at least an understanding of its meaning and scope and of the way in which he may apply it in commercial work, they will greatly increase the student's immediate usefulness and future prospects and will go far to assure to Great Britain her appropriate place at the head of the world's commerce.

It is difficult to define administrative ability, but it must surely include some understanding of the elements of finance, of political economy, of psychology—especially in the bearing of this upon the handling of men—of works organisation, of national and of international law, as well as of some specialised branch of estimating. This list of subjects looks formidable, but the things to be learned are simple, especially to a student possessed of common sense and a good memory.

Perhaps the chief difficulty in the way of adding administration to the curriculum of a technical school is that of finding competent instructors. The men who are reputed to be men of outstanding administrative ability are often men whose success in administration—if indeed it is real success—has come by means which they themselves would be unable to define. Moreover, they are highly paid, and so are out of reach.

While thus advocating the teaching of administration we would not be understood to sympathise with those—and some of our leading men are among their number—who maintain that commercial attainments are of a higher order than technical. It is a fact that commercial posts command higher—often absurdly higher—salaries than technical; but to argue from this that the highly paid director of a manufacturing firm is necessarily of more real worth to the world than, say, the chief designer, is just as absurd as to argue that the loss of PIERPONT MORGAN was more serious for the world than that of MOSELEY, or that ROTHSCHILD was a greater man than KELVIN. We believe that the anomaly of the inferiority of the value set upon technical as compared with commercial services is largely a survival of the custom of old times—times when technical and scientific training were unknown, and the only design attempted was such as fell within the competence of the mere craftsman. We do not expect, however, to see the anomaly altogether set right. The time will never come when the wages of men will really be in proportion to their worth to the world. For there are things that thoughtful men value more highly than money. All are agreed that

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the real greatness of the men of history should be measured largely in terms of the new facts they discovered or disclosed. And discovery in the world of thought is certainly no less valuable than discovery in the world of action. Thus, DESCARTES, many of whose most valuable discoveries were made in bed, was at least as great as COLUMBUS. And we would wager that the position which DESCARTES would be expected to accept to-day, were he alive and magnanimous enough to offer his services to one of the great manufacturing firms, would be no higher than that of, say, experimental physicist at £5 per week. And very likely, with his eyes wide open to the knowledge of his own abilities, and with full confidence that if only he would sacrifice his passion and gift for careful thought, and enter the commercial side of the business, in which the qualities making for success are worldly wisdom and ambition, his salary prospects would be incomparably better, he would, nevertheless, have chosen the £5 job. For the thing which was to DESCARTES incomparably more important than worldly wealth was freedom to develop and make fruitful his great gift for thought.

It is thus an honour to the technical and scientific man—the man of careful thought—that he is willing to be ill paid; but it is a reflection upon the intelligence of the rest of the world—a reflection of which, we believe, the world is already becoming a little ashamed.

Reviews.

Essentials of Electrical Engineering. By J. F. WILSON. (London: Constable & Company, Ltd.) Pp. viii.+345. 10s. 6d. net.

At the present day there are so many books intended to serve as "a text book for colleges and technical schools"—the sub-title of the present volume—that a very high standard is demanded in any new work on this subject. In our opinion the present book does not fulfil this demand, and falls decidedly below the level of other recent American books which it has been our privilege to review. The range of subjects treated is very wide, and includes chapters on the laws and principles of the electric and magnetic circuits, the working of all kinds of electromagnetic machinery and a description of lamps, switchgear, meters, transmission systems and storage batteries.

Despite the clear and full treatment, however, we are continually finding fault with the author for making statements which are either incorrect, misleading or badly stated. A few of the passages to which we refer may be quoted, and the reader can judge for himself whether we were justified in pencilling a query in the margin. P. 4, "The energy equivalent of one joule has been experimentally determined to be =0·24 calorie=0·00095 B.T.U.=0·737 foot-pound=10,000,000 ergs." P. 29, "The only known means for the production of a magnetic field is the electric current." P. 126, "The harmonics of the different groups of a distributed winding tend to neutralise and eliminate the harmonic from the resultant electromotive-force wave." P. 141, "The stray load losses . . . . are directly proportional to the armature current." P. 144, "If the frequencies are not the same, the instantaneous voltages are not equal at all times, and equalising currents flow between the alternators."

The author's explanation of the load division of alternators in parallel will give the student something to think about: "Let A and B be two similar alternating-current generators operating in parallel, the field excitation, terminal voltage and armature current being the same in each machine. If the power input to the prime mover driving alternator B is reduced, the load on the alternator tends to stop its rotating parts, the angle between the E.M.F.'s becomes greater than 180 deg., and a current flows between the armatures, *i.e.*, alternator B acts simultaneously as an alternating-current generator and as a synchronous motor, the current for its motor action being received from alternator A Therefore, the load division of alternating-current generators operating in parallel is changed by changing the power input to their prime movers. Since the input to a prime mover, *e.g.*, a steam engine, is constant at a given speed, changing the field excitation of alternator B does *not* change its output, although it causes a current to flow between the armatures. . . . ."

The danger to the elementary student of information of the kind quoted is that later on he will have to unlearn so much, or experience trouble in acquiring more exact knowledge. Though elementary knowledge is not expected to be complete, it must at least be of practical use, and no good end is served in introducing confusing generalities.

The book is well illustrated, but some of the diagrams have been reduced too much and thereby lost clearness. Fig. 45 is a very poor attempt to show "commutator structure."

STANLEY PARKER SMITH.

Ellison's Motor Ampere Calculator. (Birmingham: George Ellison.) 5s. net.

Any device which saves time in connection with the installation of electric motors helps to increase the number of power consumers. We are quite sure that electric power contractors will, therefore, welcome the Ellison "motor ampere" calculator, which is designed to diminish the trouble of constantly working out current required for motors, and determining the nearest size of cable suitable for use in connecting up to the power circuit. The calculator comprises a chart which reads in horse-power up to 100, and in amperes up to 200. The centre of the chart is occupied by four arcs reading in voltages from 1 to 600 for one-phase continuous current, two-phase and three-phase circuits respectively. Pivoted at the left-hand bottom corner is a narrow strip of celluloid, which sweeps over the whole of the diagram. This strip is set with its edge against the voltage of the supply on the appropriate sector. The abscissa scale being marked in horse-power, the ordinate through the desired horse-power is taken, and where this intersects the edge of the pointer the abscissa is carried to the scale of ordinates and gives directly the amperes and the nearest size of cable. The calculator measures 14 in. deep by 12 in. wide, and can either be hung on the wall or stood on the desk.

Sir William Ramsay as a Scientist and Man. By Prof. T. C. CHAUDHURI, M.A. (London: Butterworth & Company.) Pp. ix.+66. 2s. net.

This brief memorial of Sir William Ramsay's work, by T. C. Chaudhuri, professor of chemistry at Edward College, Pabna (India), contains a tribute to his characteristic qualities of courage and simplicity and a general review of his best-known discoveries. Some introductory remarks are also contributed by Prof. P. Neogi, of the Rajshahi College. The facts mentioned are naturally familiar to British readers conversant with recent scientific developments, but they are presented in a readable and succinct form. A list of Sir Wm. Ramsay's chief contributions is added in an appendix. It is pleasant to note this recognition of Sir Wm. Ramsay's services to science from a distant section of the Empire. In several respects the get-up of the work has a curiously Indian touch, but we have only praise for the unusually large type and the quality of paper employed.

Selwyn's Metric Conversion Tables. Edited by W. E. DOMMETT. (London: Selwyn & Co., Ltd.) Pp. 49. 2s. 6d. net.

This series of tables applies mainly to the conversion of length, area, volume and weight from British to metric measures, and are compiled specially for the use of scientific workers. There are also some supplementary data, less usually presented in results of this kind, such as equivalents of kilogram per square metre in lbs. per square foot, and similar data for velocities. The series is completed by a table for conversion of Fahrenheit degrees to Centigrade, or *vice versa*.

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The Economics of Works Costs.

By J. R. DICK, B.Sc.

(*Continued from page* 645.)

Summary.—This article deals with the following points:—(1) Symbolic statement of economic laws in general. (2) Law of rent in the agricultural industry. (3) Rent as a function of productivity of the soil. (4) Kelvin's law compared with law of rent. (5) Royalty for manufacturing processes a species of rent. (6) Law of diminishing productiveness in other industries besides agriculture. (7) Factory costs and their object. (8) Analysis of their components. (9) Labour charges, day-work, piecework and premium systems in relation to workman's productivity. (10) On costs or shop charges in general. Part of the oncost is a function of the productivity of the machines. (11) Hyperbolic laws of the capital cost of machines and the running expenses per unit of product. (12) Effects of increasing output. (13) Relation of machine oncost to direct labour cost. (14) Indirect labour and other shop charges. (15) Limits of accuracy in expressing oncosts generally as a linear function of the direct labour. (16) Relative values of direct labour and shop charges, with examples. (17) Establishment charges—how they are allocated. (18) Selling price inclusive of profit—how ascertained. (19) Relative importance of the cost factors. (20) Instances where materials preponderate in the cost—Cable making—Foundry work. (21) Where invested capital cost preponderates—Electricity supply.

Cost-Keeping in Manufacturing and its Objects.

In dealing with the equations for factory costs generally a word might be said as to their primary object, which is sometimes overlooked by cost-keepers and accountants. The systematic determination of the cost of production of a series of completed articles, although of interest, is of little or no value, unless it furnishes a clear indication for ascertaining the cost and selling price of similar articles subsequently. An accurate balance sheet of a job or department, presented weeks or months after the work is finished, is comparatively useless. Too great stress cannot be laid on the study of the principles of cost keeping by methods such that the effect of current variations in the elements composing the costs is visible for future guidance. Put algebraically, the prime cost must be expressed as a function of certain independent variables, and from this function the consequences of changes in the variables can be deduced.

General Symbolic Statement of the Cost of Production in Factories.

In a factory turning out repetition work of various types on a large scale, the general formula for the total cost of production (C) of a number of articles (N) of a given type, per unit of time, is

$$C=S+L+Q+M, \quad \ldots\ldots \quad (5)$$

where S is the material or stores required, L the direct labour, Q the "on cost" or shop charges, and M is the management and establishment charges. It is always better to distinguish between Q and M, instead of including them in one category, as is sometimes done even now. This sub-division is in accordance with the principle, followed in good accountancy, of increasing the usefulness of accounts by making them as analytical in form as possible. The items Q and M need not be defined at length as they have their usual meaning. It is well to note, however, that there is a physical reason for considering Q and M as generically independent variables. The charges falling under Q, although called indirect, are all closely associated with the machining and handling of the articles themselves, until they are put in the finished stock warehouse, or are actually sold.

On the other hand, M represents charges, such as management, rent and taxes, which are mostly book-keeping debits. They must be included in the total cost, but they are nearly independent of the processes in the workshops.

The total cost of N articles being C, the cost per article, c, is

$$c=\frac{C}{N}=\frac{1}{N}(S+L+Q+M). \quad \ldots\ldots \quad (6)$$

The amount of material for an article of definite design is invariable, and the cost S depends only on the market value of the raw material in bulk and the avoidance of waste. Its ultimate cost is a function of the elements of labour required to produce it, but, since this labour is employed elsewhere, its analysis plays no part in the cost-keeping of the particular factory considered.

It is only necessary with S to keep a strict record of the amount and money value for the output N, and to make sure that waste is a minimum. Suggestions for improving S can, in general, only come from the designers, or from those who habitually handle the materials.

How Labour Productivity Affects the Various Cost Factors.

Turning to the item of labour, L, on the day-work system of wages, this is on the average constant. Q and M, by their definitions, can in the first instance also be taken as constant, but later we will examine the variations to which they are subject. The values of L and their reaction on c, are of paramount importance in factory efficiency, which depends largely on the system of wages payment.

Even on a simple fixed day rate, the responsible and conscientious workman, under efficient and sympathetic supervision, will show on certain repetition work a substantially increased output due to the dexterity he acquires. This increase does not necessarily imply harder labour on his part, but arises from using his intelligence and experience to avoid excessive exertion or trouble in handling his work or machine.

If the day-work output increases *ceteris paribus* from N to pN the cost becomes

$$C_1=pS+L+Q+M,$$

and

$$c_1=\frac{C_1}{pN}=\frac{1}{N}\left(S+\frac{L+Q+M}{p}\right). \quad \ldots\ldots \quad (7)$$

In these expressions p is the workman's productivity, using the symbolism of the rent theory.

The saving in cost per article is the difference in the values of c and c_1 in (6) and (7) or

$$\frac{L+Q+M}{N}\left(1-\frac{1}{p}\right), \quad \ldots\ldots \quad (8)$$

and it benefits only the employer. It is assumed in this comparison, and shown later to be true that $Q+M$ in general does not change appreciably as N increases to pN.

Suppose, now, it were decided to advance the wages in direct proportion to the productivity p, then L becomes pL when N rises to pN, and the cost function is

$$C_2=pS+pL+Q+M,$$

and

$$c_2=\frac{C_2}{pN}=\frac{S+L}{N}+\frac{Q+M}{pN}. \quad \ldots\ldots \quad (9)$$

The saving in cost per article from (6) and (9) is

$$\frac{Q+M}{N}\left(1-\frac{1}{p}\right). \quad \ldots\ldots \quad (10)$$

The expressions (8) and (10) conform exactly to the rent function, with appropriate coefficients. As seen in (10), there is a substantial advantage to the employer, and the workman, too, reaps the full reward of his productivity.

If d is the profit per article done on day-work, the total annual profit is Nd, and correspondingly from (10) the total profit is

$$pNd+pN\left(\frac{Q+M}{N}\right)\left(1-\frac{1}{p}\right)$$

$$=pNd+(Q+M)(p-1) \quad \ldots\ldots \quad (11)$$

The formula (11) emphasises what may seem an absurdly simple point, but one that often escapes attention. The enhanced output involves *per se* an addition to the total an-

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nual profit, irrespective of the profit due to the saving in the shop charges and management represented by $(Q+M)(p-1)$. *It may* be argued that the increase of output from N to pN by the stimulation of the workmen will lead to dangerous "over-production," but this result is unlikely with standard articles, where the market can be automatically widened by the reduction in selling price corresponding to the cost shown in (10).

Even in the most unfavourable case for the employer as regards labour, it is apparent that "high wages do not necessarily imply high costs." The formula (9) is characteristic of the wages paid for an agreed increased output, or for the more common application of the same principle—piecework. If the factory machinery is fully utilised, with little lost time, the simplicity of piecework and its merit in satisfying the workman by giving him "everything he makes," while still permitting a surplus profit on the oncost and management expenses, are the causes of its extensive use and comparative popularity.

In some engineering departments, notably the foundry, the utility of piecework is seen from another aspect. The workman being aware that he will be paid only for good castings will, as a matter of self-interest, give just that little extra care to finishing off the moulds and closing the boxes, that will, in general, ensure a minimum of waste castings. Avoidance of waste does not necessitate his working harder, but only induces him to take the same precautions as he would if he were working in his own business.

In practice the small extra responsibility thrown upon the man does not appreciably curtail his week's output or his wages, but it means an important reduction in the time and money lost in waste castings. The same advantage accrues from most premium systems as well as piecework, since one of the terms of the contract is that payment is made only for good castings or approved work. This aspect of piecework may appear paradoxical at first sight, as the common view is that it lowers the standard of finish; and without the safeguard of inspection it would have this tendency.

BASIS FOR COMPARING THE EFFECT OF LABOUR PRODUCTIVITIES WITH DIFFERENT WAGES SYSTEMS.

Before discussing the "profit sharing" wages formulæ, which involve less simple functions of the productivity, its application to labour will be defined more closely. In the Riardian theory productivity is measured against the standard land on the margin of cultivation, which yields no profit for rent. On a similar basis, labour productivity is expressed in terms of that of the workman, whose production just covers his wages with the barest margin of surplus for shop charges and profit. Should the price of the manufactured article fall he could not permanently retain his job under the present industrial system. Should it rise, his productivity would then be greater than unity, and some men of inferior skill could be employed who were just on the "margin." The phenomenon of high costs and prices associated with low productivity has been clearly visible in trades outside of munitions work in the past three years. Unit productivity is based in the time T required for an operation by a workman on the margin. If he or another workman reduces the time to t the productivity p is T/t, which is greater than unity. Alternatively, if pN articles are produced in the time allowed for N, $p=pN/N$. If W_0 is the basis rate of wages for $p=1$ the rate w on day-work is, of course, identical, or $w=W_0$, as all workmen on similar jobs are supposed to have the same productivity of $p=1$. On piece-work, we have seen $p>1$ and $w=pW_0$ in strict linear ratio.

PREMIUM SYSTEMS: FORMULÆ AND RELATIVE MERITS.

The wages system due to Taylor, Halsey and Willans is based on giving a premium that depends on the difference between t the time actually taken and T the time allowed for the same operation, the latter time T being that required by the man of unit productivity.

The earnings wt are made up of the standard wages W_0t, and an added part equal to $W_0x(T-t)$, where x is any fraction, usually $\frac{1}{4}$, $\frac{1}{3}$ or $\frac{1}{2}$, or $wt=W_0t+W_0x(T-t)$, and

$$w=W_0\left(1-x+x\frac{T}{t}\right)=W_0(1-x+xp).$$

When $x=\frac{1}{2}$, which is the most common ratio, $w=\frac{1}{2}W_0(1+p)$. The actual hourly rate, w is a linear function of p, and as a function of t, its graph is a hyperbola. If p rises or t falls indefinitely the wages rate per hour will also increase indefinitely. The workman's gain, or addition to wages per hour compared with the day work rate is

$$\tfrac{1}{2}W_0(1+p)-W_0=\tfrac{1}{2}W_0(p-1).$$

The cost per article is reduced in accordance with the equation below, since N becomes pN, and when $x=\frac{1}{2}$.

$$L=wt=\tfrac{1}{2}W_0t(1+p).$$

$$C_3=pS+L+Q+M \text{ for production } pN,$$

$$c_3=\frac{C_3}{pN}=\frac{S}{N}+\tfrac{1}{2}\frac{W_0t}{pN}(1+p)+\frac{Q+M}{pN},$$

$$=\frac{S}{N}+\tfrac{1}{2}\frac{W_0t}{N}\left(1+\frac{1}{p}\right)+\frac{Q+M}{pN}. \quad . \quad . \quad . \quad (12)$$

The saving per article or the difference in values of c and c_3 from (6) and (12) is

$$\tfrac{1}{2}\frac{W_0t}{N}\left(1-\frac{1}{p}\right)+\frac{Q+M}{N}\left(1-\frac{1}{p}\right),$$

or

$$\frac{1}{N}\left(\tfrac{1}{2}W_0t+Q+M\right)\left(1-\frac{1}{p}\right),$$

which exhibits the employer's surplus again in terms of the rent function, with a little more complex coefficient

The rapid rise in the rate per hour on the Halsey system, as p increases, has been alleged as a serious defect against its use, particularly where little or no experience is available for accurately fixing the basis time T for $p=1$. In Rowan's formula the premium time added is equal to the actual time taken t, multiplied by the ratio of the time saved $(T-t)$, to the time allowed (T). The standard wages for the time taken are W_0t; the premium wages are

$$W_0t\frac{(T-t)}{T};$$

and the total wages are

$$wt=W_0t+W_0t\frac{(T-t)}{T}$$

$$=W_0t\left(2-\frac{t}{T}\right)=W_0t\left(2-\frac{1}{p}\right);$$

and the hourly rate

$$w=W_0\left(2-\frac{1}{p}\right)$$

$$=W_0+W_0\left(1-\frac{1}{p}\right).$$

In the last equation $\left(1-\frac{1}{p}\right)$, being identical with $(T-t)/T$, is the ratio of the time saved to the time allowed, and this permits of a simple explanation of the effect of the system, when it is introduced to the workmen. If 10 per cent. of the time allowed is saved, 10 per cent. is added to the standard rate, or the man is paid time and a tenth. If 25 per cent. is saved he gets time and a quarter, and so on. The gain per hour to the workman on Halsey's system is $W_0\frac{1}{2}(p-1)$, and on Rowan's it is $W_0\left(1-\frac{1}{p}\right)$. For $p=2$, $\frac{1}{2}(p-1)=\left(1-\frac{1}{p}\right)$, and the premium is the same in both systems. For values of p below 2 the Halsey premium is less, but as p increases beyond 2, $\frac{1}{2}(p-1)$ rapidly exceeds $\left(1-\frac{1}{p}\right)$.

The cost per article for the output pN on the Rowan scale is

$$c_4=\frac{S}{N}+\frac{W_0t}{pN}\left(2-\frac{1}{p}\right)+\frac{Q+M}{pN}=\frac{S}{N}+\frac{W_0t}{N}\left(\frac{2}{p}-\frac{1}{p^2}\right)+\frac{Q+M}{pN},$$

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and the saving, compared with ordinary day-work, is the difference between the value of c_1 and $\frac{1}{N}(S+W_0t+Q+M)$,

or,
$$\frac{W_0t}{N}\left(1-\frac{2}{p}+\frac{1}{p^2}\right)+\frac{Q+M}{N}\left(1-\frac{1}{p}\right),$$
$$=\frac{W_0t}{N}\left(1-\frac{1}{p}\right)^2+\frac{Q+M}{N}\left(1-\frac{1}{p}\right). \quad . \quad . \quad . \quad (13)$$

It is a curious fact that the premium on the Rowan formula $W_0\left(1-\frac{1}{p}\right)$, whether by accident or design, is exactly the rent function of the standard wages. Just as the rent would equal the total produce of the land, when $p=\infty$, so the premium here may also in the limit equal the full standard wages. But the total earnings in that case can never exceed twice those on time-work. The Halsey formula results in an added wage of $W_0\frac{1}{2}p\left(1-\frac{1}{p}\right)$, or the rent function multiplied by $\frac{1}{2}p$ times the standard rate, and would thus produce an infinite rate when $p=\infty$.

Rowan's bids fair to become the most popular of the existing systems of profit sharing in wages.

Its advantages may be recapitulated as :—

1. Simplicity of definition and explanation.

2. A higher rate of premium and a greater incentive than Halsey's until $p=2$, or until the job is done in half the time allowed.

3. A greater latitude of error or bad judgment in fixing the basis time T, since in any case the total wage can never exceed double the standard, and there is no temptation to revise T.

Considerable ingenuity has been exercised by some French economists in constructing more complex wages formulæ. They start from the principle of assuming an instantaneous rate of variation of wages relative to productivity or, mathematically expressed, they take certain values for the differential coefficient of the function w with respect to p.

In Halsey's this gives $\frac{dw}{dp}=a$, where a may have any fixed value, such as $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, &c., and in Rowan's formula $\frac{dw}{dp}=\frac{1}{p^2}$.

The integration of these functions results in the ordinary algebraic formulæ already stated.

As another example of the method, suppose $\frac{dw}{dp}=\frac{1}{p}$; from this is obtained by integration $w=W_0(1+\log_e p)$. Obviously, the resulting premium $W_0 \log_e p$, increases more rapidly than Rowan's, and becomes infinite when $p=\infty$.

It gives the same value approximately as Halsey's when $p=3$, and thereafter its value is less. Such a system of wages, even if it possessed extraordinary advantages, could rarely be practically applied in a machine shop, as it cannot be explained in any terms intelligible to the ordinary workman. The table of premiums would look quite arbitrary, and incapable of simple verification. An unlimited number of formulæ can be obtained by assuming $\frac{dw}{dp}$ as a more complex function of p.

Several interesting types have been thus evolved by M. Felix Bayle.* who has endeavoured to introduce them into French munition works, but with little success, on account of certain political pledges given to the workmen. Although historically the best known premium systems were not derived from differential equations, these are undeniably of some use in studying the corresponding laws of variation in wages.

ETHICS OF PREMIUM SYSTEMS.

From the quantitative representation of different premium systems little can be deduced of their relative justice or acceptability to the workman. Such questions properly belong to the science of ethics, but trenching a little on this science it will probably be conceded at once by an impartial observer of the premium system that *some* part of the wages saving from increased productivity might be claimed by the employer. On Rowan's scale, for example, the employer practically binds himself not to cut rates, as is so often done (and sometimes rightly) on piece-work. This assurance is of direct money value to the employee in making his contract, for which he may be considered to owe something to the employer. Again, if the employer affords opportunities for increasing repetition work, this implies more capital in material and machines placed at the disposal of the employee than if he were on a day-work basis. As he accumulates experience of the job he is by these conditions enabled to attain an intelligent—almost automatic—proficiency that entails less effort accompanied by higher wages than on diversified day-work. Obviously some monetary consideration might thus be credited to the employer, who initiates and maintains the conditions for an assured rise in wages. The most elusive factor in the question of wages is the standard of human productivity, on which all the systems are implicitly founded. The maintenance of a reasonable or living wage corresponding to $p=1$ is legitimately one of the chief objectives of trade unionism. Fortunately, the Rowan scale avoids much of the difficulty attached to this question by limiting the maximum possible premium. In selecting a wages system the ethical side cannot be ignored, but the success of the system will ultimately depend on its economic soundness.

(To be continued.)

* "Les Salaires Ouvriers, et la Richesse Nationale." (1917.)

Correspondence.

DIMENSIONS OF TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Low's article in your issue of November 15th (Vol. LXXXI., pp. 597-599) appears to call for some sort of a reply upon my part, but really I have already said nearly all that could be said in the I.E.E. Paper to which he refers.

I admit that my mathematics, which deals with *things*, would not satisfy the pure mathematician to whom anything beyond abstract number is a thing to be abhorred. But it does lead to the correct results, so far as the assumptions involved permit, and is within the capacity of the ordinary engineering designer. The latter can scarcely be said for Mr. Low's, in spite of its elegance, or possibly because of it.

Suppose I have to design a transformer for a given output. I first fix upon the type I prefer, and decide what copper and iron losses to allow, using graphs of typical values (as those given in the "Treatise," for example), if these things have not already been decided for me by my taskmaster. Then I estimate the probable space-factors in the copper and iron, and assume approximate figures for the relative cost of the metals. Knowing the qualities of the materials, I also know the "loss-length." From this, the aggregate loading of the windings, the losses and the space-factors, a simple slide-rule calculation will give the "fundamental-length." The leading dimensions for the "cheapest" transformer of the chosen type are obtained by multiplying this "fundamental-length" by numerical coefficients which can be at once read off from my published tables for that particular type of transformer. Winding equations give at once the numbers of turns, and these fix the sections of the conductors. There are no equations to be solved, no graphs to plot; in fact, nothing but taking numerical values from tables and simple slide-rule calculations. Including the check calculations, the whole thing goes into little more than half a column of the "Journal." Any intelligent engineer can quite easily follow the whole process illustrated by the example in section 12 (p. 148) of my Paper, and could apply the method to another example without much trouble.

In Mr. Low's method, the flux and current densities have to be assumed. In his theory these are "constant." In his

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1909 Paper he uses 10,000 c.g.s. and 1 ampere per square millimetre respectively for their values, but in his 1915 Paper he tells us that the former may be taken as 14,000 and the latter lies between 1·5 and 3. I cannot quite follow his method, which appears to involve the solution of a number of complicated equations either analytically or graphically. Will he work out my example by his method, explaining each step sufficiently to enable any designer to apply his method to another design? Let him take the same type, frequency, materials and space-factors as I have, so that the two designs may be directly comparable.

When he wrote that I did not indicate the advantage of eliminating the densities in terms of the losses, Mr. Low must surely have overlooked section 14 (p. 150) of my Paper, for I there claim quite a number. By making this elimination I have been enabled to compile, *once for all*, tables of numerical coefficients for every type of transformer likely to be of practical use, and for a very large number of unlikely ones; to make approximate comparisons between different types independent of material or size; and between different materials independent of type or size of transformer. No other theory which I have come across can give anything like such broad results. Where does Mr. Low make any such general comparisons?

In conclusion, I am sincerely flattered by his generous tribute to my work at the foot of p. 598. Only, the "English" author happens to be a Scot, and you know that these Scots hae nae sma' conceit o' their ain nation.—I am, &c.,

DAVID ROBERTSON.

Merchant Venturers' Technical College,
Bristol, Nov. 29.

THE ORGANISATION OF TECHNICAL STAFFS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the interesting and timely article on "Organisation of Technical Staffs" in your issue of the 6th inst. mention was made as to the desirability or otherwise of a comprehensive union for all technical engineers engaged in the electrical industry. This would mean that the membership qualification basis would be "craft," and not "industry," in so far as the latter is defined and prescribed by the Ministry of Labour in the setting up of Joint Industrial Councils.

A preliminary conference to form a Council for the electricity supply industry was recently held, and the workpeople were there represented by many trade unions, not one of which was wholly representative of all the workers in that industry, but each of which included in its membership some who were so employed. Those unions overlap, and some are in active rivalry in their efforts to obtain the support of identical individuals. From the point of view of efficiently fulfilling the functions of an Industrial Council, this may be unfortunate, as when an Industrial Council has been set up in any industry it would be ideal that the workers should be represented by a union whose whole interest was centred in that industry, and whose efforts and intentions were in no way complicated by any extraneous influences. The same can be said of the representation of the employers or capital interest, and also of the management or staff. The Association of the Technical Engineers engaged in the electricity supply industry, the E.P.E.A., has tried to simplify matters by making its constitution conform to the requirements of representation on a Joint Council for the electricity supply industry. There may be difference of opinion as to whether it might not have been better to broaden the sphere of the E.P.E.A. so as to include in its membership all technical engineers in the electrical industry, and in the absence of a trade union for the staff men engaged in manufacturing and contracting this may become necessary. It has, meanwhile, been decided that more important than numerical strength with divergent interests is unanimity of purpose, which is only possible in an association dealing with the members of the staffs of one industry—in this case electricity supply. If later trade unions were formed in the other sectional industries—electrical manufacturing and electrical contracting—a federation of these would undoubtedly be of advantage in dealing with the common interests of the electrical engineering craft. At present it is necessary for the technical engineer to make every effort to obtain adequate representation on the Council set up in the industry in which he is engaged. It is laid down in the Whitley Report that all sections of the industry are to be represented on Joint Industrial Councils, and in some of the publications issued by the I.R.C. mention is made of a constituent triangle—capital, management and workpeople. The power of deciding who shall or who shall not be represented has been left to the trade unions of the workers, and, unfortunately, they do not at present think their interests would be served by the presence of members of the staff. Good feeling and harmonious working already invariably exist between staff and employees in power stations, and there is no reason to presume that these would be amended in the Council chamber. It should be unquestionable that in the discussion of questions such as conditions of employment staff men who are closely in touch with, and who in many cases have the same irksome experiences and the same grievances, must be helpful to the worker. In questions affecting finance the member of the staff is more *au courant* than the worker. On other terms of reference dealing with technical education, research and so on, all must agree that the staff engineer is, by reason of his training and experience, better equipped than either the employer or the worker to advise. It is hoped that better counsels will prevail with the worker, and that he will make possible the efficiency of Industrial Councils by agreeing to sit with his employer and his staff colleague, so that all can bend their efforts to the advantage of the industry and the ultimate advantage of our country.—I am, &c.,

London, Dec. 10. "A CORRESPONDENT."

PATENT LEGISLATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Patentees will have read with interest (and generally with approval) the report of the Committee of the Institution of Electrical Engineers, and your Editorial article in THE ELECTRICIAN, of the 22nd inst. With regard to a Patents Moratorium, however, the writer thinks all patentees agree that there should be no distinction drawn between such patents as "survive" the war and such as expire *in the course* of the war, as is suggested in the report. *All patents in existence at the outbreak of hostilities should be extended automatically for a period corresponding to the duration of the war*! Take, for instance, a case of a patent which lapsed in August 1916 or 1917 and gets only (as suggested in the report) an extension corresponding to 2 or 3 years respectively. In the first case the patentee—beyond royalty claims—gets no opportunity at all of recouping himself by way of *manufacturing* profits during normal conditions, and in the second case, only a very brief period and still under abnormal conditions as to cost of materials and labour.

As probably many patentees will have been in the same position, during the war, as the writer, namely of having their patented inventions practically "seized" by the Government (the inventions being of great importance for the successful prosecution of the war), and having their working drawings distributed among a number of *outside* contractors who have got the overwhelming portion of manufacturing contracts—thereby causing immense loss to the patentee—they will no doubt agree with the view expressed above. Even with such an extension, the inventors and their financial backers will obtain but a poor return for their labours and risks.—I am, &c.,

London, Dec. 10. "PATENTEE."

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.
Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.
Orders for the Week.

Monday, Dec. 16, to Saturday, Dec. 21.—Drills as usual.

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Electric Power Supply.

The report of the INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION upon the report of the Board of Trade Committee on Electric Power Supply has been issued. After recapitulating the chief recommendations of the Board of Trade Committee, the I.M.E.A. state: "We observe with satisfaction that the report recommends that in the National interest generating stations and main transmission lines ought, as a general rule, to be publicly owned, and submit that the district electricity boards should in all cases be so constituted as to be wholly independent of the influence or control of commercially owned electrical enterprises. To secure this object, it is strongly urged that the district electricity boards should consist of representatives of local authorities and large consumers, to the exclusion of companies generating or distributing electricity. We believe that in the constitution of the boards a combination of all the public interests concerned would lead to efficient and economical administration. We consider that those representatives who are at present primarily responsible for the administration of the existing publicly owned undertakings, such as chairman and deputy-chairman of municipal committees, would be suitable to form the nucleus of the new boards. We endorse the recommendation that members of the board should be elected for a period of six years. We note with satisfaction that the committee has adopted the recommendation in regard to the appointment of five Commissioners in accordance with the terms of the resolutions first adopted by the Council of this Association on Nov. 1, 1916. All the five should be whole-time officers.

We are of opinion that ample evidence is available to demonstrate the fact that a well-situated power station, equipped with large modern units of generating plant, is able to afford a supply of electricity at the station bus-bars at a lower price than a number of separate stations of a total equivalent capacity. The question of cheap supply of electricity is not, however, solely dependent upon cheap generation. In certain cases the capital costs and operating expenses incidental to a long transmission line may counterbalance the advantage derived from the concentration of large plants. But in most industrial districts these large stations will be connected together by means of a common network, which should result in a considerable saving in capital expenditure on spare plant. They are also thereby enabled to operate at a higher load factor, and to obtain the great advantage of still lower working costs which result from a diversity of demands. We think it desirable again to draw attention to the mistaken impression which undoubtedly exists that the report recommends the establishment of 16 large power stations for the supply of the whole of the electrical requirements of the country. The number 16 refers not to power stations but to the number of districts into which the country would be divided for administrative purposes. In thinly populated districts one power station may suffice, but in others it will be quite impossible to supply all requirements from one site, and the administrative authority will be responsible for the operation of several power stations. Full opportunity should be afforded the several local undertakings to make representations to the Electricity Commissioners on the delimitation of suitable areas. We agree with the findings of the Committee in regard to the transfer of all generating stations and main transmission lines to the board, subject to the reservations herein stated. Bearing in mind the close collaboration which must exist in the operation of a number of power stations through an inter-connected system of mains, and the control which must be exercised by a District Board if the most economical results are to be obtained, we are of opinion that to allow any existing undertaker to retain the ownership of a power station within any given district, whilst the remaining power stations are transferred to the Board, would introduce serious complications in actual practice, as well as financial chaos. When local undertakings are transferred to a District Board, provision must be made to transfer all the rights and obligations under existing contracts. In paragraphs 55 and 56a of the report, provisions are made for excepting certain undertakings from transfer to the District Boards. In our opinion, these provisions cover all the cases likely to arise in practice, and subject to these exceptions, all the generating stations and transmission lines should be transferred to the Board. In the case of a power station of one authorised undertaking, situated at such a distance from the nearest power station of another undertaking which are unlikely to be interconnected for some considerable time, and extensions must be carried out slowly to meet the requirements of each local area. We consider, even in such a case, a District Board should be set up to control the development of the supply in the district as a whole, and to ensure that extensions of plant and mains should be suitable for use at a later date in connection with a supply to a much larger area.

It appears to us that the first duty of the District Boards will be to consider which stations, or portions of stations, should for the time being be employed. Then to consider on which of the existing sites extensions can be economically carried out, and if and when these provisions are found inadequate to deal with the requirements of the area the question of new sites with large modern plants would then be considered. The report clearly contemplates—and, in our opinion, rightly so—that with the exceptions already referred to, all extensions should be financed by the new District Boards. A consideration of this point will inevitably lead to the conclusion that all generating stations should be transferred to the new Boards. It should be obligatory for the District Boards to supply a local undertaking, whose generating plant has been taken over, at least as cheaply as the latter could produce it themselves. We favour direct control and operation by the several District Electricity Boards in their respective areas. We are in general agreement with the recommendation that existing authorised undertakers should retain their distributing rights. We are strongly of opinion that the terms as set out in paragraph 56 (b) of the report, upon which the several undertakings should be transferred to the District Boards, are inequitable and inadequate. In view of the admitted fact that there exists a want of uniformity between one local authority and another as to depreciation and reserve funds, we are of opinion that all sums—to whatever fund they may be allocated—other than statutory sinking funds, should be retained by the individual undertakings. The case of those authorities who have placed sums from revenue account to capital account, or who, whilst maintaining their undertakings in a high state of efficiency out of revenue have written down their capital at a rate in excess of statutory requirement, should receive special consideration. The difficulty is greatly accentuated in the case of the companies, or where both local authority and company undertakings have to be acquired by a District Board. Obviously, equality of treatment is essential, and in such cases it may be found necessary to apply Section 2 of the Electric Lighting Act, 1888. We would take the opportunity to point out that the transfer of local authority undertakings to the new District Boards should not be viewed in the light of a public purchase, but more on the lines of the setting up of a partnership.

In Clause 70 it is suggested that provision should be made whereby the District Board *may* provide compensation for displaced engineers and officials in case of hardship. We do not consider these provisions are adequate. In all cases where a power station or distributing system is transferred, thereby involving a loss to or diminution in the position of officials, a definite obligation should be placed upon the District Board to provide compensation on a fair and reasonable scale. We recommend that the scale of compensation shall be set out in any Bill that may be promoted to carry into effect the recommendations of the report, after hearing evidence from engineers and officials who may be affected.

We do not think it necessary to deal at any length with the recommendations made in regard to the use of overhead lines, wayleaves, rating, water rights, and liability for nuisance. Amendments to the existing law in these directions are considerably overdue, and we state quite definitely our opinion that it will be difficult, if not impossible, to develop a national scheme until largely extended powers are granted in these directions. We entirely support the findings of the Committee that the present position is unsatisfactory, contrary to the national interests, wasteful of fuel resources, and deprives industry of the advantages which would result from a well-devised system of generation and transmission. We are of opinion that the Commissioners should at once be appointed to assist in the preparation of the legislation necessary to give effect to the recommendations contained in the Board of Trade Committee's report. We heartily support the recommendation that assistance, both financial and otherwise, should be given by the Government, in order to ensure the early carrying out of extensions without unduly burdening the industry with high charges for interest and amortisation. In view also of the extent of possible developments, we consider the suggestion that the sinking fund should be suspended, and interest paid out of capital during the constructional period should receive support."

Profit and Output.*

Recent deplorable strikes may seem to point to lack of good will. I believe they are due mainly to misunderstanding, and want of discipline, accentuated by evil advice.

Let us consider the whole matter from the view point of our own trade, and, if possible, put ourselves in the position of a man, who, starting from the bottom, has risen to be a leading master. Let us first think of the man. He must have begun with skill and patience, as two attributes; the faculty of doggedly sticking to his job as another: and he must have possessed courage and luck. His most important step, requiring the greatest courage, was when he advanced from the ranks of those who are paid wages to the smaller ranks of those who have to pay wages. You have to experience the difference to realise the huge gulf there is between the one position and the other. It is a useful subdivision of mankind. On the one hand, the men who have wondered how they could find the means to pay next week's wages, and on the other, those who have not. As a man, he was more or less free to change his job and his place of abode, and to take advantage of chances as they turned up. As a master, he is tied to his place; he has to keep his customers in good humour, to pledge his credit, to mortgage the future when needs must and to keep his staff together in bad times to be ready for good times. When good times come, all is well, but if he does not then save money to provide for bad times, he is bound to fail. Failure means not only hard living, but the grief of seeing his valued staff leave him, because he cannot afford to keep them.

Now consider his point of view as he was before he became a master. In good times, with a good master, all was well; in good or bad times, with a bad master, all was ill. He would see bad work passed, and he would have to work with the men who did it. As a foreman, he would know that prices were cut, that stability and progress were impossible, and he would enjoy some of the advantages, and suffer some of the disadvantages of the master. Now, starting as an apprentice, the time comes when, having saved sufficient money, and gained the good will of friends, that is having established some credit, he launches out as a master. He has to acquire a shop in which to conduct his business,

* Extracts from the Presidential Address of Mr. J. S. Highfield to the Association of Supervising Electricians.

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and to buy plant, and he is at once faced with the necessity of paying standing charges. Before he can receive any revenue he has also to buy material.

In the first and second years the revenue received is likely to be less than the money paid out, and he must draw upon his savings to make ends meet, but in his third year, with luck, he should have established himself. He should have obtained sufficient business to provide a regular revenue. Out of the revenue, in addition to paying the standing charges, buying material, and paying wages for extra labour over and above his regular staff, he should first set aside every year a sum to provide for repairs to his shop, to replace worn tools, to make provision for bad debts, and some amount more in good years and less in bad ones to provide for the purchase of improved tools for the expansion of his shop and business, and to provide for the payment of his staff, and his own cost of living during very bad times. If ample provision be not made for these contingencies the business is not secure.

After these payments have been made there should remain a sum over which is the profit. If there are a number of ordinary shareholders, however, they should first receive a reasonable dividend representing the ordinary rate of interest on money invested in business, and the balance should be regarded as profit. To whom does this profit fairly belong? It belongs to those who are able and willing to shoulder the losses. These are the founders of the business, and those willing to work for small pay in the early stages and in hard times; and the shareholders who risked their savings.

As a newly established industry becomes increasingly successful, and particularly when its reserves are so large that it is as secure as any business can be, the profits should be distributed amongst those who use it; the consumer by way of reduction in price; the workpeople, including all hands by increased pay, and the shareholder by increased dividend; all fairly should benefit together.

It is abundantly clear that only out of this balance which is the real profit, can additional remuneration be made to shareholders, staff and men, or partners. It is clear that profits can be enhanced by increasing the revenue, or by reducing some or all of the items of cost. The revenue can be increased either by raising prices or increasing the volume of the business which generally means reducing prices. It is one of the most difficult problems the management has to face. To reduce cost is difficult in any well-conducted business. The best method is undoubtedly to increase the volume of work, to reduce the effect of the standing charges, and to use the greatest skill in design to reduce the cost of material.

Working Capital for Municipal Electricity Works.

An inquiry was recently held in DUBLIN into the application of the Corporation for sanction to borrow from the Bank of Ireland such sums as the L.G. Board might certify to be necessary to provide working capital for the electricity undertaking.

Mr. RICE, who appeared in support of the application, said there did not appear to be any opposition. At one time it was thought local authorities had borrowing powers under Sec. 238 of the Public Health Act, but when the matter was tested in the courts it was found that they did not possess power to borrow working capital in addition to raising loans for permanent works. They had, however, got overdrafts from banks from time to time, but the banks would not go on doing that for ever. Two councils (Lurgan and Lisburn) had obtained special powers to enable them to raise working capital; and the object of the Public Health (Borrowing Powers) Ireland Act, 1918, was to endow all local authorities with similar powers to construct works, keep them going, and pay working expenses until the returns came in. On Oct. 7 the Council resolved to apply to borrow the necessary working capital for 5 years, at 5 per cent., to carry out the business of the electricity undertaking. No sum was specified. The margin for borrowing powers on the present valuation of the city was £1,742,840. 13s. 6d., after having deducted the indebtedness. The borrowing would not have any effect on the rates. The 5 per cent. would be paid out of the profits of the electricity undertaking. No sums had come out of the rates for the last 10 or 12 years in respect of the electricity undertaking. The balance sheet for 1917–18 showed that the total expenditure was £148,195. They should be prepared to meet a four months' expenditure, which was about £49,000. They paid in weekly wages £365 and in monthly salaries £845. He urged that the Corporation should have authority to pay the bank interest on overdrafts, and for that purpose they wanted power to borrow £50,000 as the minimum. The Corporation was charging for electricity up to the maximum for which they had legal authority to private consumers.

Mr. E. W. EYRE, city treasurer, said that he had had great difficulty in pacifying the bank, because the overdraft in respect of the electricity during the three months of April, May and June ran up to £80,000 or £90,000. Taking the Corporation general account as it stood on the 15th inst., in spite of the electricity account there was a credit balance of £91,695. If the electricity debit balance were deducted from that sum there would be still a credit balance of £39,000. In face of that he thought that the bank ought not to charge a penny interest on the overdraft. He thought the amount the Electricity Committee should have power to borrow should be fixed at not less than £60,000, so that they might have a margin. Coal was an important item. The Committee had frequently to buy six months' supply in three months.

We learn that the application has been granted by the L. G. Board and the Corporation can now borrow up to £60,000 for trading capital.

The "Easifix" Lamlok Shade Carrier.

We have received particulars of the "Easifix" Lamlok shade carrier. By use of this device the removal of shades can be quickly and easily removed for cleaning and other purposes and re-attached to the holder

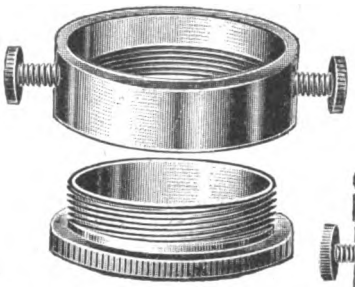

FIG. 1.—SHOWING MILLED HEAD AND SCREWS.

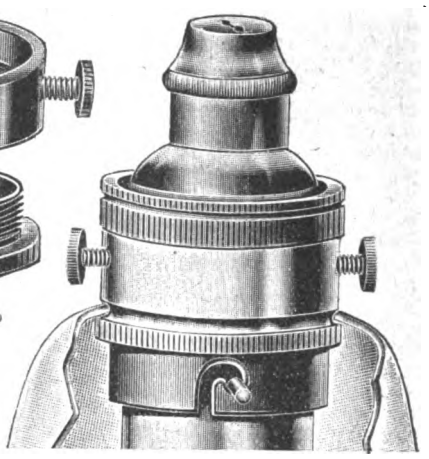

FIG. 2.—MILLED HEAD IN POSITION. SHADE IS RELEASED BY MERELY RELEASING SCREWS AND GIVING THE HEAD A TWIST.

with equal ease. A mere twist or untwist of the two little milled head screws is all that is necessary. The screws are not visible from the distance at which holders are usually seen; and thus no unsightly metal part is introduced by their adoption. The device should find ready acceptance in restaurants, hotels, offices, factories, theatres, public buildings, &c. We understand that the General Electric Company, Ltd., of 67, Queen Victoria-street, E.C. 4, have secured the sole manufacturing and selling rights of this innovation. Samples of the "Easifix" shade carrier, together with fuller particulars, will be supplied upon application.

Lincoln Electricity Works.

A L.G. Board inquiry was held at LINCOLN on Tuesday into the application of the Corporation to borrow £250,000 for electricity purposes. The Corporation propose to acquire Messrs. Clayton & Shuttleworth's electric-power station, and to extend and adapt it as a generating station for supplying power to the large engineering works in the city and for lighting, &c. The scheme was the outcome of the advice of Sir John Snell. The engineering firms are anticipating an enormous increase in industrial activities, and are contemplating very considerable extensions. One firm alone anticipated that no fewer than 2,000 houses would be required to house the additional workmen who would be employed by them. With regard to the concentration of electric-power stations, Lincoln was peculiarly situated. Nottingham, the nearest large town, was 30 miles away, and Scunthorpe was 26 miles, with little population intervening on either side. Miles of unremunerative main was out of the question, and Lincoln was undoubtedly the proper centre for a power-station. The scheme had already the approval of the Electric Power Supply Committee and the Munition Works Board.

Sir JOHN SNELL stated that, in conjunction with Mr. Charles H. Merz, he had recently completed investigations into the South Yorkshire area, including the North Lincolnshire mines, and they came to the conclusion that, unless there was a big industrial development between the situations of the generating stations on the River Trent and Rotherham and Sheffield, it would not be commercially possible to transmit energy a distance of 30 miles. Lincoln being 30 miles from any likely source of supply, the only alternative open to the city was to develop its own power supply. The present station of the Corporation was inadequate. He came to the conclusion that the proper course was for the Corporation to take the responsibility of putting down an adequate power station, which would not only supply the needs of the city in years to come, but would immediately meet the urgent demands of the great industries. Eventually, at the Corporation's request, negotiations with Messrs. Clayton & Shuttleworth for the purchase of their power station resulted in an agreement with that firm and with Messrs. Ruston & Hornsby, for the supply of power for 11 years.

The report of the SOCIEDAD COOPERATIVA TELEFONICA (Buenos Ayres) for the year ended June 30 states that net profit was $211,681, against $203,184 in preceding year. Receipts from subscribers and other sources (excluding profit on capital redemption and unpaid dividends lapsed) were $838,549, against $804,050.

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The Electric Supply Industry and the Election.

The electrical section of the Newcastle-upon-Tyne Chamber of Commerce has decided to put the following questions to local Parliamentary candidates:—

Do you agree with the policy of extensive development in the supply of electric power as a means of increasing production from the home industries, and thereby improving the prosperity and welfare of the people? In which case are you prepared to press forward immediate legislation to give effect to the necessary reform?

What are your views upon the recommendation of the Board of Trade Committee on Electric Power Supply; or the alternatives: (1) State ownership and control; (2) municipal ownership and control; (3) ownership and control by private enterprise; (4) State ownership leased to private enterprise for operation.

Legal Intelligence.

Prolongation of Patent.

Last week Mr. Justice Sargant commenced the hearing of a petition by Prof. J. A. Fleming, D.Sc., F.R.S., and Marconi's Wireless Telegraph Company, Ltd., for the prolongation of letters patent, dated Nov. 16, 1904, numbered 24,850, and granted to the former for "Improvements in Instruments for Detecting and Measuring Alternating Electric Currents."

Mr. J. Hunter Gray, K.C., and Mr. Rudolph Moritz were for petitioners; Mr. T. Terrell, K.C., Mr. Kerly, K.C., Mr. J. Austen-Cartmell and Mr. James Whitehead for the Crown; Mr. Colefax, K.C., and Mr. James Whitehead for some objectors to prolongation (the Automatic Telephone Mfg. Company, the British Thomson-Houston Company, Creed & Company, the Indo-European Telegraph Company, Siemens Brothers & Company and the Western Electric Company); and Mr. Courtney Terrell for the other objectors (De Forest Radio Telephone & Telegraph Company).

The petition set out that the scientific adviser to the petitioning company had agreed to assign to it all his wireless telegraphy patents, and the patent in question had been assigned to the company in January, 1906. The invention related to new and useful devices for converting alternating electric currents, especially high-frequency alternating electric currents or electric oscillations, into continuous electric currents, for making them detectable by, and measurable with, ordinary direct-current ammeters. The invention was particularly applicable to wireless telegraphy. In wireless telegraphy the detecting instrument was commonly called a "detector," and it enabled some indicating instrument—for example, a telephone—to respond to and thus reveal the presence of the high-frequency oscillatory currents produced in the receiving system by the transmitted electric waves. On account of their high frequency and small energy, the oscillating currents set up in the receiving antennæ could not generally affect directly any known measuring or indicating apparatus and must make their presence felt indirectly—*e.g.*, by enabling a local current to be produced or varied so as to reproduce the signals sent from the transmitting station. In the types of detectors before Fleming's invention the most useful were the "coherer," the "microphone," the "magnetic," the "electrolytic," and the "crystal," the feature common to all those being that they operated by reason of changes, more or less temporary, produced by them by the electric oscillations. While these were satisfactory for comparatively short distances, they were either too insensitive or too uncertain in action to detect the extremely small quantities of wave energy received at long distances. The invention was founded on the inventor's discovery that if two conductors were enclosed in a vessel in which a good vacuum was made, one being heated to a high temperature, the space between the hot and cold conductors possessed a unilateral electric conductivity for high-frequency oscillations, and negative electricity passed from the hot to the cold conductor, but not in the reverse direction. Fleming's detector consisted of an ordinary incandescent electric lamp, the filament of which, when raised to incandescence by a current from a battery, was the hot conductor, and of a metal cylinder arranged to surround, but not touch, the filament which was suspended from the walls of the lamp, and formed the cold conductor. The "Fleming Valve," as the result of Fleming's invention was called, enabled signals to be received with certainty at distances much greater than was possible with any previously known detector, and for some years it was universally used for long-distance signalling. The company's customers were practically confined by legislation to the International Company and the various Government Departments. The latter made little use of high-power wireless stations before the war. The Admiralty probably did make considerable use of valves, but they purchased very few from the company. In addition to the remuneration provided by an agreement referred to in the petition the company was willing to pay the inventor such a percentage of the profits made on sales as the Court might think fit during the extension period, and if the patent was extended for 14 years the inventor and the company could obtain a reimbursement and remuneration to some extent commensurate with the public value of the invention.

Mr. HUNTER GRAY, K.C., in opening the petitioners' case, said that until a comparatively recent time, for commercial purposes, signals could not be detected at a greater distance than 14 or 15 miles. He referred to the Lodge patent, and said that the 1900 Marconi patent at least doubled the distance. In 1901 the petitioners endeavoured to establish wireless telegraphy between ship and shore. To-day, the use of wireless telegraphy was of the greatest importance. A coherer was used early, consisting of two separate platinum plates with nickel filings between them. Oscillations turned the powder from a non-conductor to a conductor. One of the disadvantages was that one was not sure whether the thing would act or not, and it was also affected by thunderstorms. An improvement was made by a "tapper" which re-cohered the particles. Between 1894 and 1896 that coherer was used by Marconi in various forms. The microphone was the first improved detector which did not require a tapper, but that had its own disadvantages and was never commercially used. The electrolytic, which comprised a cell with liquid connected to a battery, generated a gas which affected the current, and that was untrustworthy, though it was used to some extent in Germany and other countries. The magnetic detector of Sir Ernest Rutherford was extensively used by the Marconi Company, and was still used in ships. It was not very sensitive and non-sensitiveness affected its capacity for taking long-distance messages. The "crystal" detector operated by what was called "rectification." By destroying the negative waves and preserving the positive waves one obtained a continuous current, and the crystal was the first rectifying detector. With a skilful operator it was successful, but it had disadvantages. Then came the invention which was the subject of the present petition. So far detectors had all involved movement of physical parts of the detectors. He explained the specification of Dr. Fleming's patent, and by means of apparatus fixed up in Court, constituting a receiving station, signals were received from both Poldhu and Chelmsford.

Mr. JOHN ST. VINCENT PLETTS, chief of the patent department of the Marconi Company, said that immediately after the 7777 patent in 1900 it was realised that, as to transatlantic communication, there was a possibility and attempts were begun almost at once to put up the necessary transmitting apparatus to see if signals could be got across the Atlantic. From that date onwards ship and shore communication increased steadily and a number of contracts for establishing communication over long distances in various parts of the world were undertaken. The long distance work ran up to several hundred miles. Stations were put up in Russia which communicated 200 to 300 miles. The system used was that of the 7777 patent and the detector a magnetic detector. Before 1909 there were a good many ship to shore installations, but a very small number compared with to-day, and they used almost exclusively the magnetic detector. The magnetic detector came in in 1902 and it very rapidly displaced the coherer. He should say that in 18 months there were very few coherers left. He thought that on one occasion signals were received across the Atlantic with a coherer, but that could not afterwards be repeated. The coherer was very sorely affected either by "atmospherics" or by one's own transmitters in the same stations. Coherers were not used in any wireless installations now. The magnetic detector still remained on many ships to-day. His company put the Fleming valve on ships because they were a more sensitive receiver and they probably would have displaced the magnetic more rapidly than they did had it not been that they were frequently burnt out by the operators using the filament at too high a pressure. He did not think that grid Fleming valves were put on board ships before the war. He knew of no other invention in connection with wireless telegraphy other than the 7777 that was so important as the Fleming. Great strides had been made since the war in wireless methods and apparatus, but those strides would not have been possible without the Fleming invention.

Cross examined by Mr. Colefax witness said that by Fleming valve he meant a valve which rectified—rectified by means of electrons. He did suggest that at the date of Fleming's patent there was novelty in the use of the device for the purpose of converting alternating electric current into unilateral current, and also in using the device for the purpose of converting low frequency alternating current into unilateral current. Before Fleming there had been no disclosure of the idea of using this valve; it was an absolutely novel idea at the date of the patent. Mr. PLETTS said he gave evidence in an arbitration between Marconi's Wireless Telegraph Company and the Helsby Wireless Telegraph Company as to the royalty to be paid for the use of Lodge's patent, which the Marconi Company had acquired. On that occasion witness stated that the patent 24,850 of 1904 (the present patent) might, and in some cases would, take the place of the magnetic detector. He was then, he said, dealing with ships, and he thought his statement was as true to-day as it was then. A statement was made in the "Year Book of Wireless Telegraph" for 1915 that long-distance wireless began in the year 1902, and that considerable progress in transatlantic work was accomplished and also in long-distance communication throughout Europe. It was the contention of the Marconi Company that all grid valves that rectified infringed Fleming's 1904 patent. During the whole lifetime of the Fleming patent the Marconi Company enjoyed in the United Kingdom a nominal monopoly in wireless telegraphy. They have had many competitors. During recent years it was approximately true they had a monopoly. There had been nothing during the life of the patent to interfere with the free use by the Marconi Company and all their customers or associated companies making use of the Fleming valve.

Cross examined by Mr. TERRELL, K.C., witness said the Marconi Company had got litigation with the Post Office for breach of contract, and they were claiming damages for loss of royalties which they would have earned under the contract, if it had not been broken, for the use of their patents, and the Fleming patent proved the most important factor in that claim, certainly from this year onwards.

Mr. J. H. GRAY, K.C. (for the Marconi Company): It is quite wrong to say royalties are being claimed. The fact is it is a percentage of the

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cost of the messages which would have been sent during the year in any particular year.

Witness further said that licences had been granted for the English or foreign patents to different other companies. The Marconi Company had shares in those other companies.

The hearing had not concluded when we went to press.

Isaacs v. Hobhouse.

On Thursday last the Court of Appeal (Lords Justices Bankes, Warrington and Scrutton), without calling upon the respondent, dismissed the application of Mr. Godfrey Isaacs, managing director of Marconi's Wireless Telegraph Company, Ltd., for a new trial of the action against Sir Charles Hobhouse for damages for alleged libel. It will be remembered that this case was heard in July, and that the jury found for defendant.

Patent Record.

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

November 14, 1918.

18,650 QUARMBY. Incandescent lamp-holders.
18,659 WESTERN ELECTRIC CO. & NASH. Telephone transmitters.
18,660 HEAFFORD & TILLEY. Instantaneous connector of electric wires.
18,661 BERRY & REID. Electric heating devices.
18,669 KRAUER. Chairs for electro-magnetic treatment of human body.
18,683 CROCHAT. Arrangement of generating groups for supply of equal number of motor groups. (14/11/17, France.)
18,689 HOLSLAG. Arc welding, &c. (30/4/18, U.S.)
18,700 SCHOLES. Switch box.
18,702 NORSK ALKALI AKTIESELSKABET. Apparatus with horizontal diaphragm for electrolysis of alkaline chlorides. (4/4/18, Norway.)
18,703 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Electro-magnetic lock-out switches.
18,713 BRITISH LIGHTING & IGNITION CO. Timing wings, &c., of magnetos.
18,714 BRITISH LIGHTING & IGNITION CO. Securing pole-shoes of magnetos.
18,715 BRITISH LIGHTING & IGNITION CO. & TURNER. Armature windings of alternating-current machines.
18,716 BRITISH LIGHTING & IGNITION CO. & TURNER. Winding armatures of magnetos.

November 15, 1918.

18,722 AUTOMATIC TELEPHONE MFG. CO. & REDFIRN. Electric sound-detecting devices.
18,740 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. & DALE. Electric switches.
18,745 HARLOW. Electrically operated signalling devices. (21/11/17, U.S.)
18,746 JOEL. Moulds and methods of casting grids for accumulator electrodes.
18,754 B. T.-H. CO. & WHITAKER. Dynamos.
18,759 BENHAM & SONS & ALLENSBY. Electric heaters.
18,760 RANKIN. Rotary switches.
18,761 BURWELL, MYERS & ITTERSON-PRONK. Electric signalling apparatus for ships, &c.
18,780 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Electro-magnetic lock-out switch.
18,792 DENTON-INGHAM. (Rolfe.) Cooling electrical machines

November 16, 1918.

18,797 STRETTLE. Trolley pole controller.
18,802 BELL. Electric switches.
18,819 BARRETT & PATE. Electric heating elements.
18,827 B. T.-H. CO. (G. E. Co.) Multi-speed alternating-current motors for ship propulsion, &c.
18,836 LATOUR. Audion or lamp relay. (17/11/17, France.)

November 18, 1918.

18,889 HEARN. Electric heating element for kindling.
18,891 NOBBS. Electric heating and cooking apparatus.
18,892 JENSEN & TILNEY. Dynamos.
18,895 DUFAUX. Direct-driven electric lighting apparatus for cycles, &c. (16/11/17, France.)
18,908 WILSON. Electrothermal arsenic refining and manufacturing furnace.
18,915 HALL. Wireless signalling apparatus.

November 19, 1918.

18,916 MURDOCH. Electrically heated strips or pads.
18,928 GARRARD, RAILING & SEARLE. Switches.
18,934 COWELL & COX. Magnetically-operated motor-controlling, &c., switches.
18,951 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO., DALE & COATES. Electric switches or circuit interrupters.
18,955 AUTOMATIC TELEPHONE CO. Automatic telephone systems.
18,957 SUCHOSTAWER. Dynamos.
18,958 SUCHOSTAWER. Producing electricity and mechanical power by permanent magnets.
18,979 KIMBER. Electric heating elements.
18,988 DENTON INGHAM. (Rolfe.) Dynamos.
19,000 ASHTON & ASTON. Dynamos.

November 20, 1918.

19,015 ROCHFORD. Electric illumination for theatrical effects.
19,031 SIEMENS BROS. DYNAMO WORKS, HOWARD & MORPHEW. Transformers.
19,037 DAY. Driving magnetos for internal combustion engines, &c.
19,040 GIMBLETTE. Electric light fittings.
19,052 B.T.-H. CO. (G.E.C.) Air-brake systems.
19,058 COLLINS. Switch-type incandescent lamp-holders.

November 21, 1918.

19,099 PRENTICE. Mounting electrical apparatus in frames or cases.
19,122 DINGLEY. Magnetos.
19,136 FIDDES-STOKES. Fixing and holding lamp shades.
19,146 HOLSLAG. Alternating-current metallic air-cutting and welding apparatus. (21/9/18, U.S.)
19,147 HOLSLAG. Electric arc welding and repairing. (11/6/18, U.S.)
19,150 LOW. Electric relays.
19,179 TAYLOR. Obtaining single phase of various periodicities from three-phase systems.
19,180 POOLE. Electric rocket connections.

November 22, 1918.

19,193 GILL. Recording visually signals received in wireless telegraphy.
19,194 HINTON. Relay contacts.
19,195 HINTON. System of wireless direction finding.
19,205 DEARLE. Holder for use in arc welding.
19,234 DUNGEY & WINGFIELD. Intercommunication telephone systems.
19,247 BORNAND & KEMP. Electrically-propelled vehicles.
19,256 WOOD. Armature winding machines.

Commercial Topics.

Iron and Steel Prices.

The Ministry of Munitions has issued schedules of prices for deliveries of pig iron and of iron and steel for export after Nov. 18 until further notice, except where priority certificates and export licences have already been obtained.

A list of the steel prices to come into operation for home deliveries on and after Feb. 1, 1919, has also been issued

* * * *

Municipal Borrowing.

Owing to the cessation of hostilities, some reduction in the national expenditure for war purposes may be anticipated, and the Government are anxious to relax as soon as possible the restrictions upon capital issues in so far as such issues are urgently necessary for the establishment of local services, trade and industry upon a peace basis. While such relaxation must necessarily in the earlier stages be of a gradual and tentative character, the L.G. Board or other appropriate department will now, in conjunction with the Treasury, be prepared to consider applications from local authorities for permission to raise loans in order to enable them to put into operation schemes of public utility, such as housing, electricity, gas and water supply, hospitals, maintenance and construction of roads, which are of urgent importance. In view of the impossibility of providing any large sums for advances from the Local Loans Fund, applications for loans from that fund cannot be considered, except in the case of the smaller authorities for very urgent services.

* * * * *

Removal of Restrictions.

The Ministry of Munitions has revoked the Cranes Order, 1916, and the Motor Engines and Vehicles Order, 1917.

The Minister of Munitions has also revoked the Shellac Control Order, 1918, as from 10th instant. The Committee of the London Shellac Trade Association has announced that the Government has come to the following decision with regard to shellac: (1) The Government stock of about 20,000 packages will be sold in accordance with the demand, the intention being to feed the market at a fair price between now and June. (2) The first public sale of 2,000 packages of such stock will be held by Messrs. Lewis & Peat on 17th inst. (3) A notice withdrawing all restrictions as regards licenses will be issued, but shipping permits to one or two countries may still be restricted.

* * * *

Ireland's Water Power Resources.

The Board of Trade have appointed the following to be a sub-committee of the Water Power Resources Committee to inquire into and report to the committee upon the subject so far as it affects Ireland :—

Sir John Purser Griffith, M.A.I., M.Inst.C.E. (chairman); Dr. J. F. Crowley (vice-chairman), Mr. Thomas M. Batchen, Mr. George Fletcher, Mr. Lawrence J. Kettle, Lord Leitrim and Mr. J. C. White. The secretary of the sub-committee is Prof. H. H. Jeffcott, B.A.I., M.Inst.C.E., M.I.M.E., to whom all communications intended for the sub-committee should be addressed at the Board of Works, Dublin.

* * * *

A Demobilisation Advisory Committee.

The Ministry of Munitions has appointed the following to be an Advisory Committee of Employers, to advise upon the Demobilisation Board of the Ministry of Munitions, the chairman of which is Sir James Stevenson, Bart.: Sir Vincent Caillard, Sir Allan Smith, Sir Herbert Rowell, Sir Wilfred Stokes, Mr. George Sutton, Mr. H. C. B. Underdown, Mr. W. L. Hichens, Sir Glynn West, Mr. Henry Summers, Mr. E. J. Brown, Mr. J. Main, Sir Harris Spencer, K.B.E., Mr. H. B. Renwick and Mr. R. G. Perry, C.B.E.

* * * *

Demobilisation and Resettlement in the City.

A Local Advisory Committee has been recently set up by the Minister of Labour in connection with the City of London Employment Exchange, 9, New Bridge-street, E.C. 4. In addition to assisting the Exchange in its extensive work of supplying suitable men and women for clerical and professional occupations in the City, the primary functions of the Committee relate to the employment of men now being discharged from H.M. Forces (including questions as to the wages which ought to be paid to disabled men) and also to the arrangements for dealing with reconstruction problems from the labour point of view. Sir T. Vansittart Bowater, Bart, is Chairman of the Committee.

* * * *

Indian Industrial Development.

In the report of the Indian Industrial Commission, which has recently been issued, it is stated that India is rich in raw materials and in industrial possibilities, but poor in manufacturing accomplishment. The deficiencies in her industrial system are such as to render her liable to foreign penetration in time of peace and to serious dangers in time of war. Her labour is inefficient, she relies almost entirely on foreign sources for foremen and supervisors, and her educated people have yet to develop a right tradition of industrialism. The necessity of securing the economic safety of the country and the inability of the people to secure it without the co-operation and stimulation of Government impose on Government a policy of energetic intervention in industrial affairs.

A long list of industries which are either lacking or are imperfectly developed, including magnetos, incandescent lamps, ferro-tungsten, "high-speed" steel, graphite crucibles, special forms of porcelain for insulators, chemical glass, certain forms of "heavy" chemicals, rubber and vulcanite, &c. It is thought that many of the difficulties experienced

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by industrialists in India will be surmounted or modified by the administartive and technical Government organisation proposed. This will at any rate ensure technical advice for the small industry, and adequate economic and scientific data for all classes of undertakings. Various recommendations are made as to financial assistance, the purchase of Government stores, &c.

* * * *

Electricity Supply.

LUTON MARKET PLACE and the Town Hall are to be illuminated electrically at an estimated cost of £54.

It is proposed to form a company for the purpose of establishing electric supply works in BALLYMONEY.

The question of obtaining a bulk supply of electricity is under the consideration of EPSOM URBAN COUNCIL.

BOLTON ELECTRICITY charges are to be increased owing to the recent awards of additional war bonus of 3s. 6d. and 5s. per week.

It is proposed to install an electric light and heating system for the asylum and town of LETTERKENNY at an estimated cost of £2,500.

The scale of BLACKBURN charges for the supply of electricity for lighting and power is to be increased by a further 15 per cent. on pre-war rates.

The restrictions upon SHOP LIGHTING have been suspended from the 9th inst. for the holiday period, provided that no extra electricity or gas is consumed.

The London County Council has sanctioned the borrowing by the FULHAM BOROUGH COUNCIL of an amount not exceeding £3,542 for dust destructor plant.

The COVENTRY charges for electric current for lighting have been increased by 20 per cent., and for power by 33⅓ per cent., for a period of three months.

NEWARK CORPORATION has decided to join with other towns in the district in getting a report from an engineer on a proposed scheme of electricity supply.

KILMARNOCK CORPORATION has received authority from the Director of Electric Power Supply to install a 5,000 kw. generator and other plant at the electricity works.

LOUGHBOROUGH CORPORATION has applied to the L. G. Board for sanction to borrow £5,000 for a new boiler at the electricity works, and £2,760 to cover excess of expenditure already incurred.

Councillor J. Thompson has been appointed chairman of the WOLVERHAMPTON ELECTRICITY COMMITTEE for the ensuing municipal year. Approval has been given to a scheme of the electrical engineer (Mr. S. T. Allen) for an overhead runway with tubs for the removal of ashes. The estimated cost is £423.

BARROW ELECTRICITY COMMITTEE has agreed to give a supply of electricity to the carriage works and engine shed of the Furness Railway Company, the works of the Barrow Hematite Steel Company and Ward's new works. The cost of the necessary switchgear and transformers will be about £1,500.

STEPNEY (LONDON) BOROUGH COUNCIL has received sanction from the London County Council to borrow an amount not exceeding £12,000 for electricity supply purposes. Of the proposed loan £9,560 is for mains, repayable within 25 years, £760 for plant, repayable in 15 years, and £1,680 for temporary works (sub-station equipment, &c.) repayable within 5 years.

In view of the removal of lighting restrictions, ARBROATH COUNCIL has asked the Arbroath Electric Light & Power Company to state the terms on which the Company would light the streets which had been formerly lit for a period of years by electricity, and also on what terms they would now undertake the lighting of those streets on the basis of the 50 per cent. lighting now allowed.

At last week's meeting of the ISLINGTON (LONDON) Borough Council the Mayor presented to Mr. James Hilton, an employee of the Council's Electric Lighting Department, with the Military Medal. The distinction was won in respect of a gallant feat in the field. Hilton, with several other men, went out to capture some German rifles left behind by the enemy. Although under fire all the time they succeeded in their task and brought back the trophies.

HARROGATE electricity department's accounts for the year ended March 31 show that the gross capital outlay is £132,973, of which £75,103 has been repaid. Revenue was £21,529 and working and general expenses were £12,625, leaving gross profit £8,904. Capital expenditure (£510) was defrayed out of revenue, and after providing for interest, instalment of loans and sinking fund there remained a surplus of £855, which has been transferred to reserve. Total maximum demand was 920 kw. Units generated were 2,264,362 and sold 1,701,277.

ACCRINGTON electricity department's accounts for the year ended March 31 show gross capital expenditure £180,076, of which £108,109 is outstanding. Revenue was £41,127 (compared with £5,352 in previous year), and working expenses were £27,743 (£34,064), leaving gross profit £13,384 (£1,711), and after providing for capital charges, &c., the the net profit was £2,777 (compared with a deficit of £9,507. Working expenses were 1·03d. (1·14d.) per unit. Maximum total demand was 3,100kw. (3,207 kw.) Units delivered to feeders were 7,777,745, and sold 6,459,900 (7,180,755).

ISLINGTON (LONDON) LIGHTING COMMITTEE has reported that in 1917 the electrical engineer (Mr. A. Gay) estimated the cost of providing additional boilers, coal bunkers, turbine and other plant for the electricity undertaking at £53,000. Owing to the delay in securing the sanction to the raising of the loan, the difficulty of obtaining satisfactory tenders and the continued rise in prices of materials and wages, a serious addition to the estimates is now necessary, an expenditure of £125,000 being essential if the statutory obligations of the Council are to be carried out, and the increasing demand for electrical energy met.

The Director of ELECTRICAL POWER SUPPLY of the Ministry of Munitions, has issued a circular to local authorities stating that in anticipation that it may shortly be found possible to permit orders to be placed for electrical plant, &c., for early post-war needs, the Ministry of Munitions is prepared to receive applications for power station and mains extensions in order that the more urgent requirements of industry, particularly in the industrial areas, may be met, so far as labour and material will allow. If any postponed extensions should now be reconsidered, he would be glad to have communications thereof. In regard to power station extensions, these should, so far as possible, conform in general with the recommendations contained in the Board of Trade Electric Power Supply Committee's report. If a number of local authorities and companies desire the erection of a power station upon which they may all draw for their supply of current, such proposals would receive consideration. As it may not be possible to meet all demands, the more urgent must receive first consideration.

Electric Traction.

LEYTON URBAN COUNCIL has decided to purchase an additional electrically propelled motor dust van from the Edison Accumulators Ltd., for £1,304.

The MANCHESTER AND SALFORD TRAMWAY EMPLOYEES have decided not to work on Christmas Day, and have refused alternative suggestions by the management for a modified service.

BURNLEY TRAMWAYS COMMITTEE has declined to accede to an application from the Amalgamated Association of Tramway Workers for a general holiday on Christmas Day for all tramway employees.

PONTYPRIDD COUNCIL has decided to proceed with the scheme for the extension of the tramways at Treforest, and the surveyor and electrical engineer have been asked to submit a report upon the matter.

At a special meeting on Monday, Blackpool Council unanimously adopted a resolution for the promotion of a Bill to acquire the undertaking of the Blackpool & Fleetwood Tramroad Co., and to extend the tramways, &c.

The employés of the GLASGOW CORPORATION object to the proposal to transfer to the Corporation Tramway Department the superannuation fund formed by the Tramways Friendly Society, and a committee has been appointed to oppose the clauses in the Corporation Bill relating to the transfer and to endeavour to secure to the employés of the department an adequate scale of pensions.

In consequence of the recent award of the Committee on Production, arising out of an application by the National Transport Workers' Federation, the Highways Committee of the LONDON COUNTY COUNCIL recommends that the award should be applied to the tramway employés concerned. The increase is 5s. a week, and the estimated cost for the remainder of the financial year is £44,000, or £110,000 for a full year.

BURY (Lancs) TRAMWAYS COMMITTEE received 42 applications for the position of manager of the Corporation tramways, and the following have been selected for interview: Charles J. Baker, traffic manager, Blackpool; Harry Beetson, chief clerk, Bury Corporation tramways department; Frank Buckley, general manager, Wigan Corporation tramways; and Albert B. Hayes, depot superintendent, Bury tramways.

Councillor Balmforth explained at the meeting of DONCASTER Council last week that the stoppage of the tramcars on two routes was due to the fact that 25 per cent. of the employees in the electricity department had been ill with influenza. By the award of the Committee on Production the employees had received an additional 5s. per week, making an increased cost to the department since 1914 of £10,000 a year. The Council would have to apply for power to raise the fares still higher.

At the meeting of the London County Council on Tuesday Mr. G. H. Hume, chairman of the Highways Committee, announced that application for the release from the Colours of tramway drivers and conductors and other members of the tramways staff had been made to the Ministry of Labour, and a deputation from the men's union had waited on the Ministers with reference to early demobilisation of pivotal men. As there was only a limited number of pivotal men, it was doubtful whether it would be possible to make any appreciable increase in the tramway service for some time, and any increase would be dependent on the coal supplies.

Imperial and Foreign Notes.

The Treasurer of Tasmania has placed £150,000 on the estimates submitted to the House of Assembly for extending the Government's hydro-electric schemes.

According to reports from NEWCASTLE (N.S.W.) an English company, with £5,000,000 capital, intends to establish works for smelting copper and the manufacture of copper wire.

Mr. H. E. Boaz has retired from the chief electrical engineer's branch of the New South Wales Government tramways department after 36 years' service, and has received gifts from his fellow officers and his staff at Dowling-street car depot.

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An additional telephone exchange, with capacity for 20,000 subscribers, and estimated to cost £78,000, is being established in the city, to be erected in Hosking-place, near Sydney, New South Wales. This will be the first automatic exchange in the city.

The proposed constitution of the AUSTRALIAN INSTITUTION OF ENGINEERS has been severely criticised by existing Australian engineering societies, including the Victorian Institute of Engineers and the Australian Institute of Mining Engineers.

The CARBON ELECTRODES supplied by the Tasmanian Government for the furnaces of the Hydro-Electric Power and Metallurgical Company, Electrona, near Hobart, have proved very unsatisfactory, as they disintegrated very quickly. The company, whose primary business is the manufacture of calcium carbide, has now commenced making its own carbons.

The ELECTROLYTIC ZINC COMPANY of Australia has given notice to the Tasmanian Government that it will require the second block of electrical energy (26,000 H.P.) which was originally estimated to be necessary for the company's works, and it is believed that in a few years the company will produce and export from 35,000 to 40,000 tons of pure zinc per annum. At present the production is 10 tons per day, and the electrical energy used 2,500 H.P.

Melbourne Council has made inquiries as to the Victorian Government's policy in regard to ELECTRIC POWER SUPPLY, this step having been taken because of the proposal of the Victoria Rolling Mills Pty., of West Melbourne, to install electric furnaces for turning out high grade steel. The engineer to the company (Mr. James Edgerton, jun.) is of opinion that the ultimate utilisation of the ironfields of Victoria is dependent upon a national supply of electric power, generated either by water-power or Morwell brown coal.

In a Bill recently submitted to the Danish "Landthing" power is conferred for the erection of a large HYDRO-ELECTRIC STATION. The power will be obtained from a suitable barrage erected upon the river Guden. It is estimated that it will be possible to obtain 600 million cubic metres of water per annum, with a fall of about 9 metres, which will yield 10 million kw., of which 8 million will be utilisable.

In the annual report of Mr Burleson, U.S.A. Postmaster General, the Government ownership of the telegraphs and telephones is advocated.

Mr. T. N. Vail, adviser to the U.S.A. Postmaster-General in ORGANISING AMERICAN TELEGRAPH SYSTEMS under Government control, has expressed the opinion that if the United States is to become a commercial and industrial world centre an American cable system consonant with its obligations and opportunities must be organised, and a system freed from its uncertainties of foreign control. There must be an American system placing the country in direct communication with every country with which America hopes to have important commercial relations, and there is immediate necessity for a cable on the east coast of South America to give America and the River Plate countries direct communication.

For the purpose of Government administration and control, the systems of the Western Union and Commercial Cable Companies, and all submarine cable systems, have been placed under the direction of Mr. Geo. G. Ward, vice-president of the Commercial Cable Company. It is also announced that the Commercial Company has brought a suit to restrain Mr. Burleson from assuming control of the company's cables.

Miscellaneous.

The Z Electric Lamp Mfg. Company, Ltd., has started a Social and Athletic Club for its staff and workers. The results achieved by the football section have been so far satisfactory. A match with the G.E.C. (Magnet) Club at Dulwich last Saturday resulted in a draw.

Mr. and Mrs. Bernard Drake entertained the heads of departments of the London offices of Drake & Gorham, Ltd., at luncheon, on the 5th inst. Mr. Drake expressed his appreciation of the way in which the staff had worked during the war, and alluded to the war contracts which the firm had carried out. These included equipments for the manufacture of explosives, poison gases, anti-submarine apparatus and power and lighting plants for camps, aerodromes and other military establishments.

The "London Gazette" of Dec. 6 contains the following alterations in the list of PROHIBITED AND RESTRICTED EXPORTS: *Delete*- (A) electric lamps (except carbon filament lamps, arc lamps for street lighting and pocket electric lamps and their parts); (A) Oiled insulating cloth, paper, silk and tape; (A) Steel containing tungsten or molybdenum and tools or other articles made from such steel; (A) Steel and steel articles containing chrome, cobalt, nickel or vanadium. *Add*--(B) Oiled insulating cloth, paper, silk and tape; (A) Steel containing chrome, cobalt, nickel or vanadium.

In the Premier's statement of the policy of the Coalition Government, it is stated that "one of the most important things the Government has in mind is the utilisation of our great mineral resources for the production of electrical power on a great scale. This will enable rural industries to be created so that workmen should find remunerative employment under conditions where they can also have a little bit of land for cultivation, and where they can bring up their children in the healthier atmosphere of the country. A great electrical power scheme would also assist in cheapening and increasing the efficiency of our town industries, so as to increase the output, diminish the cost, and thus enable all classes interested in production to benefit."

Educational.

In the faculty of engineering of UNIVERSITY OF LONDON (UNIVERSITY COLLEGE) arrangements have now been completed (1) to enable students whose courses have been interrupted by war service to resume them as nearly as possible at the point at which they left off by rejoining at the beginning of the second term (January 13, 1919). (2) To enable students who were unable to begin their engineering studies last October owing to war conditions to begin them by entering next term. For both classes of students additional work will be provided during parts of the Easter and Long Vacations, so as to enable them to get in a full session's work between January and August 1919.

Arrangements of a like kind are in contemplation in the other faculties, and will be made if a sufficient number of entries are received on or before January 6, 1919.

After a break of four years on account of the war, the Engineering Society of King's College (London) held its 21st dinner at the Trocadero Restaurant on the 6th inst. Mr. C. H. Wordingham, C.B.E., F.K.C., President of the Institution of Electrical Engineers, was in the chair, and the guests were Profs. E. G. Coker and W. J. Gandie, of University College. Principal R. M. Burrows gave an account of the work done by engineering department in training those engaged on the production of aeroplane parts, no less than 1,200 having passed through. The Aeronautical Inspection Department had been supplied by the college with 400 inspectors. The department of engineering had also been responsible for important work in connection with geological survey, the Ministry of Munitions optical and glass ware supply, and the Research Committee of the Institution of Electrical Engineers.

The chairman's reminiscences of his days spent at the college and his advice to the students were enthusiastically received. Including past and present students, about 80 were present.

The annual distribution of prizes to students of the NORTHAMPTON POLYTECHNIC INSTITUTE (Clerkenwell) took place on Saturday. The PRINCIPAL (Dr. R. Mullineux Walmsley) reported that since July 1, 1915, the Engineering Day College had devoted its energies to making munitions on a commercial scale. The workshop had produced 14,720 high precision gauges, many of them accurate to two 10-thousandths of an inch, and 43,511 gun parts for Woolwich Arsenal. Simultaneously there had been 20 courses at the Institute for training disabled soldiers and sailors. In addition, many women had been trained as optical munition workers. Another line of work had been the placing of the equipment and staff at the disposal of the Government for experimental and scientific work intended to aid the prosecution of the war. One member of the staff was lent to the Admiralty to assist in circumventing the U-boat menace. In September, 1917, there was a considerable influx of new students, quite equal to the normal peace time enrolment, for a first year's course and both first and second year courses were formed and carried through with fairly full numbers, which were a little in advance of the corresponding numbers for the preceding session. The third and fourth year courses remained suspended, as during the preceding session, although many of the students who had qualified for admission to the second year's course in July, 1917, were unable to join owing to the fact that they had reached the military age. The enrolment of students below military age from the affiliated junior technical institutes who simultaneously attended the senior institute was about equal to that of the preceding session. The evening students for 1918-19 showed a marked increase over the preceding session.

Tenders Invited and Accepted.

LIVERPOOL CORPORATION TRAMWAYS COMMITTEE invite tenders (by noon Dec. 31) for the supply of a number of motor omnibuses. Tender forms, &c., from the general manager, Mr. C. W. Mallins, M.I.A.E., 24, Hatton-garden, Liverpool.

WALTHAMSTOW URBAN COUNCIL has placed an order for two sets of apparatus for dealing with tube corrosion with the Cumberland Engineering Company for £143 each.

STRETFORD URBAN COUNCIL has accepted the tender of the British Westinghouse Company for h.t. switchgear at £2,090 and that of Bertram Thomas for l.t. switchgear at £2,482.

WALSALL Corporation has accepted the tenders of the following firms for the supply of stores to the tramways department during 1919: A. G. Engholm, P. and B. tape and Blackley tape; Hoyt Metal Company, bearing metal; National Rail & Tramway Apparatus Company, brake blocks; Anti-Attrition Metal Company, trolley wheels; P. R. Jackson & Company, armature coils; Morgan Crucible Company, carbon brushes.

Appointments Vacant.

The Council of the University of Birmingham also invite applications for the chair of chemistry, vacated by the resignation of Prof. P. F. Frankland. Stipend £1,000 a year. Applications by Feb. 8.

West Ham Education Committee invite applications for the post of Principal of the Municipal Technical Institute. Salary £600, rising to £700 per annum. Particulars from the Town Clerk.

A chief instructor of Government Technical Schools is required by the Government of Ceylon. Salary £450, rising by annual increments of £30 to £600 per annum. Applications to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1.

A lecturer in natural philosophy is required at the University, Melbourne. Salary £450 per annum. £100 allowance for travelling expenses. Applications to Agent-General for Victoria, Melbourne-buildings, Strand, W.C. 2; by Feb. 1, 1919.

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A chief lecturer in electrical engineering is required for the Rutherford Technical College. Salary £300 per annum. Applications (on forms to be obtained from the Director of Education, Mr. Percival Sharp, Education Offices, Northumberland-road, Newcastle-on-Tyne) by Dec. 20.

Applications are invited for the position of professor of physics in the University of Cape Town. Salary £800 per annum. Applications by Jan. 1 to the High Commissioner for the Union of South Africa (32, Victoria street, London, S.W.1), from whom particulars can be obtained.

Business Items.

Ernest Townson and Enoch Fairhurst, electrical engineers, 118, Bark-street, Bolton, have dissolved partnership. Debts by Mr. Townson, who continues the business in his own name.

Capt. Lucien Fialon, the well-known Parisian engineer, and representative in France of the "Paragon" Inventions and Engineering System, has been awarded the Croix de Chevalier de la Légion d'Honneur

David A. V. Rist and Herbt. Rothwell (trading as the Vulco-Magneto Company), 11, Long-acre, London, W.C., have dissolved partnership. Debts by Mr. Rothwell, who will continue the business at the same address.

Mr. C. S. Colton, for many years export manager for the British Westinghouse Electric & Mfg. Company, has recently taken up the position of managing director of the Aabada Trust, Ltd. This company, which was established in 1912, undertakes the finance and construction of public utility works, electrical apparatus, inventions and designs and general engineering undertakings. Mr. Colton has secured an expert technical staff, comprising Messrs. Alfred Dickinson & Company, as consulting engineers, and Mr. J. W. Towle, M.I.E.E., as chief of the company's engineering staff. Mr. Towle was formerly superintendent of the Metropolitan District and London Electric Railways, and later chief engineer to Ebro Irrigation Power Company, of Barcelona. Mr. Colton hopes to put on the market immediately the Aabada dry battery.

Liquidation.

The English Electrical Company, Ltd., is being wound up voluntarily and Mr. J. B. Brent, 3, Abchurch-yard, Cannon-street, London, E.C., has been appointed liquidator. A meeting of creditors will be held at 3, Abchurch-yard, on Dec. 16.

Companies' Meetings and Reports, &c.

The WESTERN UNION TELEGRAPH COMPANY, LTD., has declared a quarterly dividend of 1¾ per cent.

The accounts of the MANX ELECTRIC RAILWAY COMPANY, LTD., for the year ended Sept. 30 last show a debit balance of £31,411.

A final dividend of 11 per cent., making 20 per cent. for the year, has been declared by the Castner-Kellner Alkali Company, Ltd.

The directors of the YORKSHIRE ELECTRIC POWER COMPANY have decided to pay on the 1st prox. a final dividend of 3 per cent., being at the rate of 6 per cent. per annum, on the cumulative preference shares.

The following companies were struck off the Register of Joint Stock Companies on Dec. 6: Harold Wood Electrical & Engineering Supplies Company, Taylor & Company (Hatton Garden).

Notice is given that the 4 per cent. bearer debentures of the TELEGRAPH CONSTRUCTION & MAINTENANCE COMPANY, LTD., due for repayment on 1st prox., will be paid on and after that date at Messrs. Barclay's Bank, 54, Lombard-street, London, E.C.3.

The net profit of the CASTNER-KELLNER ALKALI COMPANY, LTD., for the year ended Sept. 30 last (after allowing for upkeep of works, and making provision for estimated liability for excess profits duty) amounted to £261,339: £45,078 was brought forward, making £306,417. The directors propose to place £50,000 to depreciation reserve, to pay a final dividend of 11 per cent., making 20 per cent. for the year, and to carry forward £48,819.

The profit of FRASER & CHALMERS, LTD., for the past year, after providing for all expenses and depreciations up to date of sale, and after making provision for excess profits duty, was £33,295, compared with £36,174 for the previous year. Negotiations are proceeding with regard to the sale of the assets of the remaining branches of the company in Canada, Australia and Singapore. Until the future policy is decided upon, all expenses have been reduced as far as practicable. The preference dividend of 7½ per cent. (less tax) for the year was paid in July, and the directors recommend a dividend at the rate of 7½ per cent., less tax, on the ordinary share capital for the year to June 30.

The directors' report of the INDIA RUBBER, GUTTA PERCHA & TELEGRAPH WORKS COMPANY, LTD., for the year ended Sept. 30 last, states that after making provision for doubtful debts and war contingencies reserve, which includes excess profits duty and munitions exchequer payments, the net profit is £143,589 and with £59,866 brought forward the total is £203,455. Deducting dividend on the preference shares paid in January and July (£12,500) and the interim dividend on the ordinary shares paid in July (£12,500) and amount placed to reserve (£50,000) the disposable balance is £128,455. The directors recommend payment of a final dividend of 15s. per share, tax free, to the ordinary shareholders, making 10 per cent for the year (£37,500), leaving to be carried forward £90,955.

At the meeting of the MONTEVIDEO TELEPHONE COMPANY, LTD., last week, Viscount St. Davids, who presided, stated that the net profit for the past year was £27,780, against £26,323 in the previous year. They had applied £9,000 to increase the reserve for renewals and had added £8,900 to the depreciation fund. They recommended the same dividend as last year—namely, 5 per cent. on the preference shares and 6 per cent. (tax free) on the ordinary shares, and they had increased the carry forward by £2,000. They had increased the number of stations by 789 for a capital outlay of £6,900. Their income from subscriptions and rentals had gone up from £78,400 to £87,000. They knew their service in Monte Video left very much to be desired. They had always wished to be allowed to put down an underground service. Without that it was impossible to give a first-rate service. They had applied for a concession, and if the Government would give them that concession they would at once put down a first-rate plant, and give a service in Monte Video at least equal to anything given anywhere else in the world.

At a meeting of the AUCKLAND ELECTRIC TRAMWAYS COMPANY, LTD., on Monday the chairman, Mr. C. G. Tegetmeier, in moving the adoption of the report and accounts (abstracted in our last issue), said the liability of the company's profits to income tax, both to the New Zealand Government and to the British Government, pressed heavily and unfairly upon the ordinary shareholders. Every ordinary shareholder, whether resident in New Zealand or in the United Kingdom, had to pay income tax on his share of the profits either directly or indirectly in both countries The system was being investigated by the New Zealand Government, and also they had the promise of the British Government that the question would be dealt with after the war. During the year expenses would be higher, the increase granted in wages being shown only to a slight extent in the present accounts, and deferred expenditure on maintenance would have to be met. The equitable course was to increase the fares, but their fares, however, were fixed by Order in Council, and it was a reasonable claim that statutory restrictions should be revised in view of present conditions.

The fifth annual meeting of the FULLER ACCUMULATOR COMPANY, LTD., was held on the 3rd inst., Mr. George Fuller, M.I.E.E., chairman of the company, presiding. He said they were still unable to give a detailed statement of their finances, due to the prolonged and complicated negotiations as to excess profits. In the meantime the directors felt justified in recommending that dividends of 10 per cent. on the preference and 15 per cent. on the ordinary shares should be paid. Their finances were in a very satisfactory state. Their turnover for the last three years had been approximately £50,000 in 1916, £150,000 in 1917, and about £280,000 in 1818. They had written £18,000 off patents and approximately £16,000 off buildings, machinery and plant, whilst, after setting aside the most they could be asked to pay for excess profits and munitions levy, they were carrying forward a substantial amount. They had greatly extended their buildings and plant, and with an eye to the future development of the company they had purchased a considerable area of additional land adjoining their works. They commenced the new year with the greatest hopefulness. The directors were optimistic men, full of enterprise and alive to all the great possibilities that lay before the company. The prospects of electrical requirements in the future were so great as to be almost overwhelming. At the close of their financial year the value of the orders on their books was over £110,000. The outlook for the sale of their products was greater than it ever was. Accumulators would be more and more necessary in the future development of the electrical trades. Among their customers were the War Office, Admiralty, Post Office, Indian and Colonial Governments, and most of the railways and mines; and amongst accumulators their block type was undoubtedly taking the foremost place. Not only had it proved most efficient in war, but its utility in industrial sevice was becoming more and more recognised: the railway companies were using them increasingly as a substitute for primary cells. A very important development in their business was the manufacture of electrical miners' lamps, in which their block cell had proved itself to be superior to the ordinary conventional plate type accumulator formerly used in such lamps. A great demand had already opened up and they had orders for many thousands of those lamps. They anticipated being very busy in the near future in supplying the greater part of the requirements of the mining industry. They had a most capable, active and willing technical staff, and one of the most up-to-date accumulator works, and therefore felt that they were well equipped to meet the flood of industrial work that the future promised. Their dividends and whatever financial successes they had had, had not been procured by any methods of cutting down wages. A modern canteen had been erected, and the catering, which had been in operation for nearly two years, was daily increasing in efficiency and appreciation. A lady welfare superintendent had been appointed and at work for a considerable time. Ambulance classes had been held and prizes awarded; there were football and rifle clubs, amusement and social committees, &c. In that spirit of kindly feeling, optimism and enterprise they commenced the year.

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, December 10, 1881.]

ELECTRIC LIGHT FOR SALISBURY.—The Town Council, having acquired the town mill with the object of preventing floods, are thinking of turning it to account to produce electricity for lighting purposes.

ELECTRIC CLOCKS IN CONSTANTINOPLE.—According to "La Lumière Electrique," a system of synchronising clocks by electricity has been introduced into the Stamboul quarter of Constantinople. Perhaps if the Turks begin by keeping time they may end by keeping faith.

CROSSING THE CHANNEL IN AN ELECTRIC BOAT.—"L'Electricité" says that the boat in which it is proposed to cross the Channel between Boulogne and Folkestone, as we noticed in a recent issue, is almost ready, and is only awaiting its electric motors, which should be ready for fixing by the 15th instant.

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CONTENTS.

NOTES	705
Arrangements for the Week	707
Regenerative Braking With Single-Phase Commutator Motors. By Dr. H. Behn-Eschenburg. Illustrated	708
The Supply of Single-Phase Power from Three-Phase Systems. Illustrated	710
Walsall Electricity Works	711
The Economics of Works Costs. By J. R. Dick, B.Sc.—*Continued.*	712
Notes on Regulations for Arc Welding	715
Water-Power in Canada	717
PSYCHOLOGY IN THE WORKS	718
REVIEWS	719
The Duplex Balance for Underground Telegraph Circuits. By M. G. Simpson. Illustrated	719
Carbon Brushes: Considered in Relation to the Design and Operation of Electrical Machinery. By P. Hunter-Brown. Illustrated	720
Government Control of Trade	722
Federation of British Industries and Peace Terms	723
Mining Machinery for Mexico	723
The Plexsim Electric Still. Illustrated	724
White Paint as an Aid to Industrial Lighting. Illustrated	724
An Electric Arc-Welding Motor Car Workshop. Illustrated	724
Industrial Lighting Fittings. Illustrated	725
The Motor Car Dictograph	725
Electricity *v.* Gas Supply	725
Patent Record	725
Volunteer Notices	725
LEGAL INTELLIGENCE	726
Commercial Topics	727
Electricity Supply	727
Educational	729
Tenders Invited and Accepted	729
Companies' Meetings and Reports	730

NOTICE.

"The Electrician" next week will be published on Tuesday instead of Friday, on account of the holidays.

Notes.

Regulations for Arc Welding.

THERE are few branches of electrical engineering which have developed with such remarkable rapidity as electric welding. Before the war this was a somewhat struggling branch of the industry, and certainly no one was sufficiently bold to dream of the welding of ships in the immediate future. The war, however, has brought about many changes and many alterations in our ideas. Among other developments, electric welding has been forced to the very forefront, and undoubtedly it will now occupy a position very different from that which it held only three or four years ago. At the same time, we cannot consider that standardised methods have yet been reached. Those who have worked keenly on the subject know very well that bad welds can be produced equally with good welds, and it is by no means easy to say just why a bad weld should be the result. Undoubtedly practical experience can achieve a great deal in the way of good work as distinct from bad. At the same time, empirical methods are by no means satisfactory, and they, of necessity, indicate a certain ignorance of the subject. In due time, no doubt, the metallurgical side of the question will be sufficiently investigated to enable us to form sound opinions. Further, there is the question of suitable regulations for the protection of individuals engaged in welding. This part of the subject was discussed at considerable length by the Institution of Electrical Engineers last week. Hitherto, no regulations have been issued by the Home Office, and it has been merely stated that users of electric welding must always adopt such precautions as may be necessary. When we come to look into the subject we find that there are two main directions in which regulations are necessary. In this connection we may neglect restrictions for protecting electricity supply systems, as this part of the subject presents the least difficulty. Where voltage fluctuations may be serious special regulations would no doubt be necessary; but on any large system we very much doubt whether serious precautions will be needed. It is otherwise, however, when we come to the individual. Here we may take first the danger of certain radiations. Protection must be provided against ultra-violet light on the one hand, and infra-red rays on the other. There would be no great difficulty in supplying suitable protection of this kind, and yet permit the welder to see the work on which he is engaged, if it were not for the fact that a very intense light is also harmful to the eyes. Consequently, very dark glasses must be adopted which render it quite difficult for the welder to see what he is doing until the arc is actually started. Then there is the further question of shock. Fortunately, the voltages required are comparatively low, and in normal dry conditions would lead to no difficulties. The difficulty is due to the fact that men may be working on staging under all sorts of weather conditions. They may be wet, and in that case will be very much more susceptible to shock than when dry. The shock itself may very possibly be a small matter; but even if a mild shock is received on a staging it may upset the balance of the worker and a dangerous fall may be the result. It will thus be seen that the whole subject is one of considerable difficulty, and a perusal of our report of the discussion, which appears in another column, will lead to the conclusion that the framing of suitable regulations will be no easy matter.

Regenerative Braking on Single-Phase Railways.

WHEN placing the order for the locomotives for the St. Gotthard Railways, the Swiss Federal Railways made it a condition that at least the weight of the locomotive should be compensated by electric braking, but left it to the designer to choose either resistance or regenerative braking. This choice renders it obvious that in the case before us the primary reason for electric braking is reduction in wear and tear on the tyres and brake blocks, and that the recuperated energy is of secondary importance. A novel method for obtaining either resistance or regenerative braking with single-phase motors has been developed by the Oerlikon Company, and a description of this method by Dr. BEHN-ESCHENBURG appears elsewhere in the present issue. Since the only additional apparatus required is a choking coil, the simplicity of the new arrangement needs little comment; and the fact that electric braking is thereby made possible at all speeds down to standstill, renders the single-phase motor much more flexible as a brake

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than the three-phase motor, which can only act as a generator when running above synchronous speed. At the end of his article, Dr. BEHN-ESCHENBURG makes the claim that, when used for the stopping of trains on a given service, useful regenerative braking results in a reduction in the total energy of 12 per cent. This claim deserves the serious consideration of all railway engineers and arouses the hope that in view of a saving of such magnitude an attempt will be made to remove the present obstacles to regenerative braking. Of these objections, only two of the most important need be mentioned here. On many railways recuperated energy has led to trouble, owing to the fact that there have been no motors needing the energy when generated; but this is surely a matter that will remedy itself in a large railway system. Secondly, the difficulty arising from production of heat in the motors during periods of braking—especially in the case of motor coaches—might be overcome by improving the means of ventilation. The problem of regenerative braking is one of the many after-war problems awaiting the attention of railway engineers in this country.

Vanishing Restrictions.

IT is with satisfaction that we note the rapidly increasing list of restrictions which are now being suspended, showing that there is a tendency to return to freedom of action and to the abolition of bureaucratic control. The sooner bureaucratic methods are abolished the better, provided this can be effected without danger. We notice, for example, that the Local Government Board is now prepared to consider applications from local authorities for permission to raise loans, assuming that these are required only on a modest scale. Then, again, consumers are now free to change from gas lighting to electric lighting without the necessity of a permit. We do not doubt that before so very long all permits of this kind will be rendered unnecessary, and that the installation of electric heating and cooking apparatus will proceed without let or hindrance. It is necessary, however, that the situation in regard to coal should be easier before this can come about. The whole position for some time to come will depend largely upon the provision of raw materials. A pamphlet on this subject has been issued by the Ministry of Reconstruction, in which it is pointed out that preference will be given to those materials on which the employment of large numbers of people depend. Thus, cotton will take precedence of timber. But there are many points that are somewhat intricate. For example, the metal trades depend to a considerable extent upon imports from Spain. As soon as German influence is able to play a part once more it may be that we shall not be able to obtain supplies from Spain as readily, or at as favourable prices, as hitherto. Again, the position of timber will necessarily be affected by the state of chaos in Russia. We may, therefore, expect control in certain directions to exist for some little time before the old conditions of freedom can be resumed.

Reconstruction Pamphlets.—The Ministry of Reconstruction has issued three more pamphlets. These deal with (1) Raw Materials and Employment, (2) Guide to Work and Benefits, and (3) Re-settlement of Civil War Workers.

Coating Cast Iron with Aluminium.—In "Metall und Erz" reference is made to a process for covering the surface of cast iron with aluminium which is said to have answered well in practice. The iron is first galvanised or coated with tin, and is then immersed in a bath of molten aluminium at a temperature of about 700°C. to 800°C. The surface is meantime scrubbed with tin brushes, and the tin or zinc on the iron surface then becomes incorporated in the melted aluminium, the surface of the iron becoming coated with aluminium instead. The coating thus formed is said to adhere very firmly.

The Oxygen Content in Steels and its Effect on Conductivity.—In a recent contribution to the "Comptes Rendus" it has been pointed out that macrographic heterogeneity in steels is to be attributed to oxygen left in a solid solution in the metal. A number of samples were treated and described, and their structure afforded evidence of the correctness of this view. The interesting statement is made that this theory of the oxygen content helps to explain the fact that the electric resistance of many steels can be calculated with very fair exactitude from a knowledge of their chemical composition.

New Alloys of Lead and Tin.—In "Metall und Erz" some particulars were recently given of several new alloys of lead and tin. The addition of a small quantity of sodium or magnesium to lead hardens it considerably. If tin is then added to either of these alloys their brittleness is diminished and the resistance to chemical action increased. An alloy of soft lead and magnesium, which is very apt to suffer surface-deterioration in moist air, is proof against such action when tin has been added. Copper is also useful as a hardening element, the percentage used, as in the case of tin, being about 5 per cent. A somewhat smaller amount of sodium or magnesium, preferably under 4 per cent., is used.

New Electric Power Works on the Danube.—The "Elektrotechnische Zeitschrift" gives some particulars of the first project to generate electricity on the Danube by water power on a large scale. This is to be located about 15 km. below Enns, north-east of Mitterskirschen. A new company is being formed to deal with the scheme, on which the Austrian Siemens-Schückert Company will be largely represented. The station will utilise a fall of 7·6 to 13·45 metres, and will comprise 17 units with a total output of 52,000 kw. to 125,000 kw., according to the level of water. It is contemplated that a considerable proportion of the power generated will be taken by [illegible].

What is an Engineer?—There have been many attempts to provide a succinct definition of an engineer. We fancy we recall a colloquial definition to the effect that an engineer is a man who can do with 1 H.P. what any fool can do with 2 H.P. Mr. A. H. Krom, director of engineering to the United States Employment Service in Chicago, has now come forward with a more comprehensive definition which, we gather, is to be regarded a standard. The definition is as follows: "An engineer is one who economically directs man power and, by scientific design, utilises the forces and materials of Nature for the benefit of mankind." This is tolerably comprehensive, and it will no doubt be gratifying to the engineer to find that his functions are not only confined to the forces of Nature but embrace the control of men.

A New Form of Variable Electric Resistance.—A recent German patent taken out by L. Strasser relates to a modification of the type of resistance in which an iron wire enclosed in hydrogen is surrounded by a heating coil. As is well known, a small change in the current flowing through the heating coil can be made to cause a very considerable change of resistance in the iron, and such resistances are claimed to have special applications for use with machines of very variable speed. The novelty embodied in the patent consists in making the heating coil of a material with a negative temperature coefficient. In this way, it is pointed out, the heating coil can be caused to bring about a much greater change in the iron wire resistance, and the sensitiveness of the apparatus is accordingly increased.

The Limits of Visibility.—Various observers have endeavoured to ascertain the smallest brightness just visible to the eye, and the minimum amount of energy entering the eye which is capable of producing the sensation of light. The quantity clearly depends on many variables, including the sensibility of the observer, and some recent experiments by Mr. Prentice Reeves suggest that the size of the luminous spot and the period of exposure are potent factors. This observer had previously arrived at the value $17{\cdot}1\times10^{-10}$ ergs per second for his own eye, the source in this case being a star 1 mm. in diameter and at a distance of 3 metres. The effect

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was thus substantially the same as a very distant light, but with surfaces subtending a much larger angle at the eye this value tends to decrease. So far as exposure is concerned, there is a rapid increase in sensibility as the exposure is increased from 0·002 to 2 seconds. After this a further exposure *seems* to have no appreciable advantage.

Radio-Telegraphy in the Air Service.—The new air service for passengers, mails and parcels delivery will begin, it is stated, in the United Kingdom and the continent of Europe. Every aeroplane will be supplied with a combined wireless and telegraph installation and an efficient operator, adopting the same system as is in force with regard to ships. As every aeroplane will doubtless have either a name or distinguishing number, it will be possible to send telegrams from any part of the world, or from any ship on the sea, to the aeroplane. It is intended that this organisation will be ready by the time peace is signed, and the relaxation of restrictions will allow the free flight of aeroplanes. Arrangements have recently been made for the erection of wireless stations in the extreme parts of China, one on the frontiers of Cashmere and the other on the Chinese side of Siberia. For this purpose machinery will have to be conveyed right across China, and transport by air will have to be arranged, for there is neither railway nor road. The Marconi Company has arranged with Mr. Handley Page for the transport by one or more of his big machines.

Coal Consumption on the Hungarian Railways.—During the war the total coal consumption in Hungary is stated to have largely increased and, what seems perhaps surprising, the proportion used on the railways is considerably greater. The total amount used for railways and other work has thus increased very greatly. Before the war the coal used per head in Hungary was smaller than that in any other European country, so that, in view of her limited supplies, the need for economy in order to meet the demands of industry is evident. It is, therefore, not surprising that Hungary, in common with other countries, is seriously considering the electrification of her railways as one of the problems of reconstruction. One factor which has no doubt accentuated the greater demand for coal on locomotives is the use of inferior substitute-materials. Thus axle bearings formerly made of tin-alloy are now made of zinc and lead; many parts formerly made of bronze are made of iron, and there appear to have been difficulties in obtaining adequate supplies of lubricating materials. All this has doubtless tended to a diminution in efficiency.

Smooth Commutators for Electrolytic Plants.—In the United States the drawbacks and merits of smooth type and undercut commutators have been the subject of some discussion. In the "Electrical World", Mr. C. F. Hutchings gives an account of some interesting experience obtained on an electrolytic plant in the Middle West. With undercut commutators it was found impossible to secure continuity of service, the period of continuous operation being less than six weeks. Machines also showed distress at slight overloads. This was ascribed to a tendency for the slot to become foul with carbon and copper dust, and to drag it across the segments, making ideal short-circuit conditions. When this happens there is no alternative but to shut down the machine. On the other hand, smooth commutator machines can be brought back to good behaviour without reducing the load by using sandpaper. The commutators in the works referred to are sandpapered each morning. It might be supposed that this would rapidly reduce the diameter of the commutator; but, as a matter of fact, they have not lost more than 1½ in. total diameter in 20 years, and seem likely to run for many years to come.

Renovating Discoloured Arc Lamp Globes.—At the present time, when arc lamp globes in the United States cost about two dollars (approx. 8s. 4d.) each, the problem of cleaning up those which have become dirty and discoloured with use is worth attention. The magnetite arc, with which such globes are largely employed, is apt to give off a metal fluff which gradually accumulates in the interior of the globe. This deposit can be cleaned off without much trouble with a little muriatic acid. A more serious matter is the discoloration which commonly takes place in globes containing traces of manganese, under the action of light. This discoloration is not merely superficial but extends into the interior of the glass and cannot, therefore, be removed by scouring. Mr. A. Herz, in an article in the "Electrical World," describes a process of baking such globes at a suitable temperature in ovens whereby, it is stated, the discoloration is completely removed in the course of about 24 hours. As the entire process, including removal of deposits, cost of gas or electricity for heating the oven and labour, only costs about 35 cents (1s. 6d.) per globe it is considered well worth while using. Globes so treated will retain their transparency sufficiently for about 75 per cent. of the time during which a new globe can be used before renewal. It may be recalled that the fact of this discolouration being removed by heat was referred to by Mr. M. Luckiesh last year.

Institution of Electrical Engineers.—At a special meeting on Thursday, Dec. 12, the president, Mr. C. H. Wordingham, made the following announcements:—

New Premium.—The Council has received from Mr. Robt. W. Paul an intimation that, having received an award from the Admiralty of a sum of £500 in respect of an anti-submarine invention, he has decided to devote that sum to the founding of a Premium for Papers read before the Institution on electrical instrument work. The Council has accepted the offer with gratitude, and will announce a scheme with regard to the matter later on.

A Memento of the Formation of the Institution.—The Council has received from Mr. A. H. Preece a letter dated Jan. 26, 1871, addressed to Mr. R. S. Culley by Mr. Frank Bolton, and stating that after considering the matter with Messrs. Siemens, L. Clark, Sabine and several others, he (Mr. Bolton) was convinced that not only had the time come for the formation of such a Society (the Society of Telegraph Engineers, the predecessor of the present Institution) but that had such a Society been formed some years previously, it could not have failed to fulfil an important mission. Following the letter was a list of gentlemen who expressed their desire to join.

Libraries in Serbia.—With a view to assisting in replacing the destroyed libraries in Serbia, the Council is presenting the bound volumes of the Institution "Journal" for the last 20 years and making a grant of £50 for the purchase of technical works by British authors, and is going to appeal to members for works on engineering. It is also suggested that manufacturers should send their catalogues in French.

The Celebration of Peace.—It has been decided to make arrangements for the celebration of peace later on in the session by some definite entertainment and reception to welcome back members who have been serving in H.M. Forces.

The Annual Dinner.—The Annual Dinner will be held again this session in April or May.

Personal.

The Board of Trade have appointed Sir John Snell to act as their adviser on all matters arising out of the report of the Electrical Power Supply Committee.

Mr. N. Carlton, president of the Western Union of Telegraph Company, has been placed in charge of the submarine cables of the United States of America.

Mr. Clifford C. Paterson is terminating his appointment at the National Physical Laboratory, Teddington, and is joining the General Electric Company, Ltd., as director of research laboratories as from Jan. 1, 1919. Pending the erection of the necessary laboratory buildings, the temporary offices and address of the research laboratories of the General Electric Company will be at the Osram Robertson Lamp Works, Hammersmith, London.

Mr. C. H. Wordingham, C.B.E., who since 1903 has been head of the Electrical Department of the Admiralty, and as such responsible for the design and supervision of the construction and completion for service of the electrical equipment of all H.M. ships, as well as for advising on all important questions of electric lighting and power in connection with dockyards and other naval shore establishments, has resigned his appointment as Director of Electrical Engineering in order to return to consulting practice. His address after Jan. 1 next will be 7, Victoria-street, Westminster, S.W. 1. Mr. Wordingham has been retained by the Admiralty in an advisory capacity.

Arrangements for the Week.

FRIDAY, Dec. 20th (to-day).

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Presidential Address by Col. R. E. B. Crompton, C.B.

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Regenerative Braking with Single-Phase Commutator Motors.

By Dr. H. BEHN-ESCHENBURG.

With the development of electric traction on main line railways electric braking, and especially regenerative braking on gradients and when stopping, has become increasingly important.

It has on occasions been considered an advantage of the three-phase system that the motors should be worked as generators without any switching-over operation. The practical use is, however, strictly limited by the fact that the speed of the train must coincide exactly with the individual synchronous speeds for the purpose of regenerating electric energy, a coincidence which with many railways rarely occurs, owing to the frequent starting up of the trains.

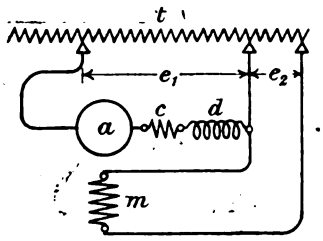

FIG. 1.

Individual mountain railways fitted with three-phase equipments have tried to eliminate this disadvantage by dispensing with this useful regeneration, mostly adopting a brake system patented by the Ateliers de Construction Oerlikon (Swiss Patent No. 20,481, of Nov. 23, 1899) which consists in the transformation of the driving motors into multiphase motors when the vehicle is on the down-grade journey—these motors being excited by means of special direct current exciters in such a manner that the current produced by the generators is consumed in brake resistances. By this means it becomes possible also to brake electrically at speeds which differ more or less from the synchronous speeds, and the brake system is made independent of the outside current supply.

In direct current railways equipped with series motors it has been customary to brake the motors electrically by using them as self-excited series generators, running on the starting resistance. Efforts and inventions to regenerate current for the trolley line by means of shunt dynamos and special excitation motors (*see*, for instance, Swiss Patent of the Ateliers de Construction Oerlikon, No. 36,123, of Feb. 14, 1916) have not been infrequent. In some recent American direct-current locomotives the success of such regenerative braking is pointed out. But here also elaborate equipments and switching operations are involved and the regeneration is reduced to narrow speed limits.

For single-phase current railways the series motor can to-day be accepted as the generally adopted driving motor. This latter is in most cases provided with a special commutating cross field in accordance with the principles of the Ateliers de Construction Oerlikon (Swiss Patent, No. 30,388, of Feb. 29, 1914). With such driving motors electric braking is made possible in a similar manner to that appertaining to direct-current series motors, as these motors can operate as self-excited direct-current generators on brake resistances. It has been proposed, for the purpose of regeneration, to excite the main field windings by means of special alternating-current exciter motors or to couple these windings through current transformers with the armature current. The first-named solution suffers through the involved type of equipment that is required; the second leads to considerable difficulties due to the necessity of suppressing the self-excitation by oscillations or periodicities foreign to the supply system.

The new orders for locomotives placed by the Swiss Federal Railways for the St. Gotthard Railway make it conditional that at least the locomotive weight should be compensated on inclines by electric braking, and it is left to the designer to choose either resistance or regenerative braking. The object of electric braking is, in the first instance, to reduce the excessive wear and tear on the tyres and brake blocks which is noticeable when mechanical braking is employed; and the question of regeneration of useful energy is not, in the first instance, considered to be of preponderating importance. On the St. Gotthard Railway, on an incline of 26 in 1,000, it should be possible to recover at the motor brushes approximately half the electric energy expended on the ascent, assuming the same train weight and the same speed.

The Ateliers de Construction Oerlikon have for some considerable time past made trials and investigations in relation to resistance braking, and also regenerative braking, in connection with their locomotives on different systems, and at the beginning of this year extremely satisfactory results were revealed, before a gathering of competent experts, in a demonstration of the useful regenerative braking of 250 B.H.P. motors. The engineers, Messrs. Lateruser, Buergi & Kristen carried out these trials.

Some little time back it became possible to simplify the wiring and switching operations appreciably, and to extend the range within which regeneration is practical, without limitations, to all loads and to all speeds down to standstill, so that part of the starting energy can also be regained without utilising for the control any gear other than the step by step switch used for standard motor equipments. Damping resistances, special super-satured reactances, current transformers, excitation equipments and phase transformers are all eliminated, and an ordinary choking coil with a predetermined reactance value is the only apparatus which is added to the standard motor installation. The ordinary series motor is transformed by the new switching diagram into a special generator or motor with new properties very suited for practical regenerative braking. The designer may decide the efficiency and power factor according to the capacity and speed involved, and the self-excitation or instability, which was regarded as a danger in connection with previous methods, is eliminated.

In the following the essential theory of the new alternating current installation is described:—

Fig. 1 represents in the usual manner the circuit of a two-pole motor or generator with a rotor *a* and the field windings *m*. *C* represents the various possible compensations or auxiliary pole windings, the exact inter-connection of which, according to some recognised plan, being for the moment disregarded as not vital to the functioning of the motor. The armature is connected in series with a choking coil *d* of suitable dimensions, and connected with adjustable pressure steps e_1 to a current transformer *t*, whilst the pole windings are connected to another suitably chosen pressure stop e_2 on the same transformer. The diagram appears on the surface to be that of an ordinary shunt motor, which everybody has hitherto regarded as unsuitable. Notwithstanding this assumption, the machine acts with a suitably dimensioned reactance *d*, in the one case as a motor, in the other as a generator, from standstill up to high speeds with a constant torque at the given pressures e_1 and e_2 and a power which increases proportionally with the speed. So far as we know, this property of electric motors has been thus realised for the first time. For a given terminal pressure the current rises from the lower limit value at standstill more quickly than the speed, and the power factor approaches to unity. The theoretical curves in Fig. 2, which refer to a generator without losses, have been drawn for three different terminal pressures, e_1, which stand in the ratio of 1 : 0·6 : 0·3,

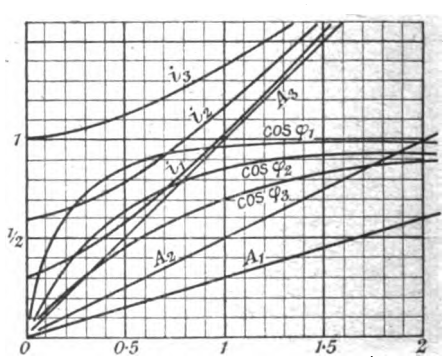

FIG. 2.

on the basic assumption of a constant excitation voltage equal to that at which the generator would rotate at the full speed 1, giving a pressure 1 at the brushes. A similar group of curves is illustrated by Fig. 2A, with constant speed and excitation, but variable terminal pressure. The curves of current, power factor and capacity are drawn for the speed, at which the voltage at the brushes amounts to 1; this voltage being represented (on the abscissa) as a function of the terminal pressure e_1 across the brushes. If we denote the total reactance formed by the armature and the choking coil together as R_1, the reactance of the pole winding as R_2, the ohmic resistances as r_1 and r_2, the current of the rotor as i_1 and that in the pole winding

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as i_2, the flux produced by the pole windings as F_2 and the electromotive force developed by the revolving armature in that flux as e_r, the speed being n, we find the following simple formulæ,*

$$i_1r_1+R_1di_1/dt\pm n\,.\,Mi_2=e_1.$$
$$i_2r_2+R_2di_2/dt=e,$$

e_1 and e_2 will be in phase; nMi_2 represents the pressure induced by rotation, or the pressure across the brushes e_r. We may therefore write

$$i_1r_1+di_1/dtR_1=e_1\pm e_r.$$

In order to simplify matters we can neglect the resistances and thus obtain

$$\frac{di_1}{dt}=\frac{e_1\pm e_r}{R_1},\quad \frac{di_2}{dt}=\frac{e_2}{R_2}.$$

The current i_1 is displaced by 90 deg. with regard to the resultant of the pressure e_1 and e_r, i_2 by 90 deg. with respect to e_r. As e_r is in

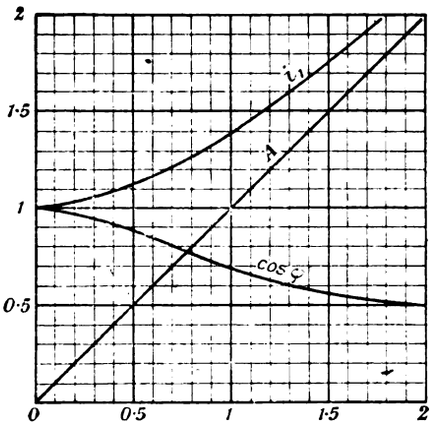

FIG. 2A.

phase with i_2, e_r must be displaced by 90 deg. with respect to e_2 and e_1. If we indicate the effective values by capital letters then we find, for the angle φ between e_1 and i_1,

$$\cos\varphi=\frac{E_r}{\sqrt{E^2_1+E^2_r}}.$$

The power developed is thus:—
$A=E_1J_1\cos\varphi$, measured at the transformer terminals.
$A=E_rJ_1\sin\varphi$, measured at the generator brushes and in general:
$A=E_1E_r/R_1$.
The torque or tractive force is therefore

$$D_r=\frac{A}{n}\,.\,716=\text{const.}\,\frac{E_1}{R_1}\,.\,Mi_2=\text{const.}\,\frac{E_1E_2}{R_1}.$$

With a given excitation and terminal pressure the torque is constant. It varies proportionally to the terminal pressure E_1 and in inverse proportion to the reactance R_1.

Characteristic values result:—

$$J_1=\frac{E_1}{R_1},\text{ for } n=0,$$
$$J_1=\frac{E_r}{R_1},\text{ for } e_1=0.$$

The power consumed in excitation e_2i_2 constitutes a loss which requires to be specially calculated or measured separately in terms of watts and voltamperes.

The vector diagram of the generator output assumes the simple form shown in Fig. 3. For operation as a motor, e_r and OA would be directed below the base line. For the machine to be of practical utility as a motor or generator it is only necessary that R_1 be chosen so large that the current i_1 at normal or maximum speed and also the induced voltage e_r which is limited by the flux F_2 and the permissible excitation current i_2, should not exceed the values for which the machine is designed. The reactance R_1 is made up of the reactions contributed by the various working parts; for instance, the choking coil, the armature, and the auxiliary pole or cross windings.

For the adjustment of the auxiliary cross fields by the auxiliary pole cross windings the same principles apply, as for series motors, due consideration being given to the phase displacement of the system, these pressures fall closer together than in the case of the pressure induced by the flux F_2 with respect to the voltage induced in the armature by its rotation. Generally speaking, with the new ordinary series motor, and therefore the means ordinarily employed to counteract the auxiliary cross field can be eliminated; for example, the connections of the cross windings of the so-called double-circuit motor can simply be short-circuited.

If one takes account of the losses in the windings occasioned by resistances r_1 and r_2, in Fig. 4, then the vector e_r is displaced by the angle φ_2 from the vertical to the right and with it in a corresponding manner the resultant OA. i_1, however, does not deviate to the left from OA by 90 deg. but by $90°-\varphi_1$, whereby we have

$$\tan\varphi_2=\frac{r_2}{\omega R_2},\ \tan\varphi_1=\frac{r_1}{\omega R_1}.$$

The angle φ increases with the angles φ_1 and φ_2 and the power factor cos φ decreases (*see* Fig. 4). We have

$$\cos\varphi=\frac{E_1\sin\varphi_1+E_r\cos(\varphi_2+\varphi_1)}{\sqrt{E^2_1+E^2_r+2E_1E_r\sin\varphi_2}}.$$

As the current in the armature and that in the pole windings are completely separated and entirely independent of each other any self-excitation is excluded, if the brushes are correctly adjusted and also if the cross windings are short-circuited. For the purpose of regulating the tractive force and speed it is only necessary to regulate the terminal pressure e_1. This is one of the main advantages of the new system, as the regulation takes place without loss, and stability is obtained without utilising special resistances. The pole windings can be connected by interior and exterior tappings to the pressure e_1 or a separate transformer can be used, and the pressure e_2 can also be made adjustable. Also the reactance R_1 can be altered and utilised for regulation purposes.

So far as properties of the motor are concerned the new arrangement does not appear to offer any advantage, as for the same capacity the weight is generally larger and the power factor smaller than in an ordinary series motor. The weight, price and losses of the choking coil employed are also additional. The conversion of an ordinary series motor with the usual connections with a view to securing working conditions as a generator for regenerative breaking relatively can be effected quite simply. The choking coil merely requires to be short-circuited and the pole windings connected to the armature. Also in passing over from regenerative braking conditions to resistance braking, which under certain conditions might be desired for a downhill journey, without retaining connection with the supply, all that is necessary is to provide a supplementary brake resistance, which can at will be included in the circuit or short-circuited. The requisite switching over or adjusting of the excitation of the auxiliary pole and compensation windings for the commutation can be executed simultaneously with the new connections of the pole-windings and the armature by putting over the reverser on the special brake position. If the reverser is put on the brake position the working of and the regulation is reduced to an adjustment of the terminal voltage and the torque by means of the controller until the desired speed is attained. Travelling backwards with the same connections, the machines now working as motors, is also possible. It is advisable to break the excitation of the field simultaneously with the restoration of the controller to the zero position.

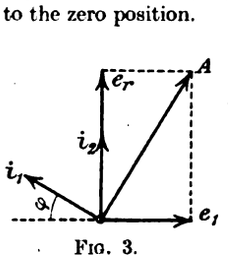

FIG. 3.

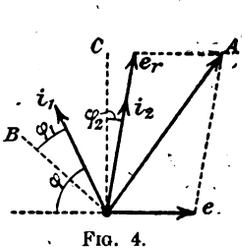

FIG. 4.

The new system renders possible electric regenerative braking at all speeds, and is especially adapted for the purpose of stopping the train, and, except for electrical and mechanical losses, the return to the supply system of the mechanical energy stored in the train; the installation requires for all this nothing in addition to the motors and the usual apparatus for the ordinary motor operation, except a simple choking coil. This simplicity, as well as the wide field of operation, places the installation in advance of all methods and equipments which have hitherto been known in connection with direct current and three-phase current equipments, and should be instrumental in securing for the single-phase current system a new and important preponderance. The functions of the system finds such clear expression in the above indicated simple formulæ and diagrams that this presentation of elaborate descriptions of tests is superfluous. A large number of measurements and observations on

* The plus or minus sign indicates whether the machine is active respectively as a motor or a generator.

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big locomotive motors and smaller stationary motors completely confirm the theoretical calculations. In the latter it seems most convenient to start from the normal motor pressure E_r, normal speed n, and the maximum permissible current i_1. The power becomes then $A = E_r J_1 \sin \varphi$. The requisite reactance R_1 of the choking coil is given by

$$R_1 = \frac{E_r}{J_1 \sin \varphi}$$

If, for instance, the energy be regained on the downward journey so as to amount to about half the normal energy consumed on the gradient, then the motor could be worked as brake generator with normal brush voltage and approximately 80 per cent. of the normal current with $\cos \varphi = 0{\cdot}8$. The overhead or rail conductor would have to supply, besides the wattless component $J_1 \sin \varphi$, also the exciter current J_2 to the motor and the transformer.

If this braking method is also adopted for the stopping of trains it will be possible to recuperate on the level some 40 per cent. of the energy required for the starting up. As this starting up energy using pressure regulation and excluding the losses in the single-phase motors amounts to approximately 30 per cent. of the energy necessary to overcome the resistance to motion of the moving train (for railways with a speed of approximately 50 km. per hour and with a distance of about 10 km. between stops), the useful regenerative braking results in a reduction of the total energy (watt-hours per ton kilometre) by approximately 12 per cent.

For direct current motors which work with starting resistances of the series-parallel type the total energy for starting up, owing to the losses in the resistance, amounts to 1·5 times that needed for single-phase motors—*i.e.*, approximately 45 per cent. of the running energy under above conditions. The use of regenerative methods hardly affects the problem. The use of continuous current involves an expenditure of 20 per cent. more energy than in the case of single-phase railways, where stops are effected with regenerative braking, even though the single-phase current motors and transformers have an efficiency 5 per cent. lower than that of the direct-current equipment.

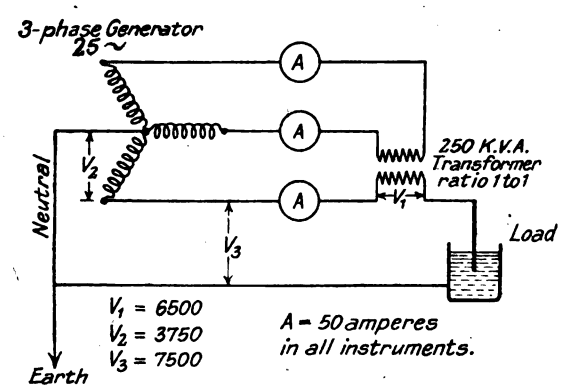
The Supply of Single-Phase Power from Three-Phase Systems.

The following is a discussion which took place at the Institution of Electrical Engineers in London on Prof. Miles Walker's Paper on the above subject. An abstract of the Paper appeared in THE ELECTRICIAN of December 13.

DISCUSSION.

Dr. S. P. SMITH said the author had done much to further this subject by developing such a balancer. He also congratulated him upon his having been awarded the degree of D.Sc. of the University of London for a thesis on this subject. He (Dr. Smith) did not want to frighten students, but the study of this subject of electric furnaces involved a great amount of work. By means of vectors, Prof. Walker had explained lucidly problems that would not otherwise have been solved without long investigation. He (Dr. Smith) illustrated on the blackboard an arrangement which he had conceived and proved by experiment, and the figures for which were given in the specification of a patent taken out by Messrs. Greaves & Etchells, for supplying two arcs in a furnace with a load from the secondary in such a manner as to get a balanced load on the primary. When using a furnace with two or three arcs one could see by an ammeter, especially during changing, that the needle swung violently at times, particularly when a shovelful of scrap was thrown on one of the arcs. The single-phase system Prof. Walker described seemed a very good arrangement. When the difficulty of obtaining adequate supplies of steel was under discussion at one time, Prof. Walker pointed out the great advantage of electrical firms using their own scrap. A single-phase furnace might be installed in reasonably large works for that purpose. That question would doubtless receive great attention in the next few years, and Dr. Walker's researches would help a good deal in that connection.

Mr. G. W. PARTRIDGE said he generated three-phase current and was a user of single-phase power. It would be interesting if the author stated his views as to the possibility of getting three phase out of single phase. The demand for single phase for traction and other purposes was so general and so likely to extend that it appeared desirable to generate single phase, which was flexible and simple in conversion and distribution. From the single-phase system, three-phase locomotives, direct-current locomotives and single-phase locomotives could all take their supply. In Switzerland it had been decided to electrify the whole of the State railways on the single-phase system. Single-phase furnaces were bound to be used, especially small ones. He imagined these could be supplied easily from an ordinary three-phase system, and more especially if the three-phase system were of any magnitude. As was well known, rotating machinery tended to balance up the current and the phases on a polyphase system. Some years ago he tried—rather too soon—to do this. The single phase was rather too heavy to deal with. They got the Brighton railway on their three-phase system, and the stopping and starting of the trains was seen on the lighting in the West End, so they had to give that up. If the single-phase demand were large, it became necessary to install the special apparatus the author had described, or have suitable damping windings of low resistance on some of the generators, so as to compensate for the pulsating armature reaction. When he first supplied single phase for traction, a thunderstorm caused short-circuiting on the overhead equipment of the Brighton railway owing to the damper windings being of too high resistance. He had known turbo-alternators to fail from the same cause. The wedges in the rotors of large machines for holding the field coils should be carefully connected together electrically. He had had experience of a motor-generator of 1,200 kw. to 1,500 kw., which was now running on a three-phase system and giving a single-phase supply. The motor-generator was independent of short-circuits, and it enabled one to improve the power factor of the main system. Some months ago he made some interesting experiments in trying to obtain a single-phase supply from a three-phase generator by the use of a static transformer. The arrangement was shown in the following diagram. They got equal current in all three phases up to 50 amperes, and then shut down and short-circuited and ran up at zero power factor, and still got 50 amperes on all four legs. He imagined such a system might be run for furnaces, and possibly for railways. An induction regulator might be fixed to regulate independently of the three-phase bus bars.



Mr. JAMES BIBBY said the use of only one arc had been claimed as an advantage of the single-phase furnace, but multiphase furnace builders did not put in a number of arcs to suit any electrical system. For refining in the open hearth there must be a sufficient number of electrodes to distribute the heat over the area of contact with the metal, otherwise there would be a cold circle on the outside, resulting in impurities going back into the metal. With regard to the liabilty of the arc to cause short-circuits, the multiphase furnace was only a series of single-phase furnaces, and short-circuits in both might be caused by the same circumstances; but in the multiphase circuit only a portion of the load was thrown off. A short fat arc was better than a long exposed one. He thought Prof. Walker had overlooked the fact that in the multiphase furnace there were two arcs in series, and they got the same line voltage as in the single-phase furnace with double the voltage. Taken over long periods, the electrode consumption with the multiphase furnace was 7 lb. per ton for melting and 3 lb. for refining. If the single-phase furnace could show a steady record of 7 lb. it deserved credit. The spherical form of furnace was not suitable for the manufacture of steel. It had not sufficient surface for contact with the slag. He did not think there was any record of a single-phase furnace being used for the manufacture of steel.

Mr. H. B. ETCHELLS said primarily he was a metallurgist, but by virtue of necessity he was an electrician. The author said: "Looking at the objects to be attained merely from the metallurgical point of view the single-phase furnace has much to recommend it." He had seen nothing to recommend it more than what he saw in the multiphase furnace. For melting, a furnace with a lining was used. The arc burrowed a crater through the steel. It did not actually get to the lining, because a certain amount of metal had collected in a small pool. So long as the arc was in the shelter of the metal round it the effect on the lining was nearly negligible; but the higher the voltage the more necessary it was to have some safeguard in series to check any short-circuit. He was completing a multiphase furnace with four electrodes and with about 2,400 kw. capacity and a maximum voltage of 95. A bigger concentration of energy could be got with a high voltage during the melting

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period than with a low voltage, without having to increase the size of the electrodes. After the metal was melted the electrodes were blazing away an arc on the surface and there was ample opportunity for radiation on to the wall of the furnace. All metallurgists would agree that the higher the actual resultant voltage on the arc the worse the lining suffered. One could have an arc of very high voltage and ample kilowatts which would leave the metal cold on the outside while vaporising in the centre. He believed that when the Schneider furnace was used for refining they came down to the same basis as all other furnaces, lowering the voltage to obviate the danger of radiating heat on to the lining. In the single-phase furnace described in the Paper he thought the open circuit voltage was about 240, and at full load it dropped to perhaps 120. That was such a bad power factor that it required fairly large loads for the actual kilowatts that one got in the arc. He had seen that morning a four-electrode furnace with 1,300 kw. behind it working at about 1,100 kw. The variation on the load was very slight, and the overall power factor of the furnace was 0·9. If furnaces could be brought to that state of efficiency in loading, he thought it was hardly necessary to go in for special rotary machinery to accomplish somewhat the same object. He did not attach much importance to the statement that the spherical design gave the maximum of efficiency. The steel fell into the bottom and got no heat. The depth of the bath should be calculated so that the steel in the bottom could be kept at a temperature that would keep it fluid. In general it was necessary for the bath to be fairly shallow relative to the diameter. The higher harmonic frequencies were damped out when one came to the high-tension side of the transformer. He believed they were wiped out a good deal by the iron. He had been wondering whether the converter Prof. Walker described wiped out those harmonic frequencies to the same extent. Did the success of the converter depend upon having a secondary circuit with a 45 deg. lag, or was it applicable to a secondary circuit with a unity power factor?

Mr. W. M. MORDEY congratulated the author on the interesting balancing transformer he described, which improved the power factor in every possible way. In Bradford, where most of the single-phase furnaces in this country were at work, there seemed to be no particular objection raised to using one-phase furnaces on the three-phase mains. He looked forward to seeing a growth of electric welding in place of rivetting which would lead to a consumption of energy probably greater than that of motors in the iron districts, and he thought that would swamp out the difficulties about using the phases separately. There was something very attractive about a one-phase furnace. Would the author give the figures on which he based his statement that the efficiency was much higher with such furnaces than with other furnaces with which it competed? Most steel makers claimed 800 units per ton of steel in the ladle. The attractiveness of the single-phase furnace was especially great in these days, when graphite electrodes were hard to obtain. They were going to have another battle of the phases, and he thought the battlefield was going to be the electric furnace. He thought it was a fact that the one-phase furnace was a practical success, and that the limiting factors would be the size and the energy that could be used per electrode. The question of the lining was very important. He imagined the steel-makers were looking to somebody to find a large cheap deposit of zirconia, which seemed to be the refractory with the greatest future. It stood 2,200°C. He was glad to hear the author's commendation of the use of static condensers for power-factor correction. He (Mr. Mordey) read a Paper many years ago dealing with that subject, and he hoped such condensers would be used instead of wasteful and expensive rotary converters.

Mr. F. H. CLOUGH said he admired the way Prof. Walker had solved the problem, but he was not quite convinced that his device was really necessary, or that power factors of 70 per cent. in a furnace were necessary. If one had a three-phase motor and a single-phase generator, such a generator could be made a constant-current machine, and practically 100 per cent. power factor could be used throughout. Single-phase voltages and currents usually had considerable distortions in the wave form, and then it was no longer justifiable to represent the condition by a single revolving vector.

Major A. M. TAYLOR called attention to a Paper recently read by Mr. F. J. Moffatt dealing with losses in furnaces. Referring to the tests of the balancer devised by Prof. Walker, it would appear that the power factor of the secondary circuit, external to the machine, is as high as 0·96. From this it is deduced that there is no external reactance, and that the whole of the reactance giving the curve shown in the Paper was contained in the secondary winding of the machine. He wondered whether the above large reactance was inseparable from the characteristics of the machine, as in certain circumstances this might prove to be a disadvantage. He noted that the power factor of the primary circuit was about 0·91 at full load; the large secondary inductance was not, therefore, entirely neutralised. This was a little disappointing if it represented the limit to which the power factor improvement could be carried. Major Taylor then pointed out that if an arc furnace could be got to work with 75 periods—and he understood that there were hundreds working in America at 60 periods—then his static frequency changer would be eminently suitable for working off systems like Glasgow, Clyde Valley, Birmingham, South Wales, Staffordshire, Derby and Notts, London Electric, &c., which worked at 25 periods. He had been working lately on a proposal which, if it fulfilled expectations, would enable a single-phase current of any periodicity whatever to be given from the secondary at unity power at a very low capital cost with high efficiency, with a perfect balance on the primary loads, with high power factor in the primary, and absolutely without any moving parts.

Assuming that the inherent reactance of Prof. Walker's balancer could be kept low, it seemed to him that a very great field was opened for such a machine, quite apart from furnace work, and he wished it every success. He did not consider, however, that the experiment quoted in the Paper proved that the balancer could deal with, say, a motor load of a poor power factor (such as 0·7), and yet give unity power factor in the primary together with a balanced load. Perhaps Prof. Walker would reply to this point, and also say how the capital cost of the balancer compared with the cost of a single-phase generator at the generating station.

Mr. H. M. SAYERS said an important practical thing in the Paper was that unless a single-phase load exceeded 20 per cent. of the whole load on the station, the unbalanced effect was not very great. Prof. Walker's machine would find many practical applications, but for many practical purposes it would not be required. The use of moving machinery for this kind of work was undoubtedly costly. He hoped Prof. Walker or somebody else would push on with the question of adapting static condensers for this purpose.

Mr. H. COATES said the Paper referred to the possibility of the dipping of the electrodes of three-phase furnaces in the steel; but there had been developed a device to prevent that, and a three-phase furnace could do its work satisfactorily without any hand control. A very good case would have to be made for the single-phase furnace to justify the initial expense for the transformers.

Mr. W. S. GIFFORD said all the original Héroult furnaces were single phase. The first three put up in England were single phase, and two had been replaced by three phase, the reason being the great difficulty and expense of running a motor-generator. For anything above 5 tons he recommended putting in a three-phase furnace, as it was desirable to have a large surface under the electrodes.

Mr. P. F. ALLAN said Prof. Walker had modestly forborne to show what might be the future effects of the principle he had developed; but he (Mr. Allan) thought it would be found that it would have a great effect in easing troubles in dealing with machinery which would be needed in linking up, especially when dealing with variable power factors.

Mr. R. G. MERCER gave particulars of Schneider and other furnaces in this country. He did not think the Schneider furnace was of use for over 3 tons. It operated beautifully, and had a low electrode consumption, and its roof and its bottom stood up very well; but the bottom electrode did not stand up well—it was relying entirely on water.

Prof. MILES WALKER, replying to the discussion, said it had been assumed that the furnace he described could only be used with one carbon on top; but, if one had a high inductance, any number of carbons could be used. So everything that had been said against the single-phase furnace on that account fell to the ground. The refractory material when white hot became a conductor of electricity, and if one went higher than 95 volts an arc formed there; therefore the voltage must be kept down. When the metal had been heaped up it was advisable to cut off on to a smaller tap and to keep on only enough power in the furnace to keep it hot. Prof. Walker reserved his full reply for the "Journal."

Walsall Electricity Works.

The Walsall Electric Supply Committee has reported on the remarks made by Councillor Talbot at the last Council meeting with regard to the interruptions to supply and the coal consumption at the Birchills power station. The report states that, with regard to stoppages in connection with new plant of any kind, difficulties must inevitably arise during the first months of working which may reasonably be expected to diminish or disappear in course of time, and the new station at Birchills has not been free from such difficulties; but the stoppages are not wholly, or even mainly, due to the station plant. Several tramway stoppages have occurred owing to the breaking of tramway wires and consequent short-circuiting. During the past three months there have been two general stoppages and five partial stoppages. The most serious one occurred on September 21st, when the tramway service was interrupted for nearly four hours, all the other services, however, being maintained. This stoppage was due to an insufficient supply of town's water, caused by the breaking of one of the South Staffordshire Water Company's mains. Even that would not have caused an interruption had it not happened to coincide with a date when one of the turbo sets was being overhauled, and arrangements have now been made whereby the supply would be maintained even in the extremely unlikely event of such a coincidence again happening. Of the other stoppages, one was due to the 250 kw. tramway rotary at Darwall-street sub-station being too small to deal with the Saturday evening load, and the Council have since approved the purchase of a new 500 kw. rotary to cope with the load. Two stoppages were due to the burning of low-grade fuel. One stoppage was primarily due to an error of judgment on the part of the charge engineer, leaving only two minor stoppages which can be referred to the station plant. One was due to the safety overspeed device being set at too near the normal running speed, and the remaining stoppage was due to a hot bearing on the auxiliary plant. In no case could the stoppage be attributed to any defect in the design or construction of the plant or station. There has been no stoppage since October 24th last, and during this period there has been the maximum load and largest output in the history of the undertaking. Until a third generating set is installed at Birchills in accordance with the original design there will always be the risk of a short interruption of supply should the running set fail in any way.

As to coal consumption, the Committee has again gone exhaustively into the matter. The records show that the results are steadily improving with the growth of the load. In the four weeks ended Novem-

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ber 17th, with poor quality coal containing 22 per cent. of ash and with 10 per cent. of coke dust, the average fuel consumption per unit sent out was 4·79 lb., and per unit generated 4·19 lb. In the Committee's report in December, 1917, it was stated that with good quality coal a maximum load of 4,000 kw. and a load factor of 30 per cent., the coal consumption would approximate 3 lb. per unit sent out. Good quality coal from this district has a calorific value of 12,600 B.Th.U. with 5 per cent. of ash. Samples analysed in November, 1918, showed the average calorific value to be 10,052 B.Th.U. with 22 per cent. of ash. The calorific value of coke dust is much lower even than this, bringing the average down to well under 10,000 B.Th. units. In spite of such poor fuel, and with a maximum load of only 2,600 kw., during the four weeks ended November 17th, taking the 8 a.m. to 4 p.m. shifts on five working days per week (*i.e.*, the best working conditions as yet obtained), the average consumption of fuel was only 3·64 lb. per unit sent out. After making proper allowance for the low value fuel with a high percentage of ash, and the fact that the turbine is only about half loaded, the above figure shows that the plant is being worked economically and is capable of 3 lb. per unit sent out when working under the stated conditions. The Technical Adviser to the Coal Controller recently inspected the station and records, and the information obtained conclusively shows that the coal consumption at Birchills is lower and the overall thermal efficiency is higher than at any of the other stations of comparable output in the West Midlands district. If the absolute figures be taken, without any reference to output or load factor, Walsall stands seventh among the 17 stations in the district. The latest returns of coal consumption at the 17 stations are given by the Coal Controller as follows: Highest consumption of coal per unit generated, 9·0 lb.; lowest, 3·19 lb.; average, 3·77 lb.; Walsall, 4·19 lb. The figures do not take into account the question of load factor. Walsall's load factor is low, and there is a much larger margin of spare plant at Walsall than at most other stations. Whilst this puts Walsall in a peculiarly favourable position for development immediately war restrictions are removed, in the meantime the coal consumption figures cannot be expected to be so good as if the station were working up to the full capacity of the running set and with a load factor equal to such places as Coventry, Wolverhampton, &c. The communication from the Coal Controller's Department stated: "The boiler-house efficiency is well above the average during the period of heavy load, but falls considerably during the period of light loads; with a good quality coal it should be possible to maintain a high efficiency even at light load, but it is difficult with some low-grade coals to maintain a high boiler efficiency at light load, due to the necessity of cutting down the draught to a point at which such fuel cannot be efficiently burnt. In addition to burning low-grade fuel, you have been helping the situation by accepting a quantity of coke breeze dust, and this again handicaps you to a certain extent during the period of light load."

The Committee's report also states that: "When it was decided in 1914 to install generating units at Birchills twice the size of those originally proposed it was fully recognised that this was a bold step to take, in view of the comparative smallness of the maximum demand at that time. This policy, however, is in process of being completely justified, and engineering opinion is now solidly in favour of large units of plant, and indeed it is doubtful whether any Government Department would now sanction the installation of small units anywhere. In spite of all handicaps, the progress of the undertaking since the installation of the two sets was completed has been eminently satisfactory. Your Committee are confident that the most difficult period is now past, and that there is an excellent future before the undertaking if the Committee are allowed to continue and develop the well-considered policy laid down five years ago."

The Economics of Works Costs.

By J. R. DICK, B.Sc.

(*Continued from page* 696.)

Summary.—This article deals with the following points:—(1) Symbolic statement of economic laws in general. (2) Law of rent in the agricultural industry. (3) Rent as a function of productivity of the soil. (4) Kelvin's law compared with law of rent. (5) Royalty for manufacturing processes a species of rent. (6) Law of diminishing productiveness in other industries besides agriculture. (7) Factory costs and their object. (8) Analysis of their components. (9) Labour charges, day-work, piecework and premium systems in relation to workman's productivity. (10) On costs or shop charges in general. Part of the oncost is a function of the productivity of the machines. (11) Hyperbolic laws of the capital cost of machines and the running expenses per unit of product. (12) Effects of increasing output. (13) Relation of machine oncost to direct labour cost. (14) Indirect labour and other shop charges. (15) Limits of accuracy in expressing oncosts generally as a linear function of the direct labour. (16) Relative values of direct labour and shop charges, with examples. (17) Establishment charges—how they are allocated. (18) Selling price inclusive of profit—how ascertained. (19) Relative importance of the cost factors. (20) Instances where materials preponderate in the cost—Cable making—Foundry work. (21) Where invested capital cost preponderates—Electricity supply.

Oncosts or Shop Charges in General.

Dealing next with the body of expenses falling under Q, which is the crucial factor in all investigations of costs, it is necessary to have a clear general perception of its relation to the primary elements S and L or the prime cost properly so called. It is common knowledge that if the output is much or little in a factory *at a given stage of development* the magnitude of Q is practically constant over a fixed period, and its value for a year or a month can be accurately ascertained. One of the great difficulties in workshop management arises, however, in its apportionment to the operations to be undertaken or to the commodities contemplated for production in that period. In effect, to arrive at the complete cost Q has to be considered as a function either of S or L or both of these prime cost elements, whose values are known, or of some new variable, such as the net time of production, whose value is also known. Looking at the constituents of Q for a machine shop, they do not appear to bear a simple relation to S. Interest and depreciation on the capital invested in stores are the chief items associated with material, and preferably these should be excluded from costs of production, and be made a charge against profits. On the other hand, Q is usually a function of L, since supervision, indirect labour, spoilt work, heating and lighting vary with the amount of the direct labour. Q contains another factor, which may or may not be directly dependent on L. This part of Q comprises the expenses debitable to the investment in machines, their setting up for the work undertaken, and the cost of power for operating them.

Machine Element in Oncosts. The Productivity of Plant and Equipment.

Where individual machines are not very discrepant in size or purpose, each workman will, on the same average money value of his wages require the same amount invested in the machine he operates, and the costs of power will be also approximately the same for each. This class of oncost can then be considered as a function of the direct labour. On the other hand, where heavy occasionally used machines are found in the same shop with small and constantly running machines a part of Q should be calculated as a function of the capital cost per machine, and the number of hours per annum it runs; and it gives more consistent results in costing to distinguish this part of the shop charges from the rest.

The question of incorporating in Q some proportion of the machine hour charges involves a little difficulty from the strict accountancy standpoint, as these charges form part of the shareholders' profits on the capital. But their inclusion in the oncost is really so valuable that it compensates for the subsequent adjustment required in the ordinary commercial books, in order to exhibit them again as a part of the gross profits. If the capital cost of a machine is I and the rate for interest depreciation and repairs is r per annum, which can be made to cover the cost of power as well, the machine will be capable of turning out N articles per annum working at full load, and the cost per article, due to the machine element, will be $c_1 = \frac{rI}{N}$.

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To increase the output a more expensive machine is later on proposed to be added, and if its annual charges are $rI(1+x)$, with a production of p_1N articles, the cost will become

$$c_2=\frac{rI(1+x)}{p_1N} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

There will be a net saving of

$$\frac{rI}{N}\left(1-\frac{1+x}{p_1}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

per piece compared with the original conditions, assuming that the change does not increase the wages of the machinist.

The total saving in cost on p_1N output is

$$p_1N \cdot \frac{rI}{N}\left(1-\frac{1+x}{p_1}\right)=rI\{p_1-(1+x)\} \quad , \quad . \quad . \quad (16)$$

where p_1 may be looked upon as the productivity of the machine. This expression would apply to a new factory or extension, where the experience with the original machine was available for guidance. If it becomes a question of the advisability of continuing to run with the older machine, when an improved design is on the market, then the effect of "scrapping" the former must be considered. In these circumstances, if V is the residual value of the first machine, the charges to be debited against the production of p_1N are

$$rI-r'V+rI(1+x),$$

r' being the annual rate of interest on V, and the cost per article is

$$c_3=\frac{rI}{p_1N}(2+x)-\frac{r'V}{p_1N} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

The saving per article is

$$\frac{rI}{N}\left(1-\frac{2+x}{p_1}\right)+\frac{r'V}{p_1N} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

and the total saving on the output p_1N is

$$rI\{p_1-(2+x)\}+r'V. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

The question of retaining or scrapping any workshop appliance can be decided commercially by evaluating (18), or (19).

If the result is positive and capital is available the change ought to be made. If the wages of the machinist (W_2) are less than before (or W_1), which is not unusual with a simplified and improved design for greater output, then there is the factor of W_1-W_2 to be added to the expression (19) when making the comparison.

Again, the choice may lie between a machine of the original type and a cheaper machine capable of furnishing the *same output* N, with greater or less annual charges for power and repairs, or for cost of attendance.

The annual charges against capital would then be $r_1I(1-x)$, where r_1 is the new rate of expenses against the investment.

The cost per article would be

$$c_4=r_1I\frac{(1-x)}{N}+\frac{W_2}{N},$$

compared with

$$\frac{rI}{N}+\frac{W_1}{N},$$

where W_1 and W_2 are the relative wages of attendance. The saving per article or the difference between these two expressions is

$$\frac{1}{N}(rI-r_1I+r_1Ix)+\frac{1}{N}(W_1-W_2),$$

and the total saving is

$$I(r-r_1)+r_1Ix+W_1-W_2.$$

This expression furnishes a criterion of the advisability of using a machine of the new type, according to whether it gives a positive or negative result, when the proper values of r, r_1, x, W_1 and W_2 are inserted.

By a suitable modification of (19) a decision as to the advantage or disadvantage of scrapping the older machine in an existing factory can also be obtained. The comparison, in different circumstances, of the financial results due to the relative amount of the machine oncosts and that of the labour charges, is an application of the economic principle called the Law of Substitution. As the name indicates, it generalises the selective processes, which the works manager employs in striving to attain minimum total costs. Thus, when labour is plentiful and cheap, he uses it in preference to scrapping old machines and adopting more efficient designs. If labour is dear or selling prices of the products are low, he reaches, sooner or later, the stage when he must substitute new labour saving devices, even if fresh capital has to be raised on onerous terms. To the reflective cost keeper, this principle of substitution will afford valuable suggestions for dealing with other problems similar to those exemplified above.

How the Efficiency of Plant is Affected by Increasing Output.

Sometimes, as we have seen, the investigation deals with a static condition of the business. But it is seldom that static conditions are permanent, as most successful businesses exhibit growth, and therefore the problem must generally include the kinematic factor p_1.

Any change with a view to an improvement in the commercial efficiency of the plant, arising from the choice of the machine units, must obviously be made in advance of the increased output p_1N. When it appears desirable to replace or add machines, the older plant is usually fully loaded with exactly the output N, and consequently when the change is made there is for a time no saving, and indeed the article may cost more until the anticipated output begins to approximate to p_1N. This can be seen at a glance from (19), for, if $p_1=1$, or the output remains at N, the value of the expression for the saving will be negative.

Thus, the evolution of efficiency in plant is marked by a series of steps at each of which the value drops below the best for a time, and then rises. The phenomenon has often confused those who have to apply Kelvin's law of efficiency of the plant employed in electric transmission. The primary statement of the law gives the best current density or rated output of a conductor for a *uniformly constant* load. If the load increases with a growing business it will be necessary to add to the section of copper and, therefore, to the cable investment, but before doing so the best value of the current density in the existing cables will be higher than originally calculated, and this value should be used, if the consequent temperature rise will not damage the cables. The second or higher value of the current density is due to the presence of fixed elements in the cost of the cables other than the cost which varies with the copper conductors themselves; and the annual cost of the energy losses must equal the annual charges against the total investment, and not that of the copper alone, before it pays to add to the amount of the investment in cables. Immediately the change is made, however, the combined efficiency of the whole of the cables will fall a little below its previous best value as we have noted above for machines in general. Intelligent anticipation in determining the machine or plant factor of oncost is thus seen to be vital in an expanding business. When a machine is not run fully loaded, and there is no prospect of enhanced output, it becomes less simple to decide when its obsolescence or antiquation involves scrapping. If the factory space is not too restricted it often pays to keep an old or inefficient machine for occasional special work. Obviously, if an output of N per annum is not reached there is no need to consider the relative efficiency of a possible output of p_1N.

In distributing the machine-hour expenses, the capital charges (interest, depreciation and repairs) are first calculated upon the total working hours per annum. From these totals is found the rate per hour, and if the cost of power per hour is added the complete charge for the use of the machine is at once available for cost keeping. The time occupied in the operation is then the independent variable for this class of oncost, instead of the money value of the labour for the same period of time.

The productivity p_1 of a machine, due to invention and development is little short of marvellous in many branches of

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industry. It is generally true, however, that, *for a definite* design, apart from a new invention, there is a limit to the increase of p_1 relative to that of $(1+x)rI$, in accordance with the law of diminishing productiveness. This circumstance determines the most efficient size of unit to provide for an increasing output, and at the same time fixes the minimum value of the machine hour part of the shop charges.

SUPERPOSITION OF THE WORKMAN'S PRODUCTIVITY ON THAT OF THE MACHINE.

In arriving at the total cost of production, the effect of the worker's productivity p has to be superimposed on that of the machine. If the machine is fully automatic and runs full time there would seem to be little scope for the workman's personality to affect the final result, but if the workman is stimulated by participation in the result, improved outputs can usually be obtained even on highly developed automatic machines. Following this idea a French engineer has suggested a bonus for the machinist based on the number of revolutions (N) of the machine, actually taken for a given piece of work, compared with the number N_1 calculated as sufficient for the normal operator. The basis of the bonus is then $(N_1-N)/N_1$, which replaces $T-t/T$ in Rowan's formula. This method of arriving at the bonus takes cognizance of the saving in interest and in the power for driving the machine, as well as the saving in labour per article. In simpler operations such as in the foundry, the productivity p_1 may be brought up to a high value, if the plant and appliances are designed to suit a particular style of repetition casting. But independently of the plant the workman's productivity can still be utilised, and in the final result a premium system based on p may multiply considerably the saving due to the correct amount of investment in plant. Herein lies the essence of all successful systems of factory organisation (or "reconstruction," using the present popular expression) so far as the workman is concerned. His operations and environment must be planned, and his remuneration must be adjusted so that with the normal amount of muscular exertion he can and will produce the maximum output in a given time.

THE COMPONENTS OF PLANT ONCOST AND THEIR VARIATIONS.

As the oncost per article attributable to the machine is a function of the capital cost I. interest, depreciation and cost of power all included in r, and the productivity p_1, or output p_1N, it is possible mathematically to determine these variables so that the oncost and the direct wages of attendance have together a minimum value. The capable works manager is accustomed to solve the problem empirically, and his solution can be made approximately right by trial and error.

The capital cost of a given type of productive machine generally conforms to a law expressed as

$$I=A+\varphi(p_1N), \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

where I is the capital cost, p_1N the output in articles or operations in a given time at full load, $\varphi(N)$ a function of N, and A a constant quantity. Dividing by p_1N

$$\frac{I}{p_1N}=\frac{A}{p_1N}+\frac{\varphi(p_1N)}{p_1N},$$

and replacing I/p_1N by i, or the capital required per unit of output, and $\varphi(N)/N$ by v,

$$i=\frac{A}{p_1N}+v. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (21)$$

It will be recognised at once from (21) that the capital required per unit of output diminishes as the rated output increases. The formula (21), whose graph is a hyperbola, is characteristic* of the cost of machines such as steam and other engines and also of many workshop tools. $\varphi(N)/N$ or v is usually constant over considerable ranges of rated output, and thus (20) can be written

$$I=A+vNp_1.$$

Many practical circumstances modify the application of a formula of this kind to the purchase and installation of machines. For example, it can seldom be guaranteed that a machine bought on this principle could be arranged to work constantly under full load.

In fact, ordinary manufacturing processes hardly permit the confining of a shop, or even one machine, to one operation, and the quantity N assumed as uniform is split up into many diverse operations of the same general type, whose annual quantities are N_1, N_2, N_3, &c. Machines cannot therefore be installed as single purpose units of large or unwieldy capacity solely with a view to their minimum capital cost, which depends on their running at full load on one standardised article. The risk of breakdown is also a potent inducement towards limiting the size of the unit of plant, apart from the difficulty of guaranteeing constant full load running throughout the year. There are some notable exceptions to this tendency to split up productive plant into units of moderate capacity. In electricity supply the product sold is the kilowatt-hour, and, as each kilowatt-hour is absolutely uniform in quality compared with any other, the desirability or necessity does not arise of splitting up the plant into units capable of an output of uncertain quantities of different things or operations. Hence the size of electric generating sets tends steadily to increase, where a growing business justifies it, so that the capital cost per kilowatt and the corresponding charges per annum tend steadily to a minimum asymptotic value as shown in (21). Careful discrimination in the capital account for plant following the principles just outlined is, of course, reflected in the permanent oncosts of interest, depreciation and repairs.

The output capacity of the unit of plant has also a direct bearing on the cost of driving power per article produced.

The amount of power required follows a law analogous to that of the capital cost.

One of the classical examples of this law is that stated by Willans for the consumption of steam in a given engine at varying loads, or

$$S=A+b\,.\,P \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (22)$$

where S is the total pounds of steam per hour, P is the horse-power, and A and b are constants. This is the equation of the Willans line.

Alternatively

$$S/P=A/P+b \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (23)$$

where S/P represents pounds of steam per horse-power hour.

The hyperbolic form (23) indicates, of course, an increase of efficiency at high loads, and similarly the advantages offered by engines of greater rated output. We have already noted that the two modes of representing phenomena of this kind always give a linear equation (22) when dealing with aggregate quantities, and an equation of the second degree (representing a hyperbola (23), when dealing with the corresponding rate per unit quantity considered. When the actual outputs are large relatively to the possible outputs the quantities of the type A/P or A/N, do not have much influence on the cost of power or the machine capital charges. In other words, the working part of the hyperbolic curve is practically a straight line, and it is therefore true that the items of the oncost represented by rI (where r also incorporates the cost of power) are directly proportional to the output p_1N, or the time required for the production of p_1N articles or operations. Thus. it is quite consistent to distribute these charges on the various operations *in direct proportion* to the times during which they occupy the machines (t). But if the rate per hour for the machinist (W_0) is approximately the same on different machines and the capital invested per machine is fairly uniform the charges may equally well be divded in proportion to the money value of the wages paid in the time t or $W_0t=L$, as we have already indicated.

INDIRECT LABOUR AND OTHER ITEMS OF ONCOST.

The treatment of the section of the oncost covering supervision and indirect labour is much simpler. The amounts coming under this section can obviously be determined relatively to the direct labour, so that a minimum value for the

* *See* Paper by Mr. Oswald Wans, Inst.Mech.Eng. ("The Engineer," Oct., 1917.)

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direct and indirect charges taken together is capable of attainment. Good supervision will facilitate the efforts of direct labour, and a plentiful supply of rough labour will avoid wasting skilled men on unsuitable work, so that there must exist a certain best ratio between the direct and the indirect labour. No general symbolic statement can be made of this problem as the data are too diverse, but for any given circumstances the problem considered as one of maxima and minima has a definite mathematical solution. This solution must be found by the light of experience, when not by calculation, if efficient operation of the workshop is to be ensured. It is apparent that the variations of the indirect labour oncost (Q_1) also follow a law of the type

$$Q_1 = B + \varphi(L) = B + hL,$$

where B and h are constants and L is the corresponding money value of the direct labour.

The quantity B is the irreducible minimum of this oncost Q_1, however small the direct labour bill L should become. Within the customary limits of variation of L in manufacturing practice B is small in comparison, and thus Q_1 may be taken as directly proportional to L or it may be distributed as a definite percentage of L.

The remaining items of the oncost—heating, lighting and the cost of small tools and general shop stores, are expressible in a similar way in two parts. One of these parts is proportional to the direct labour L, and the other is the residuum, which would exist even if L became very small. In this case again within the working limits of the variations considered the value of the oncost may be taken as directly proportional to the direct labour. Thus, except where circumstances specially demand the segregation of the machine hour costs, the standard method of allocating oncosts generally as a linear function of the direct labour is seen to be quite sound.

(To be continued.)

Notes on Regulations for Arc Welding.

At a special meeting of the Institution of Electrical Engineers on Thursday, December 12th, the President, Mr. C. H. Wordingham, said an Admiralty Committee was considering the question of electric welding, and proposed to offer advice to the Government departments concerned as to the regulations that should be made to secure the safety of operators using electric welding, and the Committee wished to be fortified with the opinion of the industry generally as to the regulations that should be made.

The following Paper was then read by the author :—

NOTES ON REGULATIONS FOR ARC WELDING.*

By H. M. SAYERS, M.I.E.E.

Electric arc welding has recently come into use for a variety of purposes and shows promise of extensive developments. The practice at present is mainly empirical. In view of the possibilities of its application to shipbuilding, one of the Admiralty Departments has set up an Electric Welding Research Committee, including a number of unofficial members representing important interests who offered to render voluntary assistance in the development of electric welding.

One of the points which has come before the Committee is the question of regulations in respect of (*a*) safety of operators, (*b*) conditions of supply; and it has been thought essential to have a discussion in order to get the views of members of the Institution on these matters.

The Home Office at present has made no regulations, but is keeping an eye on the processes, and the Board of Trade has no regulations specifically dealing with welding.

A very large and influential Research Committee has been formed in the United States. The Admiralty Committee has already drawn up a skeleton form of regulations. This Paper is therefore brought forward to introduce a discussion.

WELDING REGULATIONS.

Necessary regulations are conveniently divided into two heads :—

1. Regulations affecting the safety of operators and workers in their vicinity.

2. Regulations affecting the reliability and regulations of general supply systems.

Taking the first heading, there are two main points :—

(*a*) Protection of operators and neighbouring workers from the effect of the radiations from the arc.

(*b*) Protection from shock.

(*a*) *Protection from radiation.*—Under the first heading it is well known that the light from a naked arc has a serious effect upon the eyes and the skin. This is more serious with the iron arc than with the carbon. Arcs carrying several hundred amperes have to be reckoned with in considering protective appliances.

More difficulty arises in such work as welding the hulls of ships than in factories, for the welders must work on stages; and most, perhaps, in repair work, such as is carried on in marine and other boilers, ship spaces, &c. The object to be attained in every case is that arc radiations shall not reach the eyes or skin of either the operators or persons in the vicinity, except through screens which obstruct the injurious rays. Glass can be obtained which is practically opaque to the most injurious rays, and yet fairly transparent to ordinary light. Combinations of coloured glasses are also in use, which are fairly satisfactory.

There is no doubt a danger radius from an arc of given power, beyond which no screening is necessary in respect of eye and skin protection. But intense lights within the usual field of vision are objectionable in any working space. In repair work, especially in ship spaces, exigencies of time may require other workers to be employed close to the welders, and perhaps the only possible regulation would have to be in the general terms that efficient shielding from the arc must be employed in such cases.

(*b*) *Protection from shock.*—The pressure across a welding arc is quite low. Both for direct and alternating-current arcs it is of the order of 25 to 30 volts, but on open circuit there is the full supply pressure on the electrode. It is at this time that there is more danger of shock, and this may lead to accidents.

With direct current arcs there need be no danger if the supply conditions are properly adjusted; 100 volts is the maximum supply pressure necessary either for carbon or for metallic electrodes, including steadying resistances, and 100 volts direct current will not make a man start or stumble.

In the case of alternating-current welding the conditions are rather different; whilst the actual arc voltage as shown by a voltmeter is quite low, 30–35 volts, practice shows that a considerably greater circuit voltage must be available. It must provisionally be accepted that at least 65 volts is needed for alternating-current welding. This pressure is capable under certain conditions of giving a severe shock.

A welder will normally wear a protecting gauntlet of leather. It may perhaps be necessary to lay down the rule that for alternating-current welding the gloves must be waterproof. It is suggested that the open circuit danger can be averted by a "no current" circuit breaker in the circuit, which could be cut out by a pedal switch for the purpose of re-starting the arc.

It is submitted that both for alternating-current and direct-current welding the work should always be earthed, or connected to the earthed pole of the supply circuit.

It should be a rule that a proper hook or receptacle should be always provided for an electrode not in actual use, and should always be used. The flexible lead to the electrode must necessarily be somewhat heavy in copper section. The insulating covering must be strong and flexible. Armouring is scarcely admissible on account of weight and stiffness.

The steadying resistances must be free from fire risk and accidental contact, and the same regulations as for other similar operations should suffice.

SUPPLY REGULATIONS.

The conditions of welding are not favourable for direct supply from the mains of a supply undertaking. The cases of alternating-current and direct-current supply differ materially. Where the

* Abstract.

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general supply from the mains is direct-current from 200 volts or over, it will pay the user to put in a converting set yielding the desired voltage.

The case of occasional welding may need consideration. From the economical point of view it may pay the user to throw away 75 per cent. of the energy in resistance rather than incur the cost of a converting set. It must be expected that the work will be earthed in many cases, and it is suggested that supply engineers should tolerate this with such reservations as to power to disconnect, for testing purposes, &c., as they think necessary to protect their systems. The Board of Trade regulations will need an exception to be made in the same sense.

Where single welding units are installed, some such device as the "Langdon Davies" magnetic clutch between the motor and generator is an added protection to the plant.

ALTERNATING-CURRENT WELDING.

Where the supply is given from a multiphase system, questions of balancing arise. Obviously the simplest connection is to put the welding transformer across one phase. Where a number of welders are in use this is the simplest and most satisfactory connection, the welders being equally divided between the phases. There is, of course, the probability that unequal numbers will be in simultaneous use on the two phases, producing some unbalanced load.

With three-phase distribution single-phase current can be taken from a three-phase transformer with its secondaries connected in a particular way. This connection gives currents largely out of phase in opposite senses in two of the windings, tending to unbalance the voltage and reducing the power factor.

The whole question from the supply point of view is one of magnitude of the effect, having regard to the relative proportions of the welding load and the general load supplied by the power or substation affected. The provision of condensers or other corrective devices on the lagging-current phase may be worth while in large lay-outs.

At the present stage it seems premature to make definite regulations. Supply undertakers would be sufficiently protected by the provision that for welding plants above a certain capacity, varying with local conditions, the method of converting the supply shall be subject to their approval, which shall not be unreasonably withheld.

DISCUSSION.

Major J. CALDWELL, who was responsible for the idea of setting up the Committee, gave particulars of the position of electric welding experiments in the United States. Last year the Standards Committee of the American Institute of Electrical Engineers carried out investigations, in order to standardise spot welding. That Committee was transferred to the General Engineering Committee of the Council of National Defence. That Committee last spring obtained approval of a test specification for cast-iron chains 40 per cent. more severe than that for wrought-iron chains, and the first trial order for those cast-iron chains saved £10,000. Mr. H. M. Hobart, while attending meetings of the Standards Committee in London in November of last year, interested himself in electric welding developments here, and submitted a report on the subject to the U.S. authorities. He (Major Caldwell), on the invitation of the U.S. Shipping Board, visited America to explain the procedure adopted by the Admiralty relative to the use of electric welding at the factories and dockyards where the arc process had been applied successfully. Prof. Adams, who was President elect of the American Institute of Electrical Engineers at that time, was granted four months' leave from Harvard University and the Harvard (now Massachusetts) Institute of Technology, to devote himself to electric welding developments, and regular meetings of the mid-winter session of the American Institute had been assigned to the subject. The U.S. Shipping Board had taken over the Electric Welding Committee of the Council of Defence, and it now included representatives covering the whole field of electric welding development in America. He (Major Caldwell) visited shipyards and meetings of shipbuilders, &c., at New York, Boston, Philadelphia and Baltimore. On all such occasions it was explained how the demand for oxy-acetylene gas in this country had so enormously increased during the war that electric arc welding was taken up as a substitute, and found superior in many cases. He cited many applications of electric welding here, including the cross-Channel barge, which was then being welded entirely by electric welding, and had been a success. He found that electric welding had been utilised largely in the several services in America, and the resistance system, including butt, spot and line welding, had been used to a greater degree than in this country for heavy parts. At Schenectady the General Electric system was being used for welding three-ply 1 in. steel plates. At the Metropolitan Engineering Works, Brooklyn, 9½ in. diameter shells were formed in two parts out of 1 in. plate, with a longitudinal seam butt-welded in one operation. The necessary pressure was effected by electro-magnets. The circuit-breakers were set for 15,000 kw. Considerable use of arc welding by means of bare and flux-covered metal electrodes was limited to railway shops and welding of transformer tanks. Arc welding by carbon electrodes was employed for minor earlier work at shipyards, and the flux-covered electrode made by the Quasi-Arc Electrode Co. in America was not at the time appreciated as much as it deserved. The bare metal system of arc welding had obtained much success, especially in railroad shops. The Baltimore & Ohio had 600 electric welders, and the Grand Central also had a large number. No one method was universally adopted, but the bare metal electrode or the flux-covered electrode was used, dependent upon the conditions of electricity supply, the equipment available and the strains to which the welded part would be exposed. Capt. Jessop, of the Navy Department, and Mr. Wilson, of the Erie Railroads, with the aid of skilled welders from the railway shops, carried out many electric welding repairs on the interned German vessels.

Mr. C. R. DARLING, the chairman of the Committee, said the Research Committee was trying to secure uniformity. Sometimes a weld was good and sometimes defective, though carried out under the same conditions. That was why they were investigating with the iron arc and considering the questions of current and voltage, the use of flux and so on. Spot welding had not been used in Britain to any great extent, and a good deal of pioneer work had still to be done.

Mr. G. SCOTT RAM said he was pleased that the Research Committee had come to the conclusion that precautions were necessary as regarded the operators. Mr. Sayers had rightly pointed out that welding should come under an exemption. In the Home Office regulations it was exempted, with a proviso that such precautions as were necessary should be taken. There should be regulations for the safety of the operators and of workers in the vicinity, and in the interests of good supply. He agreed that 100 volts direct current were not dangerous, but he had found by experiments that he had not been able to let go of bare conductors at 40 volts alternating current. Electrode holders should have a handle which would prevent the hand from slipping on to the live metal. The handle should be made safe without the use of gloves. Other parts of the circuit could be well protected, especially with one wire of the system earthed. When using alternating current the transformer should be double wired. Those points were dealt with in his memorandum issued three years ago. In a case where a boy was killed by shock while assisting in the welding of a tank with current taken from one phase of a two-phase system, he (Mr. Ram) tried to reproduce the conditions, and with a high-resistance volt-meter could only get 60 volts to earth, which was probably what the boy received. With electric welding a mask or screen was necessary.

Dr. W. ROSENHAIN said regulations would be required as to how to weld and what to weld. With regard to the protection of the eyes, he agreed that most of what Mr. Sayers said regarding gelatine-filters would be applicable, but with the intense radiations of the arc they would not retain their colour or absorptive properties long. Glasses had been developed which had special and useful absorptive properties. The Committee of the Royal Society on Glass-makers' Cataract found that the radiations from furnaces were injurious, not only as regarded the ultra-violet, but also long exposure to infra-red. Sir Wm. Crookes made a number of glasses, some of which could absorb a large proportion, if not the whole, of the ultra-violet and infra-red radiations without diminishing the visible light materially. It was desirable to diminish the visible light enough to make the watching of the arc tolerable and yet not so much as to make the surroundings invisible.

Prof. E. W. MARCHANT said the liability of people's eyes to injury differed enormously. He could look at a naked arc for a minute and suffer no ill effects, but few people could do that, and the protection should be sufficient for the worst cases. The same thing held good with regard to shock. He made tests on a number of students. He found he could not give any shock to one—a black man. He (Prof. Marchant) had made tests on a motor-generator intended to operate in connection with electric welding of ships' plates. In one case, with no resistance in the circuit, with a simple arc burning straight on the machine, the voltage varied considerably with fluctuations of current. Another curve showed a similar record obtained with direct current, but with a reactance in series with the arc. It was evident from that a great advantage was gained by having a reactance in series with the arc, even with direct current. It steadied down any variations in current.

Mr. L. J. STEELE said the light intensity, apart from the deleterious effects of the ultra-violet and infra-red rays, might be injurious. He had known men in the vicinity of the welders to be injured. An eminent opthalmic surgeon, who happened to be at Haslar, emphasised the necessity of protection against the light intensity. They had not been able to get glass sufficiently translucent to enable the work to be seen at the initial stage of welding. The isochromatic screen used in photography had a gradation in depth of colour from one edge to the other. That principle might be adapted to welding, the operator looking through the transparent part at the top when starting the arc and afterwards moving the screen to the more opaque position. The hand screen would not be suitable when working on stages in shipyards, as the man must have one hand free. Making the flexible lead easily detachable from its socket might produce doubtful contact for the welding circuit, with bad effects on the welding.

Mr. A. HENDERSON said it was important to screen not only the welder, but also the men in the vicinity. Alternating current was not suitable for ship work unless great precautions were taken against shock. A slight shock might cause a man to fall off the staging. Probably continuous current would be better for overhead work.

Mr. J. SEDGWICK (Vickers, Ltd.) said he was glad the Committee were investigating the matter of current and voltage. His firm was prepared to spend about £20,000 on welding plant, and it would be disappointing if they and other firms who proposed to spend money on the development of electric welding could not get sufficient information from societies such as that as to the most desirable plant to purchase. His firm was committed now to put down plant for 60 volts and to use reactance coils in series with each welder. His firm had been fairly successful in welding

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to bulkheads the brass screws used in suspending cables, which conserved the water-tightness and saved nine out of ten minutes, which would be occupied in drilling holes for the screws.

Mr. J. H. COLLIS (Cammell, Laird & Co.) said his firm came to the conclusion that direct current was the proper thing, being safer than alternating current. He found 100 volts alternating current quite unsuitable for ship work, owing to danger of shock. The conditions under which the men worked differed so much that it seemed impossible to make a general regulation to suit all cases.

Mr. H. W. BOSWORTH said in nine cases out of ten the supply would be taken from a three-wire system, and unless you were permitted to take it from one side of the supply it would be impossible to take it from the mains at all if you had to earth the arc. In the case of a few supplies at a lower voltage, it was possible to work direct from the mains. It was easy to find out the hours of welding per year, and see whether it was justifiable to put in a motor-generator. Taking current at 1d. per unit a motor-generator was justified with 500 volts' supply for anything more than 72 hours of work per year; with 440 volts, 102 hours; 220 volts, 282 hours. With 110 volts, 2,470 hours of work were necessary to justify putting in a motor-generator. Motor-generator sets of the reducer type could not be used on a three-wire supply with an earthed neutral, and they were unsuitable to any system where the voltage was above 200, unless one pole of the supply were earthed. He had seen a Government specification for welding plant which specified that a circuit-breaker must be provided on one pole and a fuse on the other. It was safer to have both on one pole, the fuse merely acting as a stand-by, and it should also be specified that the generator shall be earthed at the negative terminal.

Mr. H. BEVAN SWIFT said the author had stated that the metallic arc was more serious in its effect than the carbon arc. He had found the reverse to be the case. The question of the arc voltage and its relative value to line voltage was largely a question of the permissible limit in the rise of the current on the short-circuiting of the electrode. With 100 volts—*i.e.*, 25 across the arc and 75 across the resistance—there was a 25 per cent. rise when the electrode was short-circuited. The 75 volts drop across the resistance showed there was a serious C^2R loss. It was a good law to have about the same amount of energy used in the resistance as consumption in the arc.

Mr. H. S. MARQUAND said it would be difficult to make hard and fast rules with regard to arc welding, and in practice it was difficult to carry them out. The difficulty was to eliminate the curious element in the workmen and the public. All that could be done was to warn people, and to limit the voltage to guard against shock. The light rays spread very much, and some men would deliberately gaze at the light. It was advisable to use a certain amount of inductance in the circuit, even with direct current. It had a good steadying effect on the arc. He would like to see a firm step made in the direction of regulating what welding should be done and under what circumstances and what ability the operators should have. Loss of life might result from passing imperfect welds.

Mr. C. C. PATERSON said it was difficult to get a screen which would enable the man to see the weld and the arc, and also his surroundings. It might be possible to devise some sort of screen with which, by lifting his head a little, he could see the work. The same difficulty had arisen in searchlight work.

Dr. PATTERSON (Swan, Hunter & Wigham Richardson) said he took exception to the statement that his firm ran their own workmen's compensation department. Firms who did not do that insured their men with outside companies. His experience was that men did not care for regulations. He had heard electric welding condemned because of rotten jobs that had been done in the past, but he saw no reason why the time should not come very shortly when the iron arc process should not be applicable to a great number of jobs, and the electrical engineers should see that they got the right kind of plant and the best advice.

Mr. J. CRICHTON said he had been connected with electric and acetylene welding some years, and there had only been one accident, and that a slight one. All the same, it was clear to him now that steps must be taken. The workman must be taken care of in the employer's interest, if not in his own. In his case it was entirely direct-current work, mostly with 25 volts, which was sufficient as a rule, though in some cases they went to 75 volts. He found welders in munition works in cubicles, but that could not be done in ship work. They often had to screen welders to keep the cold air off the work, and that should also protect those in the vicinity from the rays.

Mr. C. FARADAY PROCTOR said he had found some men were not injured by 100 volts alternating current, and some stood even higher voltage. It might be possible to choose men who would be unaffected except by very high currents.

Mr. W. R. COOPER said the capacity to stand shocks depended on the state of the individual (such as moisture on the skin), in addition to individual characteristics. With regard to the intensity of the light, that was largely a question of the adaptation of the eye. If the immediate neighbourhood of the work could be brilliantly illuminated (*e.g.*, by white-washing the metal and illuminating locally by half-watt lamps) it might be possible for the operatives to see the work before starting the weld and without interfering with the glasses.

Mr. B. LAKEMAN suggested that apparatus, especially the electrode handle, should be foolproof. There might be a spring switch which would energise a coil breaking the circuit when the electrode was laid down.

Mr. A. E. GOTT said he had had painful experiences with the stray light from the welding arc. On one occasion there was a welding arc about two yards behind him. He was in the vicinity of a wall painted green, but just on the border of the green where the wall was lime washed. It was about six hours after seeing the light that he felt the effects. It seemed to show that the rays were dispersed, outraging all the laws of reflection. Walls must be coloured with green or other absorbing colour. In considering the earthing of the arc, it was necessary, with certain classes of work, that there should be a definite polarity. If a carbon and mild steel were used, the arc must be positive and the carbons negative. The difference caused by reversing the polarity was remarkable. If doing lead work, the polarity must be reversed. If both jobs had to be done simultaneously, one would have to be taken off the centre wire of one side and the other off the other side. He had a record of a man killed by 60 volts, whereas another man could stand 2,000 volts.

Mr. W. H. SMITH (Messrs. Fry's) called attention to the necessity of welders having fireproof clothing. He could weld for several hours without ill effects, but if he passed where another man was welding he was affected.

Mr. J. T. HUSBAND said he was a boiler maker. He was chiefly concerned about the safety of the men. The men sometimes got hold of the wrong part of the electrode in picking it up. That would not have happened if they had suitable glasses. There was room for improvement in the handle of the electrode, and the protection of glasses. If proper regulations were issued for their protection he thought the men would be willing to do their bit in using the apparatus.

The AUTHOR, replying to the discussion, said he had had the same experience as Mr. Gott—catching the rays from the arc and not knowing there was anything the matter with him until hours afterwards. It was difficult to lay down regulations for working in ships and confined places, but it was necessary to have precautions everywhere. A man must take precautions against getting his clothing on fire, according to the conditions under which he was working. He agreed with Mr. Ram as to danger with alternating current of 100 volts. Regulations must be made for the weaker people. He was aware that the dye bleached out of the gelatine films, but they could be renewed. The question was what was the most efficient light in reference to the amount of energy in the radiation. The light which was most efficient as regarded absorption would come the nearest to the required conditions of seeing the surroundings and the arc.

Water-Power in Canada.

According to an article by Mr. K. H. Smith in the "Canadian Electrical News," investigations by the Nova Scotia Water Power Commission in co-operation with the Dominion Water Power Branch have revealed power sites with a total 24-hour capacity at all seasons of the year of about 100,000 H.P. Maximum advantage of all these sites may be secured due to the large storage reservoirs at each site. Under such conditions, the installation warranted for the sites in question for ordinary commercial purposes would be from two to three times the 24-hour capacity given. A number of rivers on which power sites of considerable magnitude are known to exist have not yet been investigated. At its last session the Government of Nova Scotia passed a Water Power Act designed to place the local government in control of all water-powers, with a view to removing as far as possible legal obstacles and facilitating water-power development. It is expected that regulations, worked out in co-operation with other parts of Canada, will be madeoperative at an early date.

During the past summer a water-power commission, consisting of C. O. Foss (chairman), B. M. Hill and W. E. McMullen (secretary), was organised in New Brunswick. This commission entered into a co-operative arrangement with the Dominion Water Power Branch, Interior Department, Ottawa, similar to that in operation in Nova Scotia. Attention is being concentrated in New Brunswick on hydrometric work. Although active work was not begun until August, 10 gauging stations had been established up to the end of September, and about 20 current meter measurements made. It is considered that these stations, with one or two others to be established, and those now or formerly maintained by the United States Geological Survey, will give fairly satisfactory run-off data for all parts of the province.

There has been very little actual water-power development in the Maritime provinces recently. In Nova Scotia a water-power plant supplying the town at Oxford has been improved and enlarged, including the construction of a steam reserve plant to utilise mill waste near at hand. The village of Lawrencetown, Annapolis County, is installing a water-power plant on the Annapolis River to replace a steam generating plant, the cost of operating which was found prohibitive. The town of Annapolis Royal has also made a start towards increasing the storage capacity of their municipal water-power plant. Middleton recently erected a water-power plant about 3 miles from the town to replace a gas-producer generating station. In addition to its former lighting load, the town is now supplying industrial power. In New Brunswick a small water-power development was completed some months ago to supply lighting and industrial power in small amounts for the towns of Rexton and Richibucto. At present a 2,000 kw. hydro-electric station is being built on the Madawaska river at Edmundston. This development is intended to supply power for a large sulphite mill. In general, it may be said that never before in the Maritime provinces were so many major power projects under consideration, and it seems probable that considerable development will take place at the first favourable opportunity.

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Psychology in the Works.

At one time psychology was regarded as a doubtful kind of science and one which had better be avoided rather than cultivated. Probably this was due to the fact that the term has often been used vaguely. For example, newspapers refer from time to time to the "psychology" of the Germans, when they really mean the mental attitude of the Germans. Further, many people regard psychology as something akin to psychic phenomena. Modern psychology, however, is quite a precise line of investigation, and deals, for example, with such questions as fatigue on an experimental basis. Thus it is becoming a subject which is not merely interesting, but of considerable importance.

The subject of fatigue may be considered from two points of view. Firstly, it may be investigated experimentally to determine when fatigue in any kind of work becomes serious and leads to practical inefficiency. Secondly, the operations in any process may be investigated in order to see whether they can be so modified as to reduce the amount of fatigue. This part of the subject is often called "motion study," and has received more attention in the United States than in Great Britain. For this purpose the chronocyclegraph has been employed, and consists essentially in the attachment of an electric lamp to the moving limb, so that its movements can be recorded photographically. Labour in this country has looked upon such methods as being undesirable, and merely as a means of speeding-up the worker. There is no reason, however, to regard such investigations from this point of view, because if the movements can be modified so as to lead to less fatigue it is obviously better for the worker as well as for his work. In this connection it must be remembered that unnecessary movements are merely work that is unproductive. High wages are rendered possible only by high productivity; that is, by increasing the value of the raw material through the labour expended theron. Unnecessary movements not merely add to the fatigue of the worker, but they lower the productivity, and thus a lower limit is set on the wages that may be paid than would otherwise be the case.

An interesting little book* has appeared recently by Dr. C. S. MYERS dealing with this subject. We cannot go into the exact methods that are adopted in such investigations. It is sufficient to say that they give a means of determining fatigue, and enable the investigator to decide whether better results are obtainable by changing the mode of working, or possibly the worker. Several interesting examples are given of what may be called the increase in efficiency of the human machine by working it on the most economical load. For example, in shovelling it is fairly obvious that if a very small shovel is used the output will be poor; and, equally, if a very large shovel is employed fully loaded the output may again be poor. Between these two extremes, however, there is some weight which is the best, and this has been found to be 21 lb. Consequently, shovels have been made of different capacities for different materials, so that the fully loaded weight in every case is about 21 lb. The results so obtained have been remarkable. The average amount shovelled daily rose by nearly 270 per cent., so that 150 men were able to carry out work previously performed by 500 men. Moreover, the average earnings of the shovellers increased by 60 per cent., and the cost to the management was reduced by 50 per cent.

One of the methods of investigation that is followed is that known as the "reaction time," which is the time taken for the required response to be made by the individual. By this method the girls in a bicycle ball factory were tested as to their suitability for inspecting balls for flaws. This work requires good powers of observation and quick reaction. By employing only the most suitable workers, it was found that 35 could do work which had previously been carried out by 120, and the hours of work were reduced from 10½ to 8½ hours per day, with two days' holiday per month, and their wages were increased by nearly 100 per cent. Moreover, the accuracy of the work was increased by two-thirds, and there was a large decrease in the cost of production of the balls. This shows the great importance of employing individuals at work for which they are really fitted. It is interesting to note that some of the most intelligent, industrious and honest of the girls were found unsuited to this work, and were transferred to a more suitable occupation. Thus the square pegs in round holes were discovered.

Another point that has been brought out by such investigations is the necessity for periods of rest at stated intervals if the best results are to be obtained. An unbroken morning or afternoon's work of four or more hours is economically unsound, so that the systematic introduction of rest pauses will often lead to a great improvement in the quantity and quality of work. This point is illustrated in a competition between two companies engaged in trench digging. The officer of one divided his company into three sections, of which each worked successively for five minutes and rested for 10 minutes. The officer of the second company allowed his men to work uninterruptedly until their condition demanded a rest. The result was an easy win for the company which worked with systematic rests of 10 minutes.

Apart from the little volume before us, which also deals with other forms of psychological investigations having no bearing on works management, it would be well for engineers to bear in mind the various memoranda issued by the Health of Munition Workers Committee, and to read the valuable Report by Dr. A. F. STANLEY KENT, which was issued by the Home Office in 1916, and which deals with the investigation of industrial fatigue by physiological methods. In this Report the great importance of rest is emphasised. It is shown that overtime, when performed by tired workers, results in an amount of fatigue out of all proportion to the length and severity of the labour; and it must be remembered that fatigue is cumulative in its effect. Similarly, night work is by no means as efficient as day work, although workers become accustomed to it. The effect of the length of day on output is shown by an interesting example of a yarn winder, who of her own free will worked a short day rather than a long one, avoiding work before breakfast and overtime. In this work it must be remembered that piece rates prevail. Although she worked a shorter day (eight hours instead of twelve), her output was greater than those of her fellow-workers who worked the longer day. In other words, the greater rate which was possible in the shorter day more than compensated for the loss of time.

Such investigations are of the greatest importance to engineers who wish to obtain the highest efficiency from their workers, for they point the way, not merely to high efficiency, but to a realisation of those conditions which are essential to the well-being of the country.

* "Present Day Applications of Psychology, with Special Reference to Industry, Education and Nervous Breakdown," by C. S Myers. (London. Methuen & Co.), 1s. net.

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Reviews.

Electric Motors and Control Systems. By A. T. DOVER. (London: Sir Isaac Pitman & Sons, Ltd.) Pp. xvi.+372. 16s. net.

It is very unfortunate that such a title as the above should have been chosen for this book. It is entirely misleading, in that it gives quite an erroneous impression of the contents. It implies that all kinds of electric motors and controllers are dealt with, so that all engineers interested in motors might be attracted by it. Actually it is a book for the specialist, being "a treatise on electric traction motors and their control," as the sub-title reveals.

In the words of the preface, "This book is an amplification of a portion of the author's work on 'Electric Traction.' It treats of the principles and special features connected with the application of electric motors to electric traction on tramways and railways." It is written more especially for the advanced engineering student, and the author appears to have fulfilled his object very well.

The first chapter gives general considerations concerning the selection of traction motors. It enumerates the various services met with and deals with the power and energy required. This chapter might, perhaps, be slightly fuller. For instance, in the familiar formula connecting force, mass and acceleration, a strange constant of 1·47 appears, and it will probably take the student some time to discover that this is due to the acceleration being expressed in miles per hour per second.

Chapter II. deals with continuous-current traction motors, 14 pages being given to electrical design and 35 to constructional details. There are, perhaps, too many reproductions of photographs, but it is convenient to find four such reproductions on one double page, so that they can be easily compared. The following statement is rather misleading: "In tramway motors it is possible to obtain several ratings from a given size of frame by varying the number of turns in the armature coils." The student might think this was a peculiarity of tramway motors, instead of applying to any motor whatever.

Chapter III. is on single-phase motors, and the theoretical treatment of the various types is developed on similar lines to that in Dr. S. P. Smith's Paper before the Institution of Civil Engineers.* The wording in parts is somewhat loose, as may be seen from the following example: "Thus the circulating currents are not only detrimental to commutation, but they result in (1) a reduction of the output, (2) an increase in the losses, (3) a reduced efficiency, and (4) an improvement in the power-factor. It is necessary, therefore, to consider what methods are available for reducing the circulating currents to a minimum." This seems to imply that an improvement in the power-factor is to be avoided.

Chapter IV. on polyphase induction motors is noteworthy in that pole-changing devices are treated very fully.

Chapter V. is on testing and the last five chapters deal with controllers and control systems. These last chapters occupy about half the book and are very full. Numerous examples of modern practice are given, arranged in logical sequence. Lettering on reproduced photographs does not conduce to clearness, but on the whole the diagrams can be easily followed.

An appendix gives the Standardisation Rules of the American I.E.E. relating to railway motors, and there follow 48 examples which include questions set at some of the principal examinations.

On the whole the book fulfils its purpose admirably, but no doubt it will be revised thoroughly if a second edition is found necessary.

R. G. JAKEMAN.

Practical Costing. By A. H. GLEDHILL. (London: The Gledhill-Brook Time Recorders, Ltd.) Pp. 72. 3s. net.

During recent years there has been a growing appreciation of the need for efficiency in the management of industrial organisations, and the rule-of-thumb and often wasteful methods of the past are giving way to systematic and orderly attention to every factor that affects economic production.

A reliable record and analysis of costs is the chart by which the manager is guided, and in order to rightly and rapidly diagnose accounts and detect wasteful expenditure an effective system of costing is of paramount importance. Further, it is important that such a system should be arranged so as to yield the maximum detailed information with a minimum amount of clerical labour and expense.

In the system outlined by Mr. A. H. Gledhill in his little book on "Practical Costing," this principle is consistently adhered to. The subject is treated on the basis of "time spent on the job," and full consideration is given to the methods whereby this time is properly recorded. The means advocated by Mr. Gledhill is that of the "Gledhill-Brook Time Recorder," and one of the objects of the book is to explain the advantages and method of operation of the almost automatic system for which he is responsible, comprising a time recorder containing a clockwork mechanism adapted to handling and recording mechanically the variety of records involved by his system.

Useful information on first principles of costing is introduced between pages of illustrations of record cards, such, for instance, as the routine necessary to start a job, time records, labour costs, stores, overhead manufacturing expenses, &c. So varied are these subjects that it is to be regretted that no index or even a table of contents has been included in the book.

The object of the author is apparently to place before those interested a system of costing which must be accepted in its entirety, a system which calls for special appliances. At the same time the book contains in a concise form information which cannot fail to be of value to all interested in works costing, and especially to those who are endeavouring to acquire a fundamental grasp of the subject before undertaking the study of the more extensive works on the subject.

A. P. M. F.

Present Day Applications of Psychology, with Special Reference to Industry Education and Nervous Breakdown. By C. S. MYERS, F.R.S. (London: Methuen & Company.) Pp. 47. 1s. net.

We deal with this book in our Leading Article.

* "The Use of Single-Phase Commutator Motors for Electric Traction on Long-distance Railways." "Proceedings" I.C.E., Vol. CXC., Session 1911-12, Part iv.

The Duplex Balance for Underground Telegraph Circuits.

By M. G. SIMPSON.

Underground telegraph cables are usually of moderate length, not generally exceeding 200 or 300 miles, and possess such high insulation and so small an inductance and absorption that the rise and fall of current is not appreciably affected by these properties and for practical purposes the cables may be treated as circuits possessing only resistance and capacity.

The condition for successful duplex working is that the sending currents produced by the sudden application of a battery voltage to the cable and to the artificial line shall be equal. Now it can be shown by the methods explained by Dr. H. W. Malcolm in his book "The Theory of the Submarine Telegraph and Telephone Cable," that the sending current in a cable of l length miles, resistance R ohms per mile, capacity K farads per mile and with the receiving end earthed through apparatus of resistance R_r ohms, when a battery voltage E is suddenly applied, is given by the expression

$$C_s=\frac{E}{Rl+R_r}+\Sigma_x \frac{2E(1+A^2x^2)}{Rl(1+A+A^2x^2)}e^{-\frac{x^2t}{KRl^2}} \quad \ldots \quad (1)$$

where A is written for $\frac{R_r}{Rl}$, and x is to be found from the equation

$$\tan x=-Ax,$$

and it is required to provide an artificial line in which the sending current shall have the same value.

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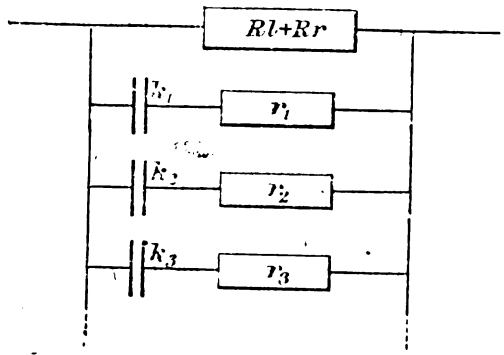
Let the artificial line be built up of condensers and resistances thus :—



If one side of such an arrangement be earthed and a battery voltage E be suddenly applied to the other, the sending current will be the sum of the currents in each of the separate branches, and therefore

$$C'_s=\frac{E}{Rl+R_r}+\Sigma\frac{E}{r}e^{-\frac{t}{kr}} \quad \ldots\ldots\ldots\ldots \quad (2)$$

This expression is of the same form as that given above for the sending current C_s in the cable, and C_s will be identically equal to C'_s provided that

$$r=\frac{1+A+A^2x^2}{2(1+A^2x^2)}Rl \quad \ldots\ldots\ldots\ldots \quad (3)$$

and

$$k=\frac{2(1+A^2x^2)}{x^2(1+A+A^2x^2)}Kl \quad \ldots\ldots\ldots\ldots \quad (4)$$

from which the proper values of $r_1, r_2 \ldots$ and $k_1, k_2 \ldots$ can be calculated by substitution of the successive roots of x given by the equation

$$\tan x=-Ax.$$

As an example, consider the case of an underground telegraph cable of length 250 miles, resistance 5·8 ohms per mile, capacity 0·1 microfarads per mile and with receiving instruments of 250 ohms resistance, whence

$$Rl=1450 \text{ ohms},$$

$$Kl=\frac{25}{10^6} \text{ farads},$$

and

$$A=\frac{250}{1450}=0{\cdot}1722,$$

x is to be found from the roots of the equation

$$\tan x=-0{\cdot}1722\,x,$$

which may be done approxinately by graphic methods and more exactly by tables of tangents.

The first three roots, which in this case are all that are necessary, are

$$x_1=2{\cdot}705,$$
$$x_2=5{\cdot}522,$$
$$x_3=8{\cdot}455,$$

and by substitution of these values in (3) and (4) we obtain the following values to be given to the condensers and resistances in the artificial line :—

$r_1=828$ ohms, $k_1=7{\cdot}5$ microfarads,
$r_2=790$ ohms, $k_2=1{\cdot}5$ microfarads,
$r_3=765$ ohms, $k_3=0{\cdot}5$ microfarads.

The same formula can be applied in the case of an overhead line, but such a line being exposed to the vagaries of the climate the balance will not be so stable.

For an overhead line of 450 lb. per mile iron wire of length 200 miles, resistance 11·8 ohms per mile, capacity 0·016 microfarads per mile and with receiving instruments of 250 ohms resistance, the formula gives the following values for the resistances and condensers of the artificial line :—

$Rl+R_r=2610$ ohms,
$r_1=1296$ ohms,
$r_2=1272$ ohms,
$k_1=0{\cdot}72$ microfarads,
$k_2=0{\cdot}14$ microfarads.

Carbon Brushes: Considered in Relation to the Design and Operation of Electrical Machinery.*

By P. HUNTER-BROWN.

The expression "carbon brush" is used to include brushes made of carbon and/or graphite, with or without the addition of various metals. Carbon renders it a peculiarly suitable material for dynamo brushes. It withstands high temperatures, is a reasonably good conductor of heat and electricity, and is not unduly abrasive; its "contact drop" is suffi ient to render possible a fixed brush position without causing excessive loss. A demand is not infrequently made for a universal brush, or at most two qualities which will meet every case of commutating work, with a third quality for slip-rings. The requirements of modern machines, however, are too diverse and too exacting for such a thing to be practicable.

The function of a slip-ring brush is to maintain uninterrupted contact with the slip-ring, thus affording a means of passing current between the fixed and rotating parts of a machine. In commutating machines the brushes, besides having to perform the mechanical function of completing the electrical circuit, assist in effecting commutation. The adoption of commutating poles has reduced this duty but has not eliminated it, chiefly because the commutating flux is correct at one value of load only, and the contact resistance of the brush is necessary to limit the short-circuit currents at other loads. Commutating poles are also fitted with a view to obtaining the maximum output per pound of material used. The armature ampere-bars per centimetre of circumference are thus increased and commutators are reduced in dimensions, and the number of segments may be less. This raises the total reactance voltage and increases the voltage per segment. Under large fluctuations of load a flash over may therefore occur. This is not directly a brush trouble, but it limits the choice of grade, as a mere trace of dust may provide the slight assistance necessary to cause the flash-over. The wide adoption of 50- and 60-period rotary converters also produces difficulties inherently connected with the high frequency, and low-voltage aero dynamos and magnetos have brought in their train their own particular brush probelms, demanding special grades of brushes.

To secure satisfactory operation, the problem may be stated thus :—

(*a*) In the case of slip-rings the brushes must maintain uninterrupted contact with the rings and carry the current with minimum frictional and electrical losses. Distribution of current between the various brushes must be sufficiently uniform to prevent local heating, and the rate of wear of both rings and brushes must be kept within reasonable limits.

(*b*) In the case of commutating machines the brush, instead of running on a smooth continuous homogeneous surface, must run satisfactorily on a composite surface consisting of narrow copper strips separated by mica or air spaces. The brushes must accordingly possess the desirable commutating characteristics necessary to give assistance in this direction, and must be capable of withstanding the unequal distribution of current which inevitably occurs in each individual brush

Properties of Carbon Brushes.

In this Paper the word "collector" is used as a common term to denote either commutator or slip-rings. By "positive brush" is meant the one by which the current passes to the collector, and by "positive ring" is meant the ring under the positive brush.

Specific Resistance.—The resistance of graphite and carbon grades varies from a minimum of about 0·0003 ohm per inch cube to a maximum of about 0·0030 ohm per inch cube according to the

* Abstract of Paper read before the Institution of Electrical Engineers.

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proportion of graphite, &c. Even taking the highest of these figures, the actual loss due to the resistance of the brush is only about 10 per cent. to 15 per cent. of the loss caused by friction and contact resistance. Specific resistance has a much smaller influence in determining the carrying capacity of a brush than the contact drop, coefficient of friction, and thermal conductivity of the material. A small added proportion of copper increases the resistance, though beneficial otherwise. The specific resistance may be reduced to about 0·000005 ohm per inch cube, there being still sufficient graphite in the brush to have a marked lubricating effect.

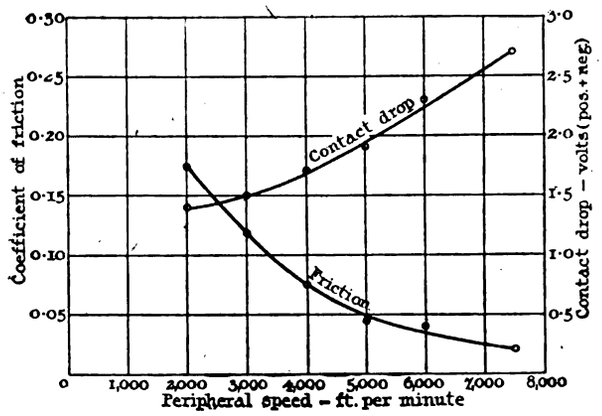

FIG. 1.—COEFFICIENT OF FRICTION AND CONTACT DROP AT 40 AMPERES PER SQUARE INCH OF A PURE GRAPHITE BRUSH. PRESSURE 2 LB. PER SQUARE INCH.

Friction.—A low coefficient of friction is of vital importance with the high peripheral speeds of modern machines, which sometimes approach 10,000 ft. per minute. High friction may lead to chattering of the brush, chipping at the contact surface and breakage of flexible conductors. An imperfect contact between brush and collector may produce destructive sparking, and at least increases the contact drop. The coefficient of friction (μ) is influenced by the brush material, the composition of the collector, the condition of the surface of the latter, the pressure on the brush, the peripheral speed, and the condition of the atmosphere. In the author's experience no temperature variations are likely to affect the coefficient of friction, except in the case of a carbon brush heated at the contact surface to the glowing point. The local heating may be so intense as to graphitize the surface partially. This, however, is an altogether abnormal condition of operation.

The passage of current through a brush alters the nature of its contact surface and thus affects the friction. Samples for test should therefore be bedded with current flowing, and the test proper should continue for not less than three days with the machine running night and day. This gives the brush time to settle down. The effect of a variation in the pressure applied to the brush is very marked. If the pressure is increased from, say, 2 lb. to 4 lb. per square inch the friction loss is very much more than doubled. The explanation of this apparent increase in the coefficient of friction (which may be anything from 10 per cent. to 100 per cent.) is not obvious but may be due perhaps to some kind of suction effect. It seems reasonable to suppose that this effect would be more likely to be produced with a heavy mechanical pressure than with a light one. The suction effect is more particularly in evidence with brushes that have developed a highly glazed surface, and it has even been observed on a commutator with recessed mica. In practice its occurrence is largely checked by vibration.

The coefficient of friction falls with an increase of peripheral speed. Fig. 1 shows an instance in which the effect of speed variation upon the coefficient of friction is very great. The decrease of μ with increasing speeds is probably due to a film of air between the brush and collector. Extraordinarily steep μ curves are occasionally obtained in the laboratory. The primary object of laboratory friction tests is to obtain correct relative values between different grades. In ordinary working, less favourable conditions may obtain and the friction loss may therefore be higher.

Contact Drop.—The contact drop of a copper gauze brush is of the order of 0·2 volt. With a carbon brush this is increased some 4 or 5 times, and from the efficiency point of view the carbon brush is at a disadvantage in this respect. On the other hand, this contact drop is the most valuable property a carbon brush possesses, constituting the whole secret of success in natural commutation. The voltage drop at the contact remains constant over a wide current range; there is for each quality of brush a critical value below which no current at all will flow. For a carbon brush containing no graphite, the minimum total voltage that will pass any measurable current was found to be 0·7 volt. This was an abrupt rise in contact drop at 20 amperes. Between 20 and 60 amperes per square inch (the working range of this brush) it rose only a further 0·6 volt. Over a range of 2,000 to 5,000 ft. per minute the contact drop was practically unaffected by the collector speed. An exceptional case is depicted in Fig. 1, showing the coefficient of friction of a pure graphite brush at various speeds. The curve is so steep and the value of μ so low at the highest speeds as to suggest the air-film explanation mentioned above. Contact-drop readings were taken at the same time as the friction readings and these also are plotted. A large increase occurs in the contact drop as the speed approaches the maximum, again suggesting the presence of an air-film.

Increase in temperature causes a reduction in contact drop, but the extent is difficult to determine, because the increase in temperature accelerates oxidation of the collector. Starting with perfectly clean rings, a drop of about 20 per cent. usually occurs shortly after switching on. The contact drop then rises much above the original value. On cooling again, the behaviour is uncertain, but the contact drop does not return to anything approaching the original value. The behaviour of graphite brushes is more consistent than that of carbon.

In actual practice considering the combined effects of an increase of temperature per second and the resulting oxidation, it seems highly improbable that any large reduction in contact drop occurs, otherwise we should have a condition of instability, since the contact resistance forms such a large proportion of the entire brush resistance. The contact drop is very definitely affected by the amount of pressure applied to the brush.

Thermal Conductivity.—Relatively very large amounts of heat are generated in very small volumes of material, and unless the heat escapes rapidly a destructive temperature rise is the result. Consider the losses occurring in a carbon brush 2 in. × 1¼ in. × ¾ in., assuming that the technical data referring to the grade in question are as follows:—

Specific resistance	0·0020 ohm per inch cube.
Contact drop at rated current	1 volt.
Coefficient of friction	0·20.
Current density	40 amps. per square inch.
Peripheral speed	3,000 ft. per minute.

The losses will then be as follows:—

Loss due to Resistance of the brush	6·0	watts.
,, Contact drop	37·6	,,
,, Friction (at 2 lb. per square inch)	25·4	,,
Total	69·0	,,

Thus over 90 per cent. of the loss occurs at the contact. Unequal distribution of the current, overloads, and circulating currents, all tend to increase and localise the heat still more.

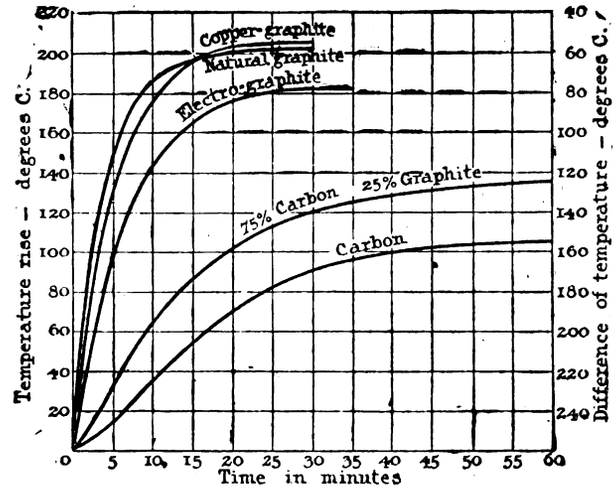

FIG. 2.

Thermal conductivity is greatest in the pure graphite and highly metallic copper-graphite brushes, and least in the carbons. In Fig. 2 are shown the results obtained by heating blocks of various materials at one end and measuring the temperature rise at the opposite end. The blocks were 4 in. × 1 in. × 1 in. They were uniformly lagged with asbestos, with the exception of ¼ in. which was left bare at one end. A hole was drilled at the opposite end

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to take the bulb of a thermometer. The bare end was then dipped in solder, which was maintained at 260° C., above the atmospheric temperature. Temperature readings were taken at the top end and the curves show the rate of rise and the final difference of temperature between the two ends of the samples.

It is clear from the curves that for a given contact loss a carbon brush is likely to reach a much higher temperature near the contact surface than one made of natural or artificial graphite. Graphite brushes, owing to their greater thermal conductivity, carry correspondingly heavier loads without such a high temperature being reached.

Hardness and Abrasiveness.—These two terms are frequently confused. By the former is meant the degree to which the material resists permanent deformation. A brush may be very hard and yet only very slightly abrasive. The purely mechanical abrasive action of the majority of brushes is very slight; it may even be necessary to incorporate a small quantity of abrasive material to prevent a brush from smearing the collector. Tests made with no current flowing, reveal that no brushes produce very rapid collector wear by abrasion. The following figures relate to tests made upon bronze slip-rings, the test brushes being 1 in. thick circumferentially, mounted one per ring. The pressure was 4 lb. per square inch, peripheral speed about 4,000 ft. per minute; duration of test 20,000,000 revolutions.

Description.	Radial Wear of Rings per 20 million revs.
Pure graphite	Less than 0·001 mm.
Carbon (non-abrasive)	,, 0·001 mm.
,, (abrasive)	,, 0·070 mm.

The most abrasive of these brushes is not a type that would be fitted upon high-speed machines but might be fitted upon a 4-pole motor running at 800 revs. per min. Assuming brushes ½ in. thick with four mounted on each track of the commutator, then to produce a radial wear of 1 in. on the commutator the machine would have to run 10 hours a day for 21 years, and this with a pressure double that to be expected in practice.

Inertia.—For high-speed work it is desirable to reduce to a minimum the inertia of the moving parts, including the brush material itself. The brush is thus more rapidly returned to its work by means of the pressure spring, when it shows a tendency to leave the collector.

Design of Brush.

Size.—The use of large brushes effects economy in holders, but a moderately small brush gives more satisfactory operation. Very small brushes involve unnecessary multiplication of parts. With a moderate size the brushes bed independently; if one brush is disturbed it means a smaller proportion of the whole; and the cooling conditions are improved. For ordinary commutator work the brush width should not exceed 1¼ in. The thickness should be that required by commutating conditions but preferably not more than 1 in. Brushes of the slide type are much superior to the grip type, owing to their lower inertia. An exception may be necessary in the case of induction motor brushes which are lifted after the motor has been run up to speed; but here the need for a slide type is eliminated by the fact that the brushes are only in service for a few moments at a time.

Fittings.—A brush should be reduced as far as possible to its simplest elements. Top-protection should take the form of insulating material. Solder should be avoided whenever possible, as under exceptional conditions it is liable to melt and run on to the commutator. Copper plating is a necessity with some types of connections and certain classes of brushes, but it has its attendant disadvantages. The brushes must have sufficient clearance in the holders over the coppered portion and therefore an undesirable amount of clearance over the un-coppered portion. Copper plating also encourages the current to pass directly from the sides of the brush to the holder, causing wear of the brush boxes; the resulting excessive clearance prevents a brush from bedding perfectly on the collector and may lead to chattering and breakage. Intimate contact with the collector is most important. The total clearance in the holders should not exceed, say, 0·2 mm. in the circumferential direction and 0·3 mm. in the axial direction. Brush boxes should be deep and should have four complete sides with unbroken surfaces. Flimsy holders are usually inaccurate and vibrate excessively under adverse conditions. Substantial cast holders can be made very accurately, resist any tendency to chatter, and form a valuable means of dissipating the heat generated at the contact surface of the brushes. For high-speed work the type which embodies a spiral spring directly behind the brush is preferred. It possesses the additional advantage of taking up a minimum amount of room in the circumferential direction, and affords a minimum of assistance to an arc to maintain itself between spindles of opposite polarity. Every brush should be fitted with flexibles proportioned to carry full current with a reasonable margin for overloads and unequal distribution of load. The use of flexibles increases the life of both brush and commutator, wear at the top of the brush is prevented, and an all-round better performance is obtained.

(To be continued.)

Government Control of Trade.

A meeting, convened by the Imperial Commercial Association and presided over by Lord DEVONPORT, was held on Tuesday at the Cannon-street Hotel, London, to protest against the continuance of Government interference and control of trade. The meeting was supported by the London Chamber of Commerce, the Industrial Reconstruction Council and a number of trade associations.

The CHAIRMAN referred to previous meetings at which Mr. Massey, Mr. Hughes (the Australian Premier) and Lord Inchcape had spoken on the subject before the meeting. During the war we were compelled to recognise that it was essential to have some State control, but the ground was now clear for action to bring pressure to bear on the Government to loosen the shackles of control and to remove them altogether at the earliest possible moment. Control was exercised by departments and individuals lacking experience of the things they controlled, and lacking the direct incentive of personal interest ever present in well-conducted businesses. The present system of control was wasteful and extravagant. The prices of commodities had been enhanced by action on the part of the Government itself, who in many cases had raised the prices, he supposed, for the purpose of paying for the war, but it ought to be proclaimed by the Government, if they were proceeding on the basis of "salting" commodities, that it was through Governmental action that the prices were so greatly enhanced. Had the Government kept shipping freights at the lowest possible point since it took over control of the ships? There were numerous examples where it had increased them enormously. To restore an efficient, economic and sound basis to trade the Government must be induced, or compelled if need be, to let go of control at the earliest possible moment, and hand over to the owners of the business the unhampered sway which they exercised prior to the war. It had been admitted that the nationalisation of railways was an assured certainty, and it had been rumoured that persons in high places were convinced that the successful future of shipping would be dependent upon its nationalisation, but he thought Lord Inchcape slew that the other day when he said that the shipowners, rather than work under Government interference would wind up their concerns and quit shipowning. With regard to the Imports and Exports Bill, it would be a terrible thing if our business so far as imports and exports were concerned were put under Government control for such a period as three years. They wanted nothing at the expense of the State. They simply asked that they should be handed back at the earliest possible moment the full control and conduct of their affairs, and be left alone to deal with and develop them in their own way.

Mr. E. J. P. BENN (chairman of the Industrial Reconstruction Council) said the Industrial Reconstruction Council stood for self-government for industry. It believed in the complete organisation of every trade, culminating in a trade parliament for each industry. In that parliament all interests should be represented—employers and employed, the merchant, the retailer and the wholesaler. The movement was barely a year old, and yet they were able to point to 72 bodies in 72 trades, as a result of the new spirit of co-operation and determination to develop, which had arisen out of the war. The merchant class would do well to make it more evident than they had sometimes done in the past, that they were prepared to put the whole force of their organisation behind British goods in preference to the goods of other nations. The 72 bodies now working were almost without exception busily employed in dealing with this question of bureaucratic control. The common danger of control in those 72 trades was doing a great deal to heal the breach between Capital and Labour. For four years the national policy had been to discourage civil activity. Central control was a synonym for waste of time, men, money and material. Thanks to a censorship, the most absurd claims were advanced on behalf of the system. The outstanding success of control was surely the ninepenny loaf. It was admitted that we pay a subsidy of £60,000,000 per annum in this connection. His belief was that when the history of that transaction came to be written we should find that the actual cost of the loaf had been increased from 1s. to 1s. 6d., and that we had paid the 9d. and charged the other 9d. to our great great grandchildren. Prof. W. A. Bone, D.Sc., F.R.S., told them the other day that the nation was being taxed no less than £40,000,000 to £50,000,000 per annum for the luxury of a coal controller. That gentleman was still spending £5,000 a week on advertising coal economy, though, with coal rationed, nobody could economise a halfpenny worth of coal anyhow. Sir Henry Gibson, the Auditor-General, in his reports, furnished numerous examples of waste. £15,885,562 worth of goods for which no invoices had been received, in one department alone. National shipyards, £4,000,000, which might better have been put straight down the drain. The real official, the man who understood the true functions of government, was against control, and would sympathise with the

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movement which was inaugurated to-day. It was the job hunters and *State* socialists who were blocking the way, and there were thousands of each sort in our 80 Government departments. People were asking what the state of trade would be. It would depend upon the degree of confidence engendered in the various markets, and there could be no confidence so long as there remained a vestige of the blight of bureaucracy. No abuse mattered provided that it was perpetrated in the name of the nation's need. But that need had passed, and the day for criticism and inquiry had arrived. Specious arguments were being used in order to bolster up this system of control. The chief of these was Belgium. Belgium would secure that which she required more expeditiously, more economically, more satisfactorily if the great commercial community of this country were left free to get on with the job, than if between it and Belgium an impassable barrier of officialdom were erected. In business we had a way of saying that time was the essence of the contract. No official in any office had anything to lose by doing to-morrow what ought to be done to-day. Agreements in restraint of trade were illegal. He suggested that regulations in restraint of trade should be put on the same footing. As a result of the agitation of the past few weeks there was a great show of the removal of restrictions. Camouflage was now being practised by the bureaucracy. In the middle of November "The Times" informed us that an Act of Parliament had been passed to perpetuate that huge machine for the ruthless destruction of personal liberty known as the Ministry of Munitions. A fortnight ago "The Times" informed us that the Minister of Pensions had taken powers to commandeer lands and buildings for the accommodation of his staff, as if there were not enough lands and buildings to accommodate staffs. We had a Ministry of National Service, a huge and expensive machine which registered everybody. The obvious and simple thing to do would seem to be to use that machine and that information for the purpose of demobilisation. But the Labour Exchanges must be considered, and so the whole of the National Service Ministry and all the millions that it had cost were scrapped; and we had to start all over agin, filling up fresh forms, and giving the same particulars in another way. The Labour Exchanges had been passed round from one Ministry to another—Trade, Labour, Munitions, Pensions, National Service—and they had been a nuisance in turn to each. In America all censorship was removed and all restrictions on the Press had been abolished. President Wilson, in his annual address to Congress the other day, said, "The moment we knew the armistice to have been signed we took the harness off. It is surprising how fast the process of a return to a peace footing has moved in the three weeks since the fighting stopped. It promises to outrun any inquiry that may be instituted and any aid that may be offered. It will not be easy to direct it any better than it will direct itself." We should need to carry on the process of trade organisation until we were strong enough to demand a complete system of self-government for industry, and for that reason he made no apology for asking for the support of those present for the Industrial Reconstruction Council.

Mr. F. M. B. FISHER (Director of the Imperial Commercial Association) moved a resolution that the meeting desired to draw the attention of the Prime Minister and the Government to the past evils of State Control of trade, and to the disastrous disabilities which British trade was suffering, as against the comparatively unrestricted trade in friendly and neutral countries, that the meeting strongly protested against the provision of the Imports and Exports (Temporary Control) Bill, which proposed to give his Majesty's Government power to control trade for a period of three years after the termination of the war, and was strongly of opinion that the said power should be limited to a period of one year, and that releasable commodities be set free forthwith; that the meeting urged (*a*) that no treaty or commitment of any kind should be entered into between the Government or commission, committee or individual set up on its behalf, and any Allied or neutral Power which shall bind or restrict any section of trade in this country, without the fullest consultation with business men directly concerned in the trade affected; (*b*) the importance of all sections of trade, including the merchant and the trader, being represented on all reconstruction trade committees where their interests were involved; and (*c*) that the peace terms should include provision in the indemnity for the full payment of outstanding enemy trade debts, including interest, and safeguarding of the British creditors from loss in exchange.

Mr. TREADWEN seconded the resolution, which was carried unanimously, and a vote of thanks to Lord Devonport, moved by Sir Chas. McLeod, concluded the proceedings.

Federation of British Industries and Peace Terms.

At the adjourned general meeting of the Federation of British Industries on the 12th inst., Sir Vincent Caillard presiding, a memorandum on Peace aims was unanimously approved. The Federation endorses the arguments for compelling the enemy countries to make such reparation as is possible by paying the full cost of the war, but they desire to urge more particularly on the Government the serious economic aspects of the question. Unless the enemy countries pay, the burden will have to be borne by this country in the form of immensely increased taxation for many years to come. This taxation must fall ultimately upon industry and form an element in the cost of production. A great increase in the total cost of production can only have three possible results—an increase in the price of the product, a diminution in sales, or a reduction in the remuneration received by all classes engaged in production. The first will be impossible owing to the competition of the countries who have taken no part in the war or who have taken a lesser part than this country, the second means national disaster, the third will mean that producers of all classes will have to work harder and receive less than they have ever done before. Capital will be driven away from British enterprises to those of less heavily burdened countries, and both the creation of new industries and the development of those already in existence will be seriously restricted. The general standard of living would inevitably be reduced, and it is even probable that the total national wealth would prove insufficient to provide simultaneously for the war charges and for the important but costly reforms in housing, wages and hours of labour now contemplated. The Federation, therefore, urges the absolute necessity of transferring the burden to those nations solely responsible for the war. The items which can be dealt with are:—

(1.) All expenses incurred as a direct or indirect consequence of the war by the Allied Governments; (2.) Complete compensation for all loss of Allied public property or to private property owned by Allied subjects, wherever situated; (3.) Compensation for all personal injuries, including a sum representing the capitalised cost of all pensions paid to disabled men and to widows and orphans; (4.) An estimated sum to cover the loss in national power of production caused by the death or disablement of potential producers, and; (5.) All enemy debts and obligations on whatever account; and (6.) Interest on all these charges from the date incurred until final payment.

If the enemy Powers are unable to meet this debt by an immediate capital payment, its collection will probably extend over a considerable period. Prolonged military occupation of any considerable portion of enemy territory would be very burdensome to the Allies by withdrawing a large number of men from productive employment, even if the actual cost of such occupation were borne by the enemy countries, while it might well impede the development of any stable and responsible democratic authority in the territory occupied. The Federation would suggest that the necessary safeguards might be provided by assessing an adequate minimum annual sum to be furnished by the enemy countries, and by placing specific revenues calculated to produce this sum at the disposal of an inter-Allied Commission. Payment in kind, either by raw materials or in the form of replacement of property damaged or destroyed should only be permitted under safeguards which would effectually prevent any possible injury to the development of industry and employment in the Allied countries. Payments in kind should be made to the inter-Allied Commission which would dispose of the goods and credit the sums received to the enemy Governments. The Commission should be empowered to refuse any manufactured articles which could be supplied by Allied countries. The institution of such a Commission, if accompanied by a complete disarmament of the enemy forces, and by any necessary restriction on the development of aircraft or other means of sudden attack, would enable extensive military occupation to cease at an early date.

Mining Machinery for Mexico.

In an article in the "Board of Trade Journal" on the characteristics of the Mexican mining machinery market and of the chief suppliers—United States, United Kingdom and Germany, it is stated that Mexico, from its geographical position, with direct railroad communication with the United States, naturally draws most of its foreign expert labour from that country. It follows that with Americans in charge of the mechanical departments of the various mines they naturally prefer to use machinery they know, and hence buy their supplies in the States. Perhaps nowhere in all the world is competition keener than in Mexico, and the British manufacturer, if he desires to enter the Mexican field, should either visit the country or send someone out in order that he may become familiar with the conditions. The American agent, as a rule, is a man who has had considerable experience in selling machinery, in Latin-America, and comes fully equipped, with up-to-date catalogues in Spanish and English. He can quote the price of the article delivered at a certain point in Mexico, and will point out any economy that may be effected. The British agent is generally a stranger in the country and speaks but little Spanish. His samples as a rule are excellent, but the reverse can be said about his advertising matter, which too often is not in the least suitable to the country.

In the past Germany has more or less confined her supplies of mining machinery to shoes and dies, tube mills, electrical supplies, mining cars, light railroads, small locomotives and electric street cars. As regards shoes and dies for use in stamp mills: Formerly these steel forgings used to be sold almost exclusively by British firms, who acquired an excellent reputation throughout the country. Then the Germans entered the market and gradually reduced the prices to such a point that in several cases the British manufacturer did not care to compete. The tube mills supplied by the Krupp firm have an excellent reputation in Mexico, and have given good results, but British manufacturers make an equally good mill. One of the reasons why these mills have been so much in favour in Mexico has been the exceptional terms that the sellers have made in selling them. They have often given 18 months' time for payment, and were always open to any proposition from the buyer. As regards the heavy electrical supplies (electric motors, &c.) they have not a good name in Mexico. The cheapness is very often to be noted, and so is the bad service they give. The opinion amongst mining men is that these motors are not to be compared in the results they give with those furnished by the large British houses. The only reason why British motors are not known in Mexico is that their sale has never been pushed for lack of proper agents to handle them.

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The Plexsim Electric Still.

We have received from Messrs. Simplex Conduits, Ltd., an account of an interesting development, which was exhibited at the British Scientific Products Exhibition—the "Plexsim" Electric Still. A general view of this apparatus is shown in Fig. 1. It is intended primarily as a convenient means of providing distilled water in central stations, laboratories or works where accumulators are used, and is particularly suitable for collieries where batteries of miners' lamps have to be constantly refilled and charged. From the sectional illustration (Fig. 2) it will be seen that the cold water enters at A where it should be controlled by screw-

FIG. 1.—GENERAL VIEW OF PLEXSIM ELECTRIC STILL.

down water tap. It passes through the pipe B to the outside of the condensing chamber and coil C and D. After filling the tank and coil, the overflow water passes through the pipe E into the small feed tank G, which is so arranged that there is no loss of heat at this point and no disturbance of the constantly boiling water in the evaporating chamber J. The overflow water is taken by the pipe F to a suitable waste drain. The heating elements K are mounted on the underside of the evaporating chamber, and when the water is flowing and the

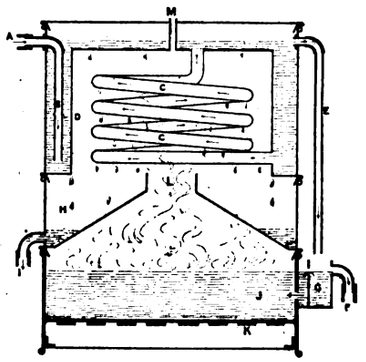


FIG. 2.—SECTION OF STILL.

current is switched on, the water rapidly boils. The steam given off rises through the cone L and impinges on to the various surfaces of the walls and coil in the condensing chamber, where it rapidly condenses, the drops of distilled water falling into the distillate chamber H from whence it flows through the outlet (I) into a suitable receptacle. Thus the action is simple and automatic and no attention is required. The flow of the feed water should be so regulated that the temperature of the waste water is about 150°F.; at this point the still is working at its greatest efficiency. All parts of the still are easily detachable and accessible, including the heating elements. Its construction is robust and it is designed for workshop use.

White Paint as an Aid to Industrial Lighting.

While good overhead lighting is now the usual system for industrial establishments, supplementary local lighting is sometimes used for lighting certain machines or portions of the shop. To assist such local lighting it has been found that the use of white paint has proved very effective. In one case a large machine room containing massive vertical slotters, finished with very dark paint, was lighted with an overhead system to an average intensity of about 2 foot-candles. The lighting of the tables in the region where the cutter operated was insufficient for setting the cutter accurately to the pencil markings on the rough castings ready to be machined. As a remedy a lamp on a drop cord was provided for each machine, and the surfaces of the machine which faced the table were painted white. This step eliminated inconvenient shadows from the local lamp and increased the illumination on the table by about 75 per cent. Thus, as the foot-candle meter readings taken at

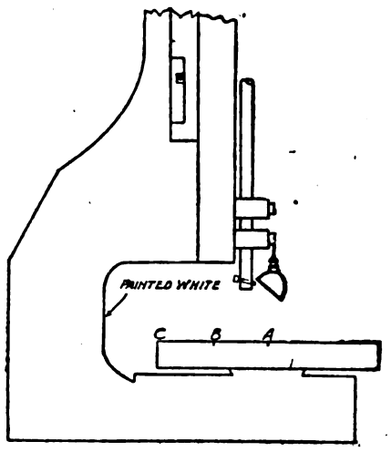
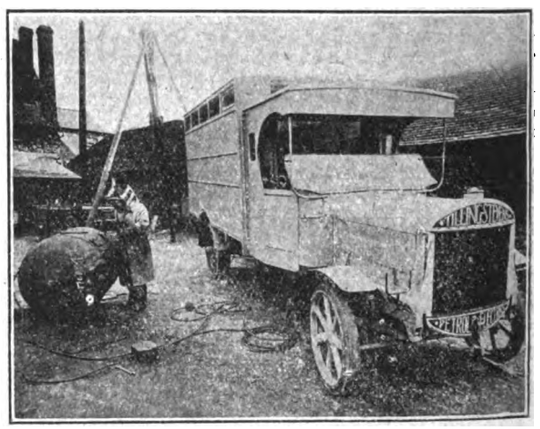


DIAGRAM OF MACHINE SHOWING THE IMPROVEMENT IN LIGHTING OBTAINED BY PAINTING THE VERTICAL SURFACES OF THE MACHINE FACING TABLE.

the base plate showed an improvement with the use of paint of 100 per cent. in the lighting at the points "A" and "C," and over 50 per cent. at the point "B" in the adjacent figure. In view of the economy at present necessitated by coal restrictions, the use of white paint in this way appears to be of material advantage.

An Electric Arc-Welding Motor Car Workshop.

The travelling car workshop is much used by firms concerned with engineering and boiler and by shipbuilding yards. There are now a number of yards in the United Kingdom so equipped. A typical 40 H.P. standard "Tilling-Stevens" petrol electric car, adopted by Messrs. P. A. Mudd & Company, ship repairers, presents some interesting features. The car is fitted with specially wound dynamo and motor for arc welding. The prime mover, a 40 H.P. petrol engine, is direct coupled to an electric generator which supplies current to an electric motor, and this drives the back axle through



TILLING-STEVENS ARC WELDING CAR.

Cardan shaft and worm gearing. By adjustment of the engine throttle and a resistance the strength of the generator and motor fields can be varied, the range of speed of the vehicle being controlled by the throttle pedal and resistance lever. Reversibility is obtained by changing the direction of current in the motor field by means of a controller, which also provides a neutral position. Switch gear diverts current from the electric driving motor to the arc welding apparatus, power being therefore supplied by the same engine and dynamo which, when on the road, propels the car. The driver has

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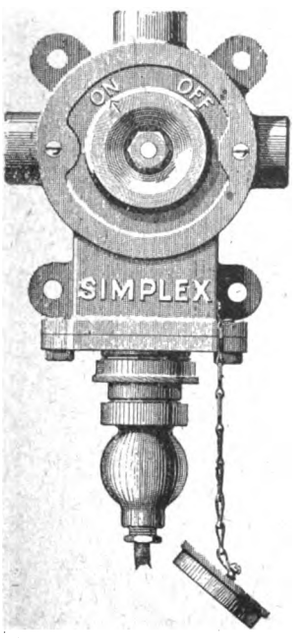
access to the welding control gear at the back of his seat. Cables from this gear run down through the floor to terminals on either side of the body of the car. Welding leads, in convenient thimbled lengths, are connected for running to the place of work, when the car is at a standstill, junction boxes being provided for the insulation and protection of the temporary connections. Besides lockers, bench, vice, &c., the car carries air compressor plant for operating pneumatic chipping hammers, drillers, &c.

The arc welding plant carried is suitable for welding steel plates (¼ in. thick to 2 in. thick, and upwards), steel and iron forgings and castings, &c. Uncaulkable places in boilers (both land and marine) are welded, corroded landing edges built up, and cracks in furnaces and flues made good. Either the carbon arc and metallic arc can be used. With the carbon, the arc (used for cutting up plates and scrap iron, also for welding) is made between the rod and the work by lightly tapping with the carbon and drawing the arc out to a length of about 1½ in. In the metallic arc (used for all kinds of repair work) the carbon is replaced by a metal electrode, and coated with a flux to prevent oxidation. Sometimes portions of the metal are removed by the carbon process before commencing the actual weld by the metallic arc. The sizes of electrodes vary with the thickness and class of work—the average is from 3/32 in. to 3/16 in. diameter. An important feature of the metallic electrode system is that vertical or overhead welds can be made.

Industrial Lighting Fittings.



SIMPLEX WATERTIGHT SWITCH AND PLUG, HEAVY PATTERN, FOR ROUGH CONDITIONS.

Simplex Conduits, Ltd., have issued a new catalogue of industrial lighting fittings, which includes many new designs of inexpensive reflectors and lanterns suitable for factory use. The workshop reflectors are shown in many sizes, arranged for intensive and extensive illumination. In these days, when economy and efficiency are the watchwords of factory practice, it behoves all works engineers to look well to the lighting of their works, and see that the light upon which money is being spent is, like every other material, used for the purpose for which it is intended, and not wasted in glare and shadows. The outside lanterns shown vary from inexpensive small sizes, suitable for 100 watt gas-filled lamps, up to the large lanterns taking 1,500 watts. There are also shown indirect and semi-indirect fittings of inexpensive types for drawing offices, booking halls, shops, stores, &c. At the end of the catalogue are illustrated switch and plug fittings, designed for heavy factory use and special positions, where it is desired to have both watertight and gas-tight fixtures.

The Motor Car Dictograph.

An interesting electrical device which deserves to be more generally known is the "Motor Car Dictograph," for facilitating communications between passenger and driver on motor vehicles. The ordinary speaking tube has its limitations for such work, and it requires some ingenuity to provide an appliance which makes speech easily audible amidst the noise of traffic and the rattle of the car. The motor dictograph is simple in construction, utilising a telephonic loud speaker operated by two dry cells whereby the person in the car can speak into the appliance at a distance of about 2 ft., and there is also a buzzer to attract the chauffeur's attention. The fact of electricity being employed allows great latitude in the positions of speaker and receiver, which can be assigned any convenient places. It is stated that during 1917 over 90 per cent. of high-class closed body cars were fitted with this device. The Dictograph is handled in this country by Dictograph Telephones, Ltd., of Southwark-street, London, S.E.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.
Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.
Orders for the Week.

Monday, Dec. 23, to Saturday, Dec. 28.—Headquarters closed.

Electricity *v.* Gas Supply.

Correspondence has recently passed between Mr. H. Faraday Proctor, hon. sec. of the Incorporated Municipal Electrical Association, and Mr. A. B. Gridley, director of Electric Power Supply, in regard to the restriction upon the connection of electric supply consumers who are already supplied with gas. On Dec. 5 Mr. Faraday Proctor wrote: "The Council requested me to write to you asking whether you would secure freedom of choice in the use of gas or electricity to consumers or prospective consumers in preference to the existing arrangement which favours the utilisation of gas due to war requirements."

In reply, Mr. Gridley wrote on Dec. 6 that "the fact that a gas supply may be available on the premises need now no longer be a reason for declining to entertain applications for supplies of current for domestic purposes. In modifying to this extent the restrictions which have hitherto held, I would remind you that until the coal situation has materially improved, the Electricity (Restriction of New Supply) Order, 1918, must unfortunately remain in operation."

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 SPECIFICATIONS.

120,593 LANCASHIRE DYNAMO & MOTOR CO. & WHITMORE. Magnet coil winding specially applicable to field coil windings for dynamo-electric machines, transformers and the like. (8/10/17.)
120,598 ABLITT, QUINCEY & ADAMS. Electrodes of secondary batteries. (17/10/17.)
120,600 HOPE. Electric fuses. (7/11/17.)
111,483 LEVIN. Electrolytic gas generators. (18/11/16.)
120,625 CLARKE. Magnetic apparatus for indicating vertically and orientation in inclined bodies subjected to centrifugal force. (15/11/17. Cognate application, 7,244/18)
111,851 TUA. Electric switches. (24/11/16.)
114,615 TUA. Electric switches. (4/4/17. Addition to 17,364/17.)
120,651 ADAMSON. Electrically-operated riveting, pressing, stamping and the like machines. (30/11/17.)
120,653 VICKERS LIMITED & BARCLAY. Rotors for dynamo-electric machines. (30/11/17.)
120,677 B.T.-H. Co. (G.E. Co.) Systems of electrical distribution. (5/2/18.)
120,678 BRITISH INSULATED & HELSBY CABLES & WILSON. Removable electrical fuse-carriers or connecting devices. (7/2/18.)
120,681 FERY. Electric cells. (9/2/18.)
120,689 BAXTER. Electric cells and batteries. (5/3/18.)

COMPLETE SPECIFICATIONS OPEN TO PUBLIC INSPECTION BEFORE ACCEPTANCE.

120,714 ANZANI. Magnetos suitable for internal combustion engines. (7/8/17.)
120,734 SKINDERVIKEN. Telephone transmitter. (7/11/17.)

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

November 23, 1918.

19,287 BEST. Miners' safety lamps.
19,305 WHALEY. Magnetos.
19,311 BARBOUR & PARTRIDGE. Electrical switches, starters and controllers.
19,317 AKT.-GES. LANDIS & GYR. Time switch. (18/12/17, Switzerland.)
19,323 RAILING & ROBERTS. Combined electric light fitting and ceiling fan.
19,326 READ. Use of wind power for generating electricity.

November 25, 1918.

19,340 NEW SWITCHGEAR CONSTRUCTION CO. & FUKE. Time lag devices for automatic switches, &c.
19,372 HINTON & SHAUGHNESSY. Magnifying telegraph signals by means of three electrode vacuum devices.
19,374 HEATH. Electric lamps.
19,388 ELIBSON. Accumulator plates.
19,399 OZAKI. Incandescent lamps.
19,404 SCOTT. Electrical contact makers.

November 26, 1918.

19,422 NORTON. Operating and tripping mechanism of oil-break switches.
19,460 WESTINGHOUSE LAMP CO. Filaments of highly refractory metal. (19/12/17, U.S.)
19,465 SHOENBERG. Generating high-frequency currents.
19,468 FLORY. Means for supporting shade of incandescent lamp.
19,491 MARR. Sound transmitting instruments.
19,492 MARR. Telephonic head piece receivers.

November 27, 1918.

19,494 MCCOLL. Protective devices for alternating-current systems.
19,569 SAUNDERS. Electric couplings.
19,595 WESTINGHOUSE LAMP CO. Filaments. (19/12/17, U.S.)

November 28, 1918.

19,649 & 19,650 TROTTER. Controlling and regulating speed of air-driven dynamos.
19,664 MARINC. Electroplating internal-combustion engine cylinders, &c.
19,670 B.T.-H. Co. Prepayment devices.
19,675 LANGDON-DAVIES & SOAMES. Current regulators for alternating-current circuits.

November 29, 1918.

19,728 VAN CONWENBERGHE. Electrical transmission of synchronous movements. (24/2/16, France.)
19,756 SOC. ELECTRO-METALLURGIQUE FRANCAISE. Electrodes of furnaces. (3/12/17, France.)
19,759 B.T.-H. Co. & WEDMORE. Protective devices for alternating-current distribution systems.
19,777 AVANTI DANSK ELEKTRO-MEKANISK FABRIK & NIELSON. Automatic quicksilver switches for electric flat irons.
19,785 HIGHFIELD & CALVERLEY. Apparatus for transforming electrical energy.

November 30, 1918.

19,792 GRAHAM. Shock absorber and protector for electric lamps.
19,814 ROSE. Visual and audible electric indicators.
19,818 FRANKLING. Electrically welding iron, steel, brass, &c., studs to iron, steel, &c.

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Legal Intelligence.

Petition for Prolongation of Patent.

During the week Mr. Justice Sargant continued the hearing of the petition of Prof. J. A. Fleming, F.R.S., and Marconi's Wireless Telegraph Company, Ltd., for the prolongation of patent No. 24,850 of 1904, granted to Prof. Fleming and assigned to the company.

Mr. W. Bradfield, manager of Marconi's Wireless Telegraph Company, produced a document showing in the case of each of the subsidiary companies the number of shares held by the Marconi Company in those companies and the total dividends which had been received in each year from them. Generally speaking, in the case of each of the subsidiary companies, as part of the consideration from the Marconi Company to them, there was either an assignment in general of all patents or licences of all patents, present and future, made by the Marconi Company in the particular country. The first was the Marconi International Marine, which showed very much the largest total dividends received—£84,500. The number of patents involved in the various transfers amounted to 100. The Marconi Wireless Company of America paid a dividend of £4,082 in 1912. In 1917 the American Marconi Company paid the Marconi Wireless Telegraph Company £10,000 in dividends; that was chiefly attributable to the fact that the American Company were doing a tremendous amount of work. They were selling all sorts of military apparatus both to the Army and Navy authorities. The French Marconi Company had paid the English Company £1,446, rising gradually to £7,760 in 1917. The Belgian Company had paid no dividend since 1911. The Russian Company paid up to the time of the troubles in Russia in 1916 a dividend of £2,971. The Australian Company paid dividends from 1913 up to date amounting in the last year to £1,800. He believed the Australian Company had something like half a dozen ships that had been fitted with valves during the past year. Witness was of opinion that the other companies had not used the valves, at any rate commercially, but might have done so experimentally.

Prof. E. W. MARCHANT said he regarded Prof. Fleming's invention as of very great importance. It disclosed for the first time that the thermionic discharges studied by Prof. Fleming with respect to the vapour had a frequency that could be used in wireless telegraphy. It would not have been possible for anybody to have introduced the principle of the three-electrode valve without the disclosure of the phenomenon which Dr. Fleming discovered.

Sir DUGALD CLERK also said he considered the invention a very important one.

The petitioners' case was closed, and Mr. MORITZ addressed the Court on the evidence.

Mr. COLEFAX, K.C., opening the case for the six opponents, said it was not that they feared an issue of infringement or an issue of validity with regard to the patent, but they had been made aware of the extraordinary claims which the Marconi Company had been making in respect of the patent, and accordingly they thought it right to oppose the petition. One matter that had not escaped the notice of those interested in such matters was the subtle transition that appeared in the Marconi patents when referring to the three-electrode valve. Up to a certain time it was recognised by that name by which it was known in the electrical world, and then it came to be called the Fleming valve. The case was unique almost in this respect, that there never had been any difficulty whatever or any disinclination on the part of the public to use the invention, or any difficulty on the part of the company in putting the invention into operation. During the whole of the life of the patent, subject only to the growth of the use of wireless, it had been of equal value. His contention was that there was no invention at all. There was no conflict that the instrument was old; its use for rectifying alternating currents was also old. Whatever use (if any) there had been of the invention Dr. Fleming made in 1904, it was absolutely negligible. Even taking the old device with which he worked, but which was not novel, the use of that had been in accordance with the later invention, the 1908, or at any rate in accordance with a property known to exist in 1904, but of which Dr. Fleming did not avail himself. Petitioners had closed their case and had not given any evidence upon which his lordship could form the conclusion that the Fleming valve was used, which meant that the Fleming valve as a detector. There was plenty of evidence that what they did was to use the Fleming valve. As a matter of fact, it was not the Fleming valve, but the De Forest valve; but what they did was to use it as an amplifier, which they admitted was outside the invention in the patent. It was a grid valve used as an amplifier. Counsel also submitted that the patent as it stood was invalid.

Mr. COURTNEY TERRELL, for the De Forest Automatic Telephone Company, said the whole of the merit claimed in this case was the property, not of Fleming, but of De Forest. Dr. De Forest, whose main patent (the three-electrode patent of 1908) was at the time when the renewal fees became due in extremely difficult circumstances, and he could not afford to pay the renewal fees. He allowed the patent to lapse, and after the patent had lapsed and had become open to the world, they then suddenly saw an enormous development of the use of valves in this art. The valves that were used were not Fleming's valves, but De Forest's. In the use of continuous wave telegraphy the three-electrode valve continued to be used for amplifying, and ultimately the detection was performed, not by means of the Fleming device, and not, indeed, by the valve, but by another device altogether.

Mr. KERLY, on behalf of the controller, said he was of opinion that a prolongation ought not to be granted. What was here asked was to have the opportunity of levying in future a tax, which would be an immense tax, upon the public in the future, not only upon the public in the ordinary way of possible buyers or users of the patented invention, but through the great departments of the country, who were using, and would continue to use, what was alleged to be the patented invention hereafter. If this invention was of great public utility, which meant to them that the public wanted, for which in ordinary circumstances they would be prepared to pay, why had it not come into general use? The answer was because it did not suit the Marconi Company, and there was no other answer. No sufficient merit in the invention had been proved, neither had inadequate remuneration of the patentee been proved.

Mr. P. H. PETTIFER said that from May, 1912, to May, 1916, he was employed at the long-distance station of the Marconi Company at Clifden. In the receiving apparatus there no use was made of a Fleming valve. A carborundum crystal was used as detector, and after that a three-electrode valve.

On Monday Mr. Justice SARGANT delivered judgment, and said that the case was one of great commercial interest. The legal and scientific importance was much less, and the extreme elaboration of the technical evidence appeared to be due, to a great extent, to the fact that other proceedings in connection with the patent were pending. The petition for prolongation was under sec. 18 of the Patents and Designs Act, 1907. Sub-section (4) of that section required the court to regard the nature and merits of the inventions in relation to the public, the profits of the patentee and all the circumstances. Sub-section (5) spoke of one condition only—namely, that the patentee had been inadequately remunerated; but that involved that the patentee should establish that the invention was one of more than ordinary merit in the sense of general utility and that the alleged inadequacy of remuneration was not due to any fault of his own. After referring to the character of the invention, he said that in one respect the claim of the specification was too wide, and an application to amend it was to be made. It was sought ultimately to extend the life of the patent with the limitation comprised in the amendment. It was unnecessary to decide whether one objection was good—namely, that an amendment could not be made after the expiration of the patent. The first inquiry was as to the general merit of the invention, and the objectors had failed in their attempt to show that there was no subject-matter in the alleged invention. Without deciding the general question or the particular question whether the specification was obviously bad without amendment, his lordship dealt with the question of the merit of the invention in relation to its general utility to the public, and said that it was a pioneer invention in the sense of its being a representative of an entirely new class of instrument in connection with the detection of wireless waves, and was one of unusual ability, and such as ought to be rewarded by some extension, should the other conditions for extension be proved to exist. The invention could not, however, be regarded as epoch-making, or even in the first rank as regarded utility.

As to the remuneration received, his lordship had not been invited by any party to separate the co-petitioners, or to take into account the retaining salary paid for many years by the Marconi Company to Dr. Fleming as consulting adviser, on terms under which (*inter alia*) the company was to have the benefit of that invention and his other discoveries. The first item, actual cash profits on the sale of valves, was £8,500. As to the second item, shares received on sales of foreign patents to subsidiary companies, £1,200,000 share capital had been received for the company's Argentine patents in 1907, and over £100,000 share capital had been afterwards received for other patent rights. That share capital must be taken, for present purposes, as being worth par at the date of the purchases, and that consideration was not attributable exclusively to the main Marconi patent: some appreciable part must be allocated to the Fleming patent. Even if a small proportion of 1 per cent. of the aggregate price was to be appropriated to it, over £13,000 had to be added to the petitioner's remuneration on that score alone. A third head of remuneration was as to pending claims against the American Government and some of the Departments of the British Government—particularly the Post Office. On the whole, the petitioner could not be held to have established a case of inadequate remuneration. His lordship then considered the kind of remuneration which consisted of the use by the Marconi Company of the invention as part of its general system of wireless telegraphy. The company had been the only possible users of the invention. The petitioner had failed to show that there had not been adequate remuneration. In the result, he dismissed the petition for prolongation. There would be one set of costs among the objectors other than the Crown.

The first Tuesday in next sittings was fixed for the hearing of the application for amendment of the patent, which would necessarily be required before the hearing of the petition for its revocation.

J. A. Scoular v. Notable Electric Company, Ltd., and F. Warner.

Last week Mr. Justice Bailhache heard this action for the recovery of £300 balance of moneys which plaintiff alleged was due to him for goods sold, work done and materials provided.

COUNSEL for plaintiff said he understood the Notable Electric Company was a limited company in which Mr. Warner had considerable interest. In 1917, Mr. Warner was minded to start a factory for manufacturing electric light bulbs, and Mr. Scoular, who had been familiar with the work for some time, was approached to equip the factory at Merton. Plaintiff's case was that in June, 1917, it was agreed that he should provide defendants with an equipment for making drawn wire tungsten filament lamps, which, when the necessary hands had been trained properly, would produce an output of 1,000 ordinary 60-watt lamps per day of 10 hours, that plaintiff should instruct defendants'

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managers and employees to the best of his ability in the manufacture of the lamps, for a period not exceeding six hours per day, for three months, commencing June, 1917, that defendants should provide all raw materials of suitable quality, including uniform drawn wires, and finished caps, and also good quality bulbs, and tubing necessary for the manufacture of the lamps, and that the cost of equipment and instruction should be £2,000. Defendants had paid to plaintiff on account sums amounting to £1,700, leaving £300 still due.

Defendants alleged that plaintiff did not complete his part of the agreement, failing to provide defendant company with an equipment, which, when the necessary hands had been trained properly, would produce an output of 1,000 ordinary 60-watt lamps per day. It was alleged that the motor supplied by plaintiff was incapable of doing the work required, and fired and became useless, that the gas fires fitted by plaintiff to the machines were defective and inadequate for the output required, and that the machines supplied were in such a condition as to continually break down and require repairing. Defendants counter-claimed for £1,637. 10s., the principal item being loss of profit on 42,000 lamps being the difference between 64,000 lamps that the equipment should have turned out between November, 1917 and February, 1918, and the number actually turned out, 22,000—6d. per lamp, £1,050.

Witnesses were called on both sides, and after addresses by counsel, Mr. Justice Bailhache gave judgment for plaintiff for the amount claimed, £300, with costs, and he gave judgment for defendants for £435, with costs on the counter-claim.

Employers' Liability Act.

At the Bow County Court last week, his Honour Judge Graham, K.C., and a jury heard an action by Thos. Ed. Knight against the Charing Cross, West End & City Electricity Supply Company to recover £300 damages for personal injuries, owing to an alleged defect in the plant. Plaintiff's case was that he was employed as a boiler scaler, and on June 20 asked for a brush and pail for his work. This was not forthcoming, so he went out on top of the boiler to fetch it. One of the tubes burst in a boiler 50 ft. or 60 ft. away, with the result that in trying to grope his way to safety in the blinding steam he fell off the boiler to the concrete floor below, a distance of 24 ft. He was seriously injured, and had not recovered since.

Plaintiff gave evidence, and in cross-examination said he had no knowledge that three men and two mates were kept specially for testing the tubes; the testing had nothing to do with him. Had there been a guard on the boiler he could not have fallen off. He agreed there were 720 tubes to every boiler, and that it was a common occurrence for one to blow. His opinion was that if tests were carried out as had been suggested, the defects should have been discovered.

Evidence was called for the defence to prove that every care that was humanly possible was taken to prevent such an accident by testing, and the Board of Trade's stringent regulations were fully carried out.

The jury gave a verdict for paintiff and £75 damages, and judgment was entered for this amount, with costs.

On Tuesday the Judge refused an application for a new trial, and declined to grant a stay of execution pending an appeal.

Breach of Factory Regulations.

At Barnsley last week the Low Temperature Carbonisation Company was summoned by the Inspector of Factories for failing to protect live wires as far as reasonably practicable. It was explained there were trolley wires in a trench conveying electric current to machinery. A space of about 12 in. had been left to enable a machine to run, and that was unprotected. A fatality occurred on Nov. 2, when a labourer fell on the unguarded wire and was killed. Since then the unprotected space had been reduced as far as possible. A fine of £20 was inflicted.

Commercial Topics.

Prices of Petroleum Products.

Owing to the improved shipping position, the following reductions in the price of petroleum products are officially announced: Gas oil has been reduced 7½d. per gallon, and fuel oil £4 per ton. From Jan. 1 petrol will be reduced 3½d. per gallon and kerosene 4d. per gallon.

* * * *

Boilers Revocation Order.

The Minister of Munitions has revoked the Boilers Returns and the Boilers Control Orders, which provided respectively: (*a*) for the making of certain returns, and (*b*) that no person except with a permit might purchase, sell or deal in any second-hand steam pressure boiler other than boilers for use in locomotives, motor cars, vehicles or ships.

* * * *

British Engineers' Association.

In view of the recent rapid progress of events affecting British engineering industry and the export trade, the Council of the British Engineers' Association, in order to cope with the vast amount of important work which will devolve upon it in the immediate future, have decided to strengthen their administration by the appointment of a director, who will be the chief organising and executive officer of the association. For this responsible position the Council have secured the services of Mr. D. A. Bremner, O.B.E., who, as an engineer, business organiser and administrator, has had a wide experience at home and abroad. Mr. Bremner will assume his position on the 1st prox.

Relaxation of Priority for Government Work.

The Minister of Munitions notifies that all uncompleted contracts for the Admiralty, War Office and Ministry of Munitions which have been placed in classes A or B, including the various grades thereof, need no longer be given the priority attaching to them under the Order of March, 1917, except in cases where the contractor is notified that a particular classification is still required. Contractors must notify the ordering departments of the Admiralty, War Office or Ministry of Munitions of any modification of the original date of completion resulting from this relaxation of the Order.

* * * *

Stocks of Non-Ferrous Metals.

In order that the trade may know the position in regard to stocks of the important metals, the following particulars have been published of the stocks (exclusive of old metal and scrap) in this country in the possession of the Minister of Munitions on 1st inst., viz.: copper 27,530 tons, spelter G.O.B. 18,768 tons, spelter, refined, 6,544 tons, aluminium 10,215 tons, soft pig lead 49,111 tons, nickel 1,735 tons and antimony regulus 3,303 tons.

It is intended to publish, at monthly intervals, the stocks held on the first day of each month. In addition to the above the Minister holds large quantities of scrap, mainly brass, of which it is impossible to give any figures at present.

* * * *

Metals Suspension Orders.

By an Order of the Minister of Munitions the operation of the under mentioned Orders has been suspended as from the 17th inst. until further notice:—

The Copper (Sale or Purchase) Order, 1916, Dec. 8, 1916.
The Copper (Use in Manufactures) Order, 1916. Dec. 8, 1916.
The Copper (Control) Order, 1917. Jan. 1, 1917.
The Brass and Copper (Returns) Order, 1916. Dec. 1, 1916.
The Brass (Swarf and Scrap) (Control) Order, 1917. Feb. 24, 1917.
The Cupro-Nickel Scrap (Dealings) Order, 1917. March 9, 1917.
The Spelter (Control) Order, 1917. March 23, 1917.
The Spelter Control (Amendment) Order, 1918. Jan. 22, 1918.
The Lead Order, 1917. Sept. 1, 1917.
The Lead Control Amendment Order, 1918. Feb. 19, 1918.
The Type Metal (Returns) Order, 1918. May 28, 1918.
The Lead (Amendment) Order, 1918. June 28, 1918.
The Tin (Dealings) Order, 1917. Dec. 21, 1917.
The Tin (Dealings) Order, 1918. April 25, 1918.
The Chrome Ore Order, 1917. Aug. 31, 1917.

* * * *

The Australian Iron Industry.

The House of Representatives of the Commonwealth of Australia recently passed a Bounties Bill in order to encourage the establishment of the iron and steel industry in Australia. It is hoped that by means of the provisions in the Bill the galvanised and iron sheet industry will be firmly established in the Commonwealth.

* * * *

Electricity Supply.

The street lighting is to be improved and 98 electric lamps are to be lighted in HANLEY.

MAIDSTONE COUNCIL has increased the price of electric current by an additional 5 per cent.

GREETLAND (YORKS) URBAN COUNCIL proposes to obtain a supply of electric current for street lighting and other purposes.

On the advice of the LEISTON LIGHTING COMMITTEE, the Urban Council has decided to go into the question of providing the town with electric supply.

LEIGH (LANCS) ELECTRIC SUPPLY COMMITTEE has increased the charges for electric current by 10 per cent. as from Jan. 1, making 35 per cent. increase within the last two years.

The Board of Trade have suspended the operation throughout Scotland of Part IV. of the Lighting, Heating and Power Order, 1918 (which prohibits shop-window lighting), from Dec. 20 to Jan. 4, 1919, inclusive.

Extensions of the generating plant of Bury (Lancs) Corporation cannot be carried out at present, but owing to the increasing demand for supply, negotiations have been opened up with the Lancashire Electric Power Company, in the hope that it will be possible to inter-connect the two systems at Radcliffe, and thus get a temporary bulk supply.

STOKE-ON-TRENT CORPORATION has been informed that the scheme for plant extensions has been approved in principle by the War Cabinet Electrical Services Sub-Committee. The Electrical Engineer (Mr. C. H. Yeaman) has, therefore, been asked to prepare a report upon the proposed new generating station and to select a suitable site, &c.

Owing to the lighting restrictions and economies effected by consumers, the EDINBURGH ELECTRIC LIGHTING COMMITTEE estimates that there will be a drop in the year's revenue of £12,600. The increase in wages will involve an additional expenditure of £2,350, but there will be a saving of £5,200 on the coal bill owing to their reduced output and an increased revenue for lighting public stairs. There will, therefore, be a decrease of £5,700, and it is proposed to increase the price for lighting from 3¾d. per unit to 4d. per unit, and power by ½d. per unit.

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The accounts of the WIMBLEDON ELECTRICITY DEPARTMENT for year ended March 31 show gross capital expenditure £269,123 (increase £389), of which £127,299 has been repaid. Income was £44,266 (compared with £38,044 in previous year) and working expenses were £31,306 (£27,586). Interest required £5,862 (£6,090) and loan contribution and sinking fund £12,662 (£12,531), leaving net profit £380 (compared with a deficit of £4,220). Working and special charges were 2·015d. (1·783d.) per unit sold, and capital charges 1·193d. (1·204d.) Maximum supply demanded was 2,219 (2,040) kw. Units generated were 5,181,030 (5,079,485)

On the recommendation of the Electric Supply Committee, SHEFFIELD CORPORATION has adopted an award of the Committee on Production, and an application from women workers has been referred to the Industrial Commissioner for arbitration. The Committee disapprove of the Board of Trade electrical power scheme, and hoped the Government will take no definite action until an adequate opportunity has been afforded municipalities of presenting their views on it. The estimates of the committee put the gross profit at £204,625 for the year ending March 25, 1919, and £240,386 for the year ending March 25, 1920. An amicable settlement of the dispute with the Ministry of Munitions on the question of the new power station at Blackburn Meadows has been made.

Last week the L.C.C. authorised WOOLWICH BOROUGH COUNCIL to borrow an amount not exceeding £15,000 on account of expenditure already incurred in connection with the extension of the Globe-road electricity station at a total expenditure of £132,871. The original estimate of the work amounted to £77,000, but additional works were executed and large additional expenditure was incurred. The L.C.C. has asked the Borough Council to state whether the expenditure now returned will complete the extensions, and for an assurance that no additional expenditure will be incurred without first obtaining the Council's sanction to the requisite loan. The great demand for electrical energy in Woolwich produced by the war had brought about a change in the financial position of the undertaking, and the accounts for 1917-18 showed a net surplus of £5,701. It is desirable that the Borough Council should make a careful review of the present position and future prospects of its electricity undertaking with a view to the reduction of the unremunerative debt, more particularly that outstanding on the Plumstead station.

ROTHERHAM CORPORATION claims to have the first super-power station erected in this country. The new station, which is adjacent to the present works, will be ready to supply electric current early in the new year. The first two turbo-alternators are of 12,500 kw. each, and by mid-summer next a 30,000-kw. set will be completed. With the existing generating plant the capacity will then be 70,500 kw. There are special advantages in respect of railway facilities and water supply, and an abundance of fuel within easy reach. It is computed that fuel can be brought from the pit-head to the overhead bunkers in the boiler-house at about 7d. per ton. There are 12 large water-tube boilers, each equipped with special coal-feed arrangements and a suction ash plant. It is computed that the coal consumption per unit delivered on consumers' premises will be less than 2 lb. per kilowatt. During the past year Rotherham Electricity Department has extended its sphere of influence by taking over the electric supply area of the Mexborough & Swinton Tramways Company. The necessity for the new developments was partly due to some 15,000 H.P. being required for the new rolling mill plant of Messrs. Steel, Peech & Tozer and other purposes of the firm. At present there are applications from existing works for between 40,000 kw. and 50,000 kw. The old and new works have cost over £1,000,000, and sanction has been obtained for the expenditure of a further £800,000.

Councillor John Owens and Councillor P. S. Brook have been appointed chairman and deputy-chairman of the CHESTER ELECTRICITY COMMITTEE for the current year. The chairman and deputy-chairman, the mayor, Councillors W. H. Denson, F. H. Illingworth and E. Noel Humphreys have been appointed a sub-committee to confer with the tramways sub-committee as to the charges for energy to the tramways, and with a sub-committee of the Watch Committee as to the charges for public lighting, and to supervise experiments made in the development of electricity as an aid to agriculture and rural industries.

The electrical engineer (Mr. S. E. Britton) has arranged terms with Messrs. E. Webb & Sons, Saltney, for supply of electrical energy, and with Messrs. Crichton & Co. for an additional supply of electrical energy. The Council has, therefore, decided to apply, subject to the consent of Hawarden Rural Council being obtained, to the Board of Trade for an order authorising the supply to Messrs. Webb & Sons and for consent to run overhead transmission lines. The terms for the supply to Messrs. Webb and Messrs. J. Crichton are as follows: (*a*) The Corporation to provide plant and transmission lines at an estimated cost of £4,572, but of this sum Messrs. Webb & Sons will provide £2,384 and Messrs. J. Crichton £2,188. If the estimate be exceeded, the proportions will be settled by Mr. Britton. The Corporation will repay the sum so provided at the end of seven years, or at any time, or from time to time during such period, either as a whole or by instalments, and during the period will pay interest at rate of 5 per cent. or the current joint stock bank rate, whichever shall be the lower. Each company will take a supply of energy equivalent to 20 per cent. per annum on the amount of the capital expenditure allocated to each company at the current rate per unit for bulk supplies for seven years.

Having regard to the conclusion of the war, a special committee is to be appointed to report to the Council on all questions relating to the development of the city.

Electric Traction.

BELFAST TRAMWAYS COMMITTEE has decided not to give a tramway service on Christmas Day.

In Birmingham there will be no Christmas Day service of the Corporation tramcars.

MAIDSTONE TRAMWAYS COMMITTEE recommends the extension of the light railways in the North and South King-street wards.

DOUGLAS (ISLE OF MAN) has rejected a motion to abolish Sunday tramcars, but it has been decided to give a restricted service.

The parcels and goods carrying scheme of the SOUTHAMPTON CORPORATION tramways department, which was inaugurated in February last, has been discontinued owing to lack of support.

The MUSSELBURGH & DISTRICT ELECTRIC LIGHT & TRACTION COMPANY has applied to the Board of Trade for power to abolish the 1d. fares for a mile or part of a mile and to charge 1½d.

HULL CORPORATION recently authorised the borough engineer (Mr. F. W. Bricknell) to purchase an electric truck for the collection of street sweepings near depots, and an order has been placed with the British Electric Vehicles, Ltd., for a 20 cwt. truck, to be fitted with an ironclad "Exide" battery.

The Board of Trade has extended to Aug. 7, 1919, the period limited by the LONDON ELECTRIC RAILWAY ACT, 1913, for the construction of the works authorised by the Act, and also the time fixed for compulsory purchase of lands, &c., and for the payment of interest out of capital raised for the construction of the Edgware & Hampstead Railway.

In a report to the EDINBURGH Tramways Committee the manager of the tramways (Mr. R. S. Pilcher) states that he considers cheap and rapid transit facilities to the outskirts of the city can be best obtained by adhering to the zone system of fares rather than by changing to the universal fare system. He suggests the reduction of the number of stages and a cheap penny fare radiating from the centre.

The manager of the YORK CORPORATION TRAMWAYS (Mr. J. W. Hame) recently prepared a report on the effect of higher tramway fares on the gross receipts. In many Yorkshire towns (Wakefield, Bradford, Huddersfield, Mexborough, Swinton and Scarborough) the penny fare has been discontinued, and the minimum fare is 1½d. At Wakefield the falling off in passengers has been only 2·28 per cent., but the increase in the receipts was 20·67 per cent. At Huddersfield the falling off in passengers in the week immediately following the advance in fares was 13·2 per cent., but this figure is reported to be rapidly diminishing. At Bradford the receipts per car-mile have risen from 16·87d. during the week immediately preceding the advance in the fares to 21·85d. per car-mile. Increased fares have therefore been introduced in York.

Last week SHEFFIELD CORPORATION approved the proposals of the Parliamentary Committee to Promote a bill for powers to extend the Handsworth tramway section. Free passes on the tramcars are to be given to blind persons. It was also decided to adopt an award by the Committee on Production (Engineering and Foundry Trade Workers), to proceed with the erection of a new depot at Crookes, to purchase additional tramcars and buses, to withdraw most of the Sunday morning munition workers' cars, and to suspend the services on Christmas Day.

The revised estimate for the tramways and motor service for the year ending March 25 next was revised. The total receipts are returned at £630,410, and the total expenditure £635,893, leaving net deficit £5,483. An award by the Committee on Production which took effect from the first full pay day in November, together with the engineering award, will mean an additional cost of £24,000.

WORCESTER CITY COUNCIL has decided to raise no objection to the proposal to reduce the tramway service, to cut out some of the stopping places and to increase the fares on certain routes. There was some opposition to the proposals and Mr. Fairbairn said he was not satisfied that the undertaking had suffered as a consequence of the war. He had no confidence in the appropriate Government department, which was presided over by a gentleman who was so largely interested in tramways. It was well known that the particular Government department was now run in the interest of tramway undertakings. It would have been more reasonable to have increased the fare on the Rainbow Hill route, which was a far more unprofitable section than the Blabourne section. He was not prepared to admit that during the war the undertaking had been run with due care and management, and he thought the Company had taken advantage of the war and neglected their duties so.

The Highways Committee of the LONDON COUNTY COUNCIL has informed the Amalgamated Association of Tramway and Vehicle Workers that all car services on the Council tramway systems will be suspended at 4 p.m. on Christmas Day.

A report of the Highways Committee upon the Government subsidies granted during the latter part of the war to the motor-omnibus services in South-Eastern district was presented on Tuesday by Mr. G. H. Hume.

Dr. SCOTT LIDGETT said some method ought to be found to stop the wasteful competition between two services. The County Council tramway service had done its best to help the Government during the war and it ought to be treated as well as the omnibus companies.

Mr. W. J. SQUIRES agreed, and said that nearly £100,000 had been paid by the Government to the omnibus companies for what they had done. The grant for the year ended June 30, 1917, was £44,312. Possibly the Government might consider representations made to them on behalf of the Council.

The report was adopted.

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Imperial and Foreign Notes.

The "Industrial Australian and Mining Standard" says there is a fair prospect that the first section of the electrified VICTORIAN SUBURBAN RAILWAYS—the Sandringham to Essendon section—being completed before the end of the year.

The "Industrial Australian and Mining Standard" says nearly all the equipment for the manufacture of calcium carbide by the Hydro-Electric Power & Metallurgical Company, at Electrona, North-West Bay, Tasmania, has been made in Australia, and the expenditure on the carbide and electrode works up to date has been over £70,000. The crushing and dressing plant were made in South Australia, the carbide drum-making plant in Sydney, and the electric furnace iron work, electrode holders and plant for the electrode factory in Victoria.

H.M. Consul-General at Gothenburg (Sweden), who is making a collection of British commercial reference books, trade catalogues, &c., for exhibition at the Consulate-General, would welcome the assistance of United Kingdom manufacturers and merchants in making the collection as complete as possible.

The chairman of the Post Office Committee of the U.S.A. HOUSE OF REPRESENTATIVES (Mr. Moon) has introduced a Bill for the permanent Government ownership of the telegraph and telephone lines as auxiliary to the Post Office Department. Mr. Moon stated that President Wilson was in favour of the Bill, which authorises the purchase of the telephone systems and a preliminary survey of telegraphs.

The War Service Committee of the U.S.A. Rubber Industry announce that all restrictions governing production of rubber products and the amount of crude rubber that may be imported from primary markets have been withdrawn. Rubber will be consigned to the Rubber Association as hitherto, and the usual guarantee will be required, but maximum prices and allocation features are entirely eliminated.

The American Nitrogen Products Company is erecting plant on the north arm of Burnard Inlet, British Columbia, for the production of nitric acid and fertilisers. The company, which is an American one, has a capital of $2,000,000, and will employ the arc process. Their plant is being constructed close to the Lake Buntzen power plant of the British Columbia Electric Railway Company, which will supply 3,500 kw. at a low rate.

In a report of the SWEDISH RAILWAYS ADMINISTRATION it is stated that in 1915 it was found necessary to make a closer inquiry into the question of electrification, as it appeared that the high cost of fuel made it advisable to adopt electric traction. It is estimated that if the change had been made in 1913 it would not have cost more than the actual price of fuel in 1915. As the war proceeded it was found necessary to have recourse to wood instead of coal, and this considerably reduced the speed of trains. A journey from Stockholm to Kiruna (Lapland) now occupies 39 hours; with electrical working the journey could be done in 18 hours. The journey from Stockholm to Gothenburg now occupies 11 hours, whereas an electrically-driven train could do it in 5½ hours. The Railway Administration estimates that the electrifying of the railways can be carried out in about 10 years. There is plenty of water power available, and already several large power works are in existence. It is also reckoned that cables laid along the railway lines would be able to supply power for agricultural purposes.

Miscellaneous.

The following addition has been made to the list of firms and persons with whom trading by firms and persons in the United Kingdom is prohibited: Accumulatorenfabrick (with the partners in same, E. Snijders and J. F. Fredricks), Amsterdam.

The following alterations to the list of PROHIBITED AND RESTRICTED EXPORTS are published: *Delete*—(A) aluminium and alloys of aluminium; (A) antimony and alloys of antimony; (A) ferro-manganese; (A) ferro-silicon; (A) nickel. All the foregoing entries are transferred to class (B). *Delete*—(B) rubber, gutta percha or balata goods (not otherwise specifically prohibited); (A) lathe tools and measuring tools.

Some particulars have been published of the results of the APPLICATION OF ELECTRICITY TO GROWING CROPS at Llantwit, Fardre. The experiment was carried out under the direction of Mr. W. A. Chamen (general manager) and Mr. C. T. Allan (engineer) of the South Wales Electrical Power Distribution Company. A two-acre piece of ground of heavy loam, 70 per cent. clay and 30 per cent. sand, was selected. In 1916 the field grew oats, and was two-thirds ploughed, but not manured up to the end of 1917. In March, 1918, colliery manure, 20 tons per acre, was spread over the ground. Ploughing was followed with 10 cwt. of 30 per cent. superphosphate and 2½ cwt. of sulphate of ammonia, and in May 48 cwt. of Templar from Loch Leven were set, over 18 tons being lifted in October, compared with 14 tons from a similar amount of seed in 1917. Though there was a lot of wet weather, the electrical apparatus gave no trouble at all. Early morning and evening treatment gave an influence of 252 hours in 1917 and 588 hours in 1918. The electrified land yielded 9·46 tons per acre, compared with 8·40 tons on neighbouring and similar land. In the report of Mr. C. T. Allan it is stated that the apparatus never failed, though difficulty was experienced in keeping the network charged during heavy rain. The total yield was increased, and the neighbouring land (with which comparison was made had been under electric treatment in the previous year. The area of network was also smaller, the wires only running one way instead of being crossed. The cost of equipment, which could easily deal with 100 to 150 acres, was approximately £300. A similar experiment on a fied of oats yielded an increase of 35 per cent. in grain and 17 per cent. in straw.

Educational.

Prof. W. A. Bone, who delivered the LADY PRIESTLEY MEMORIAL LECTURE at the Imperial College of Science on the 11th inst., said the smoke nuisance caused preventable damage to buildings, furniture, human vitality and plant life amounting annually to not less than £50,000,000, as well as involving a prodigious loss of valuable by-products. As regards the present price at which electricity is supplied to the average householder, he described it as a public scandal. Our distribution of electricity required very drastic reform.

At the TECHNICAL COLLEGE, LOUGHBOROUGH (LEICESTERSHIRE), there are complete courses of training in the theory and practice of electrical and mechanical engineering, and the workshops provide accommodation for 500 students working at the same time. The complete course covers a period of 5 years, during which works training in all branches will be given. The next term will commence on Jan. 4, 1919. Prospectuses, containing full particulars of the courses, can be obtained from the Director of Education, Mr. W. A. Brockington, O.B.E., M.A.

Tenders Invited and Accepted.

LIVERPOOL CORPORATION TRAMWAYS COMMITTEE invite tenders (by noon Dec. 31) for the supply of a number of motor omnibuses. Tender forms, &c., from the general manager, Mr. C. W. Mallins, M.I.A.E., 24, Hatton-garden, Liverpool.

SHEFFIELD TRAMWAYS & MOTORS COMMITTEE requires tenders for 50 double deck top-covered tramcar bodies with trucks. Tenders to general manager by Jan. 7, 1919.

DUBLIN ELECTRICITY SUPPLY COMMITTEE invites tenders for 200 single-phase and 100 three-phase meters. Tender forms from the electrical engineer and tenders to the chairman of the Committee by noon Dec. 23.

The NEW ZEALAND PUBLIC WORKS DEPARTMENT requires tenders by noon Jan. 6 for the supply and delivery of transformers. Conditions from the Public Works Offices, Wellington, Auckland, Christchurch (Electrical) and Dunedin.

STRETFORD URBAN COUNCIL has placed orders with the British Westinghouse Co. for h.-t. switchgear at £2,090 and with Bertram Thomas for l.-t. switchgear at £2,482.

Appointments Vacant.

The Council of Birmingham University invites applications for the chair of physics. Salary £1,000 a year. Particulars from the Secretary and applications by Feb. 8, 1919.

Birmingham Corporation Tramways Department requires a telephone electrician. Applications to the general manager.

A lecturer in physics is required at University College, Exeter. Salary £250 to £300 per annum. Particulars from the Registrar and applications by Jan. 1.

West Ham Education Committee invite applications for the post of Principal of the Municipal Technical Institute. Salary £600, rising to £700 per annum. Particulars from the Town Clerk.

Applications are invited for the chair of chemistry at King's College, London. Initial salary £600 per annum. Applications to the Vice-Chancellor, University of London, South Kensington, London, S.W.7 by Feb. 8.

A head of the engineering department and two teachers of physics chemistry and mathematics are required at the Swindon and North Wilts Secondary School and Technical Institution. Applications to the Principal by Dec. 28.

A lecturer in natural philosophy is required at the University, Melbourne. Salary £450 per annum. £100 allowance for travelling expenses. Applications to Agent-General for Victoria, Melbourne-buildings, Strand, W.C. 2, by Feb. 1, 1919.

Business Items.

In a pamphlet issued by the Phœnix Brazing Company, of Star-lane, Barking-road, E. 16, particulars and illustrations are given of the Phœnix improved process of cast-iron brazing.

We have received from Messrs. Mosses & Mitchell a combined blotter and paper weight, which also serves as a reminder that the firm supply "Vulmos" vulcanised fibre.

Sidney T. Jolley and Alfred Hy. Knight (trading as the Accumulator Service Company), 7 & 9, Station Approach, Wanstead Park Station, Essex, have dissolved partnership. Debts by Mr. Jolley, who continues the business.

Stanleigh E. Herrtage and Geo. Wm. Lester (trading as Herrtage, Lester & Company), electrical engineers, 4, Queen-street-place, London, E.C., have dissolved partnership. Debts by Mr. Lester, who continues under the same style and at the old address.

Bankruptcies and Liquidations.

The Larne Electric Light Works, Ltd., is being wound-up voluntarily, and Mr. J. D. A. Norris, Suffolk House, Laurence Pountney-hill, London, E.C., has been appointed liquidator.

The discharge of Saml. Smith (trading as Smith & Sons), electrical engineer, &c., 22A, 24 & 26, Victoria-square, Widnes, is suspended until Oct. 25, 1920.

An application for the discharge of Andrew Matson, lately electrical engineer, of 10, Hardwick-terrace, Stockton-on-Tees, will be heard on Jan. 14 at the Court House, Bridge-road, Stockton-on-Tees.

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Companies' Meetings and Reports, &c.

The YORKSHIRE (WEST RIDING) ELECTRIC TRAMWAYS, LTD., will pay a final dividend of 3 per cent. (being at the rate of 6 per cent. per annum) on the 6 per cent. cumulative preference shares.

At an extraordinary general meeting of the BRITISH WESTINGHOUSE ELECTRIC & MFG. COMPANY, LTD., on the 12th inst., the resolutions recently passed altering the articles of association and increasing the capital of the company were confirmed.

The directors of the EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH COMPANY, LTD., have declared a third quarterly interim dividend of 3s. per share, payable (tax free) on the 15th prox., in respect of profits for the year 1918. The share register will be closed from Jan. 7 to 14 inclusive.

The EASTERN TELEGRAPH COMPANY, LTD., announce the payment on the 15th prox. of dividend at rate of 3½ per cent. per annum, less tax, on the preference stock for the quarter ending 31st inst., and the third quarterly interim dividend of 1½ per cent. on the ordinary stock, tax free, in respect of profits for the year 1918. The transfer books of the ordinary stock will be closed from Jan. 7 to 14 inclusive.

The trading profit of the BARBADOS ELECTRIC SUPPLY CORPORATION, LTD., for the year ended June, was £3,197, against £2,970 in the preceding year. Repairs and renewals cost £484. Consumers increased from 1,403 to 1,541, and the connections from 19,562 to 22,208 25 c.p. (equivalent lamps). £1,270 was expended on house connections and additions to mains.

The gross receipts of the MANX ELECTRIC RAILWAY COMPANY for the year ended Sept. 30 were £17,554 and expenditure was £11,741. A debit balance was brought forward of £28,223, and adding debenture interest (£9,000) the debit balance is £31,411. There was a gain in working of £5,812, against a loss of £52 in 1917. Passengers carried totalled 173,005, against 119,683. Debenture interest has again been funded by the issue of second debentures.

At the meeting of the STIRLING & BRIDGE OF ALLAN TRAMWAYS COMPANY, LTD., last week the chairman (Mr. Henry F. Brand) referred to the negotiations between Stirling Council and the company for the purchase by the former of the tramway system with a view to its electrification. The negotiations were interrupted by the war, and though he had no desire to push the Council, he thought it right to say that in the opinion of the directors the question of the purchase of the tramways was not one that could be postponed indefinitely; and, failing the Council's taking over the system, the directors would consider the question of the application of mechanical traction.

In the report of the NEW TRANSPORT COMPANY, LTD., for the year 1917 it is stated that parliamentary action has been more energetic, a great many questions having been asked in the House of Commons in regard to the proposals of the Company. On Dec. 6, Sir Albert Stanley, M.P., accompanied by Sir Hubert Llewellyn-Smith, as a result of the deputation which had waited upon him, visited the Company's works and professed himself perfectly satisfied with what he saw. The directors emphasise the obvious determination of the Board of Trade not to have any official dealings which might commit them to even an inquiry.

The past year's net revenue of the PROVINCIAL TRAMWAYS COMPANY from local companies was £39,054. After adding amount brought forward (£8,555), transfer fees, &c., the total is £78,722. Deducting administration expenses (£2,072), income tax (£7,925), interest to debenture holders (£8,750), preference dividend, interim dividend on ordinary shares and other charges, the balance is £48,108. The directors have set aside to reserve and depreciation £12,000, added to reserve account for third-party insurance, &c., £5,000, to reserve for deferred repairs £15,000, leaving £16,108. They now recommend a dividend on the ordinary shares of 10d. per share and a bonus of 6d. per share, making 2s. per share, or a dividend at rate of 10 per cent. for the year, carrying forward £7,804.

The report of the BRITISH COALITE COMPANY, LTD., states that the plant of the Barnsley Smokeless Fuel Company, at Barugh, which is under the management of Low Temperature Corbonization, Ltd., has continued at work with good progressive results. It is hoped, however, to improve considerably on what has already been achieved, and to this end the plant is being largely used for experimental purposes. Good prices have been obtained by Low Temperature Company for all products. The company's interest in the Barnsley Smokeless Fuel Company has been still further increased. Under the terms of the agreement with the Low Temperature Carbonization Company for the exploitation of the company's process throughout the United Kingdom, £9,000 has been received to date.

Mr. A. W. Tait, who presided over the annual general meeting of FERRANTI LIMITED last week, stated that electrical development had made large strides during the war, and would make still greater strides in the near future. One of the points in the forefront of the Coalition programme was the question of the economical generation and distribution of electricity throughout the whole of this country, in order that industry might be supplied with one of its greatest essentials—cheap power. There should, therefore, be a very large business in their own home market, apart from the developments which were taking place and would take place in other countries throughout the world. It was hoped that at the conclusion of the war it might be possible to bring forward a scheme for funding the arrears of dividend on the preference shares and for readjusting the company's capital, and also to provide for future developments.

The report of the ELECTRICAL SECURITIES TRUST for the year to Nov. 14 states that an opportunity occurred to realise the debentures and "B" debentures of the North Wales Power & Traction Company, and as it was desirable to close the debenture holders' trust, the trustees made arrangements for selling the remaining assets held as security for the debentures to a syndicate or pool. The debenture holders approved, and on the sales being completed the trustees had in hand £62,834. At a meeting held on October 15, 1918, the debenture holders authorised the trustees to pay the secretary a fee for the period from the time they took over the securities, to pay fees to themselves for the eight years they had acted as trustees, including special fee to Mr. Shepherd in connection with three visits to Canada, and to Mr. Tait in connection with the realisation of the debentures of the North Wales Power & Traction Company, and to pay the legal charges of the solicitors. After meeting these fees and expenses a sum of £58,000 was available. This sum was accepted by the debenture holders in full discharge and satisfaction of all claims against the trustees or the company. £55 per £100 had already been repaid, and this further distribution gave each debenture holder repayment of the balance of £45 of his capital and £13 per £100 towards payment of premium and interest. The board are considering the question of winding-up the company.

New Companies, &c.

BRITISH SPIRO TURBINE, LTD. (152,171.)—Private company: reg. Dec. 9, capital £50,000 in £1 shares, to acquire from Sir Wm. R. Garforth the benefit of a patent relating to rotary engines and the like, and to carry on the business of engineers, manufacturers of and dealers in steam, oil, gas and electrical engines, &c. First directors, Sir Wm. R. Garforth (permanent director and chairman), Capt. G. H. Bles, J. Lithgoe and T. Beardall. Reg. office, City-chambers, Infirmary-street Leeds.

CARDIFF DOCKS ENGINEERING WORKS, LTD. (151,976.)—Private company. Reg. Nov. 19, capital £3,000 in £1 shares, to take over the business of marine, mechanical, electrical and general engineers and welders carried on as "J. H. Korner & Grivas" at Cardiff. Secretary: C. C. Perkins, 3, Clare-gardens, Cardiff.

GENERAL ENGINEERING COMPANY (HORNSEY), LTD. (151,971.)—Private company. Reg. Nov. 18, capital £12,000 in £1 shares, to acquire business of engineers carried on at Hornsey by Marks, Tongue & Kamenicek, mechanical and electrical engineers, tool makers, &c. Reg. office: Campsbourne Works, High-street, Hornsey.

McWHIRTER & SONS, LTD. (10,177.)—Private company; reg. Dec. 4 in Edinburgh, capital £10,000 in £1 shares (3,000 preference), to acquire business of electrical and mechanical engineers and electricians carried on by William McWhirter & Sons at Glasgow. First directors, W. McWhirter, A. C. McWhirter and A. S. McWhirter. Reg. office, 17, Douglas-street, Glasgow.

ORBIT ELECTRICAL COMPANY, LTD. (152,080.)—Private company. Reg. Nov. 29, capital £60,000 in £1 shares (30,000 cumulative participating preference) to purchase the business of manufacturers of and traders in electrical batteries, pocket and other flash lamps and general electrical appliances, fittings and accessories carried on at Electric Works, Station-road, Chadwell Heath, Essex. First directors are H. B. Stocks, R. D. Browne and T. T. Rankin (all permanent). Reg. office: 2, Coleman-street, E.C.

PORTABLE TOOL & ENGINEERING COMPANY, LTD. (151,886.)—Private company. Reg. Nov. 4, capital £10,000 in £1 shares (5,000 10 per cent. preference), to take over the business of auto tool and gauge makers and electrical and general engineers carried on by A. H. Stead, E. R. Dippe, L. W. Watson. First directors: A. H. Stead, L. W. Watson, E. R. Dipple and J. Woodall. Reg. office: 63, Finsbury-pavement, E.C.

REGENT SHEARS (1918), LTD. (152,090.)—Reg. Nov. 30, capital £75,000 in 70,000 preference shares of £1 each and 100,000 deferred shares of 1s. each, to take over the business carried on by Regent Shears, Ltd., and to carry on the business of manufacturers of and dealers in sheet metal working machinery, press tools, stamping dies, electrical engineers, &c. First directors are E. G. Gubbins and J. Flower. Reg. office: Capel House, 62, New Broad-street, E.C.

Company Registered outside United Kingdom.

KNIGHT & KILBOURNE (EUROPEAN) PATENTS COMPANY (1,682 E).—Particulars filed Oct. 3, 1918. Reg. in Delaware, U.S.A. British address: 2a, Sandy-lane, Coventry. E. M. C. Instone, of the Firs, Kenilworth-road, Coventry, is authorised to accept services. Directors G. T. Knight (Passadena, Cal.), P. Martin, E. M. C. Instone, S. de Jongh (Amsterdam) and G. S. Steel.

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, December 17, 1881.]

ELECTRICITY v. SMOKE.—Dr. O. J. Lodge was announced to deliver a lecture on the above subject last Thursday night at the London Institution.

ELECTRIC LIGHT AT STRASBOURG.—It is proposed to form a company at Strasbourg to supply electric light to the workshops and factories of that town, as well as others in Alsace.

THE NEW ATLANTIC CABLES.—It is reported that a small section of the American Telegraph & Cable Company's second cable was successfully laid at Penzance the other day. The section lies between Penzance and Whitesand Bay, near Land's End.

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CONTENTS.

NOTES 731
Arrangements for the Week 733
Application of the Electric Furnace to the Metallurgy of Iron and Its Alloys. By H. Etchells 734
Land for Public Purposes 735
The Economics of Works Costs. By J. R. Dick, B.Sc.—*Continued.* 736
Carbon Brushes: Considered in Relation to the Design and Operation of Electrical Machinery. By P. Hunter-Brown. Illustrated.—*Concluded* 738
An Electrical Apparatus for Boiling Water. By F. Biermann. Illustrated 740
The Manufacture of Vacuum Detectors. By O. B. Moorhead 741
THE TRAMP ABROAD 742
REVIEW 742
Note on the Production of Continuous Electrical Oscillations by the Three-Electrode Valve. By E. V. L. Appleton, M.A., B.Sc. Illustrated 743
Progress in Photometry With Special Reference to War Problems. 744
CORRESPONDENCE 745
The "Swarren" Conduit Coupling 745
Co operation in Engineering and Allied Trades 746
Effect of Government Control 746
Industrial Council for London Electricity Undertakings 746
Reconstruction and Government Control 746
LEGAL INTELLIGENCE 746
Patent Record 747
Commercial Topics 747
Electricity Supply 748
Tenders Invited and Accepted 749
Educational 749
Companies' Meetings and Reports 749

Notes.

The Great Transition.

SOME idea of the magnitude of war work that was being carried on by our industries up to the time of the armistice was given last Saturday by Mr. CHURCHILL, the Minister of Munitions, at a joint conference of Employers' and Trade Union Advisory Committees. When we read that during 15 successive days Sir DOUGLAS HAIG's artillery discharged more than 12,000 tons of shells per day upon the German front, and that during October the average production of filled shells in this country was over 47,000 tons a week, we get some little idea of what has been done. Now, quite suddenly, this torrent of output is stemmed, and our efforts have to be turned into peaceful directions as quickly as possible. It is gratifying to hear from Mr. CHURCHILL that the change is coming about more easily than was anticipated, but much will, of course, depend upon the steps taken by the Government. There are at present huge Government stocks, and these must be placed upon the market in such a way that our engineering industries are maintained in a stable condition. So far, home prices and export prices for steel and iron have been fixed up to May 1, 1919, and have provided for the gradual removal of Government subsidies. We are glad to hear that priority certificates are no longer required except for special national reasons. Consequently, civil orders may be placed and executed without delays of this kind. We hope that this fact is fully appreciated, for more than once recently we have been surprised to find manufacturers still speaking of priority certificates. Mr. CHURCHILL also announced that the Government are prepared to place very large orders if necessary, and among the branches mentioned were electric lighting and cooking. Contractors are advised to communicate with the Ministry of Munitions if they desire orders of this kind to keep their works fully employed. A speech was also made the other day by Dr. ADDISON, the Minister of Reconstruction, and we were interested to note the statement that the Government were prepared to spend £6,000,000 on the training of men who had joined up as apprentices or after having only half completed their courses. This is an important step. Another point to which Dr. ADDISON referred was the difficult one of purchasing raw materials on a falling market. Manufacturers very naturally hesitate to purchase largely when there is a prospect of prices coming down. On the other hand, trade cannot be resumed fully unless such materials are purchased to an adequate extent. It appears that the Government are prepared to take some action in the matter, but the details of the scheme are not yet disclosed.

British and American Trade Journalists.

ON Dec. 18 a pleasant gathering took place at the Stationers' Hall when the party of American technical journalists, who were on a visit to this country as guests of the Government, were entertained by the Worshipful Company of Stationers, together with a number of their London colleagues. The meeting, arranged by the Circle of Scientific, Technical and Trade Journalists, afforded a useful opportunity for the exchange of views on topics of mutual interest, and we cordially endorse the resolution passed at the meeting advocating future co-operation between the technical press in both countries. The American party only arrived from France shortly before the meeting, and owing to the uncertainty of their programme, the notice was unavoidably short. Nevertheless, a very representative gathering assembled to meet the American guests, and their addresses were listened to with great interest. We were very glad to note the consciousness of the high standing of technical journalism as a profession revealed in these speeches. As one of the speakers said, the services that the technical press can render to industry are immense, probably far greater than those possible to daily newspapers, which have necessarily to deal with such a wide range of interest. Striking instances were quoted of the help given to the American Government by technical papers in the United States, and this experience could be fully corroborated in this country. We need only conclude by wishing our friends a pleasant passage back to their country, and continued prosperity in their profession.

Photometric Developments During the War.

IN his presidential address before the Illuminating Engineering Society last year, Mr. A. P. TROTTER referred incidentally to several interesting researches which the Illuminating Engineering Society had been conducting in regard to the illuminating power of flares, parachute lights, &c., and on the brightness of radio-active self-luminous materials, which, as is well known, have found many special applications during the war. By permission of the Ministry of Munitions, some account of this work was given at the meeting of the Society on Dec. 19. The two researches

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present an interesting contrast. In one case we have to deal with rapidly varying and transient lights, attaining sometimes as much as 130,000 c.p. In the other, we are dealing with minute objects of the same order of brightness as weak moonlight. The special photometric apparatus described by Mr. TROTTER and Mr. CLINTON for this work was distinctly interesting. The experience gained should have a stimulating effect on the design of photometric instruments in the future, and we are glad to find that the work proved of considerable value to the authorities. To anyone with a scientific mind it would seem obvious that appliances such as flares and luminous paint, the whole utility of which depends on the light they yield, should be subject to photometric measurement, and the authorities undoubtedly acted wisely in placing the matter in the hands of men who have experience in this field. We have here one instance of the large amount of valuable work that has been done unobtrusively by scientific and technical societies during the war, and no doubt in course of time we shall have other encouraging instances brought before us of the help they have rendered in the prosecution of the war.

University Courses for Journalists.

AT a meeting at the Institute of Journalists on Dec. 16 the question of the training of journalists was revived in an interesting discussion, Dr. W. L. COURTNEY presiding. The matter is an important one. At present it might be said that most journalists drift into the profession rather than consciously prepare for it. It is doubtless true that many of the characteristics of a really able journalist—the instinct for good "copy," a knowledge of men and affairs, and the power to foresee the trend of public opinion and prepare for it—cannot be completely taught in schools. But there is a great deal, including the ability to write rapidly and clearly in good English, and the art of condensation and selection, which could certainly be taught in a preparatory course. Sir ARTHUR QUILLER-COUCH, in a letter read at the meeting, commented upon the poor powers of expression possessed by most youths after leaving school—a defect which many teachers at colleges have long recognised and which is unfortunately common in the engineering profession. Too often the man who knows most is least able to convey his knowledge to others. In the case of the technical journalist, a course at a university or technical institution of standing should be regarded as essential, and if a regular curriculum for prospective journalists at our leading universities is proposed we hope that the needs of those also propose to deal with scientific and technical matters will be borne in mind. It would be a great advantage if all technical students were to pass through some such course, for, as it is, our engineers as a rule can neither write nor speak the King's English in a way that is worthy of the work on which they are engaged. At the meeting to which we refer, Prof. CUNLIFFE, of Columbia University, gave a most interesting account of the School of Journalism at that institution, and the idea seems to be now a familiar one in the United States. Those who spoke in favour of the establishment of proper educational facilities for prospective journalists included many pressmen of long experience and established reputation. Such prejudice as exists need not be seriously considered when we recall the lukewarm support originally afforded to technical colleges and engineering institutions which have now fully proved their value. We feel sure that the profession of journalism would gain in usefulness and reputation by the establishment of organised training, and we are glad to see that a representative committee is to be formed by the Institute to inquire into the matter.

Mica Insulation Manufacture in Sweden.—It is stated that a factory has been started at Gothenburg, in Sweden, for the manufacture of mica insulating materials, and that supplies will be derived entirely from native sources, the concern having its own mines.

Electro-Magnetically Controlled Coupling for Train Lighting.—According to a patent taken out by the firm of Ehrich & Graetzin, in Berlin, a system of train lighting is to be introduced in which the speed of the dynamo is governed by means of a coupling controlled by an electro-magnet. The slip depends on the excitation, and this in turn is controlled by the current generated by the dynamo.

Synthetic Mineral Oil.—Much has been heard of attempts in Germany to produce various raw materials by synthetic means, rubber being a well-known instance of materials imitated in this way, though hitherto with relatively little success. It is now stated that the Baden Aniline and Soda Works is investigating the synthetic production of mineral oil, and that easily liquified hydrocarbons suitable for the purpose have already been produced. It is hoped to apply the process on an industrial scale shortly, but at present it appears to be still in the experimental stage.

Royal Institution.—Among the courses of lectures that will be delivered before Easter are the following:—Prof. MacGregor-Morris on "The Study of Electric Arcs and their Applications"; Capt. G. P. Thomson on "The Development of Aeroplanes in the Great War," and "The Dynamics of Flying"; Prof. Hele-Shaw on "Clutches"; Prof. C. H. Lees on "Fire Cracks and the Forces producing them"; and Prof. Sir J. J. Thomson (Master of Trinity) on "Spectrum Analysis and its Application to Atomic Structure." The Friday Discourses will begin on Jan. 17 when Prof. Sir James Dewar will give a Lecture on "Liquid Air and the War."

The I.M.E.A. and Electric Power Supply.—Upon the recommendation of the general manager, Mr. H. Faraday Proctor, the following resolution was adopted by the Bristol Electrical Committee on the 20th inst.:—

> That the report of the Incorporated Municipal Association, dated November 29, 1918, upon the question of electric power supply, be approved, with the exception of that portion of paragraph 2 which deals with the constitution of the District Boards.
>
> This Committee is of opinion that where companies are now operating, and continue to operate as either generating or distributing authorities, they should not be excluded from representation on such Boards.

We are glad to see that the above exception has been taken to the I.M.E.A. report, for it indicates a desire for fair dealing which is highly desirable.

The Advantages of Armature Ball Bearings on Electric Cars.—The "Electric Railway Journal" refers to some very favourable experiences of the use of armature ball-bearings, in connection with motor-maintenance. One advantage is that the danger of the armature rubbing on pole-faces is reduced, and the only attention that the bearings need is to be filled with grease every three months. After 100,000 miles running, spread over two years, the inner and outer races are in almost perfect condition and balls were only very slightly worn (0·0·005 in. for 1-in. diameter balls), while the average drop of the armature was only 0·001 in. to 0·014 in. Ball bearings are of special value on systems where frequent expert supervision is impracticable.

Re-opening of the Riga Polytechnic.—The closing of the Polytechnic at Riga appears to have been one of the many prejudicial consequences of war disturbances and the Bolshevik agitation in Russia, but it is stated that a movement has been set on foot for its re-opening shortly. During the last 10 years the industrial activities of this city have developed very actively, and the engineers trained at the Polytechnic appear to have taken a large share in the furthering of engineering trades. It is hardly surprising to find that the German technical Press regard Riga and the adjacent Baltic area, as a sphere for the activities of German concerns. We hope, however, that firms in this country will see that Britain shares in the future work of reconstruction.

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Joint Industrial Councils.—A return has been issued showing the progress that has been made in the work of industrial organisation on the lines of the Whitley report. The leaflet is dated December 2nd, and since that date several additional interim industrial reconstruction committees have been formed. The number of committees of one kind and another given in the return amounts to 73. The name and address of the secretary is given in each case.

Institution of Electrical Engineers.—At the meeting on Thursday, December 19th, the President stated, in regard to the informal dinners following the meetings, that the Council were in a difficulty. On some occasions the number of members attending the dinners exceeded and on other occasions fell short of the number for which provision had been made. It might be necessary to ask members to send postcards intimating their intention to be present.

Engineers' Ballot on 47-Hour Week.—The result of the ballot of the members of the Federation of Engineering and Shipbuilding Trades on the question of the acceptance of the employers' offer of a 47-hour working week, instead of the 44 hours demanded by the men, was declared on Monday. There were 285,558 for acceptance and 147,086 against. By the agreement between the parties the other working conditions are to be maintained for the present.

Use of Meters on Tramcars.—The "Electric Railway Journal" gives some instances of the utility of meters on tramcars with a view to checking waste of energy. Some comparative tests, made with the same equipment on level lines and gradients show that as much as 26 per cent. saving in energy could be made in this way. Originally 2·093 kw.-hr. per car-mile was obtained in a test in which the dials of all meters were kept covered, so that the driver could not obtain any information as to the current he was taking. Subsequently, after a period of training in which instruction was given on the handling of the cars, by observations of meter readings an energy saving of 0·253 kw.-hr. per car-mile (about 12 per cent.) was obtained—in spite of the fact that climatic conditions were less favourable than in the first trials. On very severe hilly routes it was eventually found that the energy consumption could be reduced from 3·41 kw.-hr. to 2·52 kw.-hr. per car-mile—a saving of 26·1 per cent.—mainly due to better handling of controllers and brake equipment.

Utilisation of Copper and Steel Scrap in Canada.—According to "Engineering" the copper scrap obtained during the machining of the copper driving bands of shells produced under the direction of the Imperial Munitions Board, Ottawa, is now being refined and cast into ingots. Up to the middle of August, 10,000 tons of copper had been thus reclaimed, representing a value of approximately $5,000,000. Steel scrap is also being continuously recovered in large quantities, the present annual value of which is approximately $5,000,000. A subsidiary organisation of the Imperial Munitions Board operates works at Toronto, which are believed to be the largest electric steel works in the world. Here the steel scrap accumulation collected from several hundreds of munition factories in Canada is converted by the electrical process into ingots and forgings. Operations commenced in July, 1917, and the present monthly capacity of the works is about 5,000 tons of shell steel. Up to May 31, 900,000 6-in. shell forgings had been produced in addition to 69,500 9·2-in. shell forgings.

Transmission of Heat Through Heavy Building Materials. A series of researches on the above subject by Mr. A. H. Barker and Mr. M. Kinoshita, carried out at London University for the Research Committee of the Institution of Heating and Ventilating Engineers, has now been published. Much of the work consisted in developing standard methods of testing heat transmission through thick walls, and the authors describe their methods in great detail and evolve a series of formulæ which can be applied to this problem. The apparatus comprised a suitable insulating chamber heated electrically, so that the internal ventilation was under strict control. One of the chief conclusions drawn from these experiments is the need for caution in drawing conclusions from tests on any particular wall, the age of which has an important bearing on its insulating properties. It is shown that currently accepted coefficients are 25 per cent. low if applied to an old wall and that a special addition to heat losses—amounting to in this case 45 per cent.—had to be made for effects of wind and rain. Dampness in a wall may readily increase its average emission by 50 per cent.

Institute of Chemistry.—Our attention has been called to the fact that the Institute keeps an Appointments Register, and that facilities are available, free of charge, to companies and firms requiring the services of properly qualified analytical, research and technological chemists, and to universities, colleges, technical schools, &c., requiring teachers of chemistry and technology. The war has brought to many manufacturers the realisation that in the great majority of productive industries the assistance of an adequate staff of properly trained and qualified chemists is not only essential but highly profitable. Many qualified chemists with valuable practical experience in analysis, in research, in plant control and management, will shortly be available. Companies and firms are therefore invited to notify their requirements to the Registrar of the Institute, 30, Russell-square, London, W.C. 1. The requirements should indicate the industry, the general nature of the duties to be entrusted to the chemists, the salary and prospects attaching to the appointments, and to whom replies should be addressed. It is anticipated that many of the chemists engaged in the factories under the Department of Explosives Supply, Ministry of Munitions, will shortly be available for employment in private works or elsewhere. It is important that the public and those interested in chemical manufactures should realise how great a national asset the services of these chemists may prove. Many of them have carried out on the large scale valuable investigations relating to the difficulties that have arisen in the course of manufacture, and on the recovery of waste products. There is no doubt that many such chemists can be usefully and profitably employed in the scientific management of factories and that they will prove extremely valuable to our chemical industry.

Obituary.

J. BANNEUX.—The death is announced of M. J. Banneux, a former director-general of Belgian telegraphs. Deceased was 72 years of age, and retired from the service in 1913.

E. J. HOUGHTON.—We regret to record the death of Mr. E. J. Houghton formerly electrical engineer of the London, Brighton & South Coast Railway Company, which occurred at his residence at Croydon on the 16th inst., aged 74 years. Mr. Houghton retired from the railway service in September, 1909, after more than 50 years' service, during 34 years of which he held the position of chief electrical engineer of the Company. He was the pioneer of electric train lighting in this country, a train equipped with the system he designed having first run between London and Brighton in the year 1881.

Personal.

Sir John A. F. Aspinall, who for about 20 years has been general manager of the Lancashire & Yorkshire Railway Company, has decided to retire from the position in January next, but he will become a director of the company.

Ald. Knowles Edge, J.P., deputy-mayor of BOLTON, last week presented the D.C.M., which was awarded at Gallipoli on Jan. 4, 1916, to Sergt. J. G. Jones, R.F.A. Prior to enlistment, Sergt. Jones was an electrician in Bolton.

Arrangements for the Week.

ROYAL INSTITUTION.

At Albermale-street, Piccadilly, London, W. Six Christmas Lectures for Juveniles on "The Fish of the Sea," by Prof. D'Arcy W. Thompson, F.R.S.

Tuesday, Dec. 31st.

3 p.m. Lecture I.—"Jelly-Fishes."

Thursday, Jan. 2nd.

3 p.m. Lecture II.—"Star-Fishes."

Saturday, Jan. 4th.

3 p.m. Lecture III.—"Cray-Fishes."

WEDNESDAY, Jan. 1st.

ROYAL SOCIETY OF ARTS.

3 p.m. At John-street, Adelphi, London, W.C. Juvenile Lecture on "Liquid Drops and Globules," by Mr. C. R. Darling. (Lecture I.)

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Application of the Electric Furnace to the Metallurgy of Iron and Its Alloys.*

By H. ETCHELLS.

It was the experiments of Siemens, and later of Henri Moissan, which directed attention to electricity as a desirable means of conducting metallurgical operations, and as a means of widening our knowledge in regard to the reactions governing the extraction and the melting of metals.

Considering that iron is the metal which fills the premier place in the world's industry, it is not remarkable that many industrial workers should have striven to apply the apparent advantages of electro-metallurgy to endeavour to improve the metallurgical processes dealing with the production and subsequent treatment of this metal.

The first two fields to be investigated were the production of iron from its ores and the utilisation of electro-thermal processes in the art of steel-making. Investigations were carried out concurrently in both of these directions. I do not propose to enter into copious details in regard to the various investigations which were followed, but I would like to lay before you some of the fundamental ideas upon which electric furnace processes are based.

Electrical methods appealed to many investigators and still appeal to many people to-day, because of the high temperatures which it is possible to obtain by their use. Some people have the idea that the employment of increasingly high temperature brings many benefits and is a sure remedy for all ills. As is well known, in the combustion furnace heat is produced by the oxidation of some combustible substances, the product of combustion being gas. The efficiency attained, or the ratio between the amount of heat usefully employed and the heat value of the fuel, is generally rather low, averaging perhaps 25 per cent.

On the other hand, the average efficiency of an electric furnace is about 60 per cent., whereas the highest efficiency in combustion furnaces is only attained in the blast furnace somewhere in the neighbourhood of 66 per cent.

Calculation shows that 1 ton of pure iron consumes theoretically 400 kw.-hr. of electrical energy to raise it from normal atmospheric temperatures up to its melting point. Therefore, bearing in mind that after the metal is melted it often has to be superheated, and also maintained above its melting point during the process of refining, the efficiency of electric furnaces, which are to-day melting mild steel at the rate of 480 units per ton, and completely melting and refining at the rate of 650 to 800 units per ton, is reasonably high.

It is necessary to qualify the statement that there is no limitation to electric heating; theoretically, there is not, because the temperature of the electrical arc goes up to 3,600°C., while with resistance heating, providing a suitable resistor material could be obtained, concentration of energy could be made enormous; practically, there is a limit, because on the one hand the only material which will stand up to the temperature of the electric arc in any degree, is carbon. If we depend on resistance heating there are not many materials which can be heated above 1,700°C. by resistance methods.

At the same time we can attain industrially considerably higher temperatures than those attained by combustion furnaces, for the following reasons:—

1. At high temperatures carbon oxidises to CO and not to CO^2. The oxidation of 1 lb. of carbon to CO^2 generates 8,100 lb. calories, whereas the oxidation of 1 lb. of carbon to CO generates only 2,430 lb. calories.
2. The gaseous products formed escape readily from the furnace.
3. In commercial work, at present at least, it is not feasible to supply pure oxygen for combustion purposes.
4. Atmospheric oxygen is accompanied by four times its volume of nitrogen, and if air is used for combustion the nitrogen absorbs a considerable quantity of the heat generated.

The theoretical limit of temperature for the combustion furnace is, therefore, in the neighbourhood of 2,000°C., and in practice it is very hard to exceed, to any extent, the temperature of 1,650°C.

The application of heat in the electric furnace suggests itself as being ideal. Where arc or resistance methods are used, it is possible, in the majority of processes, to apply the electric heating right to the spot where it is required, and the only losses which occur on a large scale in properly designed furnaces, are those due to simple radiation alone. This accounts for the considerably greater efficiency of the electric process.

At the same time there is such a considerable disparity in the price of coal or gas on the one hand, and in the price of electrical energy on the other, that even with the higher efficiency of electrical heating it is only in those countries where carbonaceous fuel is scarce and where other methods of generating electrical energy are possible that the electrical process is the cheaper.

The first electric furnace for steel making was due to Héroult, and since that time much progress has been made. One of the earliest furnaces is the Girod, in which the current is fed by upper electrodes across an arc gap and into the charge in the furnace, and extracted from the furnace charge by means of water-cooled iron studs embedded in the lining of the hearth. Although this may be justly designated a risky device to incorporate in the hearth of the furnace, Girod built quite a number of furnaces and worked them with considerable metallurgical success, attaining a reputation in France for the quality and variety of alloy steels comparable with that of many of the best steel-making firms in this town.

In the electro-metals furnace, which originated in Sweden, there are at least two upper electrodes and a bottom electrode which is in contact with the furnace lining. Two-phase current is applied, one phase to each group of upper electrodes, and the hearth electrode is made a common neutral connection. The electrical advantage of such a furnace with a hearth connection, is that one upper electrode can be regulated without disturbing the balance of the current flowing through the other upper electrodes; in fact, one electrode can be lifted out altogether, and the current from the other upper electrode will continue to flow into the furnace and to be extracted by the bottom electrode.

In three-phase furnaces built without a bottom electrode the regulation on one electrode affects the load on the others.

In its simplest form the Greaves-Etchells furnace uses three-phase current, but only two phases are applied to the top electrodes and the third phase is connected to the furnace hearth. Contrary to the furnace bottom acting as a simple electrical connection, the hearth is designed to act as an electrical resistor, and this causes heat to be generated in the hearth of the furnace.

The aim of good furnace design should be to bring the heat of the arc as near the charge as possible and to avoid radiating the heat from the arc on to the roof and side walls of a furnace, as the radiation loss through the walls is considerably increased thereby, and also the wear and tear on the roof and walls is likely to be increased. This argument is, perhaps, one of the greatest objections to the free-burning arc type of furnace, but it must be pointed out that the regulation of the electrical load on a free-burning arc furnace is not liable to the same fluctuation as that of an arc contact furnace.

Pure electric resistance heating in steel-making has not had any successful degree of practical application up to the present, except indirectly as we may consider it as forming part of the principle of the induction furnace.

From an engineer's standpoint the induction furnace is ideal, but the metallurgist will soon realise the practical difficulties which occur in dealing with liquid steel in narrow channels. Among other things, these comprise:—

1. Irregular and excessive erosion in certain parts of the lining, giving considerable difficulty in the matter of repairs.
2. Excessive radiation owing to the tremendous surface exposed for the volume of metal dealt with.
3. Awkward manipulation for charging.
4. Difficulty of using and evenly manipulating the slag.

Such furnaces are used, however, in certain parts of the world and have been improved to some extent to minimise the above-mentioned difficulties, by Rochling and Rodenhauser in the form described by the Author.

Chemical Reactions of Electric Steel Making.

The chemical side of the electric process of steel making is quite different from that of any other process. It combines the oxidising conditions of the open hearth processes with a finishing state, in

* Abstract of a Paper read before the National Association of Industrial Chemists (Sheffield branch), November 1, 1918.

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which the reducing conditions are even stronger than those of the well-known crucible process. But in addition to the manipulation of two different atmospheres in this way, the elimination of certain chemical impurities can be undertaken during both periods.

The oxidation period is most conveniently combined with the melting period. As the steel is melted in the furnace it drains into the lower part of the furnace and forms a bath of liquid metal there. The addition of slag making materials such as lime, iron oxide and a little sand, serves to steady the loading of the electric arc, while at the same time the iron oxide consumes any carbon present in the metal. Phosphorus is also oxidised and passes into the slag as calcium phosphate.

When the whole charge is completely melted a very short time of continued heating, generally about half an hour, suffices to bring the charge to the slagging stage. At this stage the slag containing the phosphorus is completely raked off over a special spout provided for the purpose. Before raking the slag off every attempt should have been made to bring the slag into a fluid condition. If the carbon in the steel has not been reduced to a very low figure, something under 0·15 per cent., it will be found rather difficult to get the slag fluid. Fluidity must be obtained by the judicious addition of sand and fluor-spar.

The total silica contents of the slag should be kept as low as possible, and careful attention should be paid to neutralising with lime any silica which is formed by the oxidation of silicon originally contained in the metal.

It should also be borne in mind that a complete removal of the phosphorus is not possible if the slag is very siliceous, or if the carbon remaining in the metal exceeds 15 per cent.

When the Carbon is oxidised to a low figure the manganese also becomes oxidised to a low figure, but contrary to open hearth practice, wherever there is an appreciable percentage of carbon present, it will be found very difficult to eliminate the manganese. After the metal has been completely denuded of its first slag, any excess of dissolved iron oxide in the metal should be reduced. If it is intended to make a carbon steel. this can be conveniently done by adding a shovelful of pea-sized anthracite. A rough carburisation can then be accomplished with more anthracite on a basis of about 70 per cent. carburising efficiency. On the other hand, if it is desired to make a low carbon steel, such as a case-hardening steel, ferro silicon should be used in heavy lumps for de-oxidising the metal.

After the metal has been de-oxidised, and re-carburised if desired, the power should be switched on, and all the anthracite dissolved into the metal before a second slag is added. The load will be rather erratic under these conditions, but it will be found impossible to get the anthracite to completely dissolve in the metal unless the further heat is applied in this way.

The second slag should be made up of about 70 per cent. of burnt lime, 20 per cent. of fluor spar, and 10 per cent. of sand. If this slag is found too stiff, when the metal is hot it can be thinned out to the desired fluidity by the addition of small quantities of sand and fluor spar. When the slag is fluid, powdered anthracite should be added in small lots at intervals. The anthracite will react with the slag to reduce any metallic oxides contained in the slag. The slag will become perfectly white, and the complete de-oxidiaton of the metal will quickly follow. If the metal shows any tendency to be oxidised at this stage the addition of a few lumps of ferro silicon will facilitate de-oxidisation more quickly than the slag alone could do.

The steel is best poured with the addition of a little aluminium in the ladle, but nothing like the quantity which is used in other processes.

Time does not permit me to enlarge upon the qualities of electric steel; many of those present have had the handling of this material and know that when it is properly made it is infinitely superior to any other class of steel, with the exception of crucible steel. Even in the particular domain of crucible steel, electric steel is a serious competitor.

The war brought upon us a very greatly increased demand for high-speed steel, and at the time when the crucible furnaces of the country and the men available to work them were not sufficient to cope with the demand, the 10-cwt. size of the "Greaves-Etchells" furnace was installed in many Sheffield works, and not only succeeded in turning out high-speed steel regularly from the usual materials available in crucible practice, but also used up large quantities of poor grade ferro-tungsten, high-speed runnings, swarf and scrap, which would otherwise have been practically wasted. Those who have used electric high-speed steel made by an expert, say that it is more uniform and gives better mechanical results than crucible steel, but it is very hard, of course, to get reliable data on these matters.

Electric Smelting.—Turning now to electric smelting, we are faced with a much more difficult proposition than melting, and the difficulty lies in the practical designing of a furnace to give the most economical results. Where electric steel making may score in many localities because of the quality of the product, the same cannot be said of electric smelting.

The consumption of power per ton of product is on a much larger scale. The industrial figure of 2,225 kw.-hr. per ton of pig-iron, which is stated to have been attained by the Swedish Elektro-Metallshaft furnace, shows very high efficiency. But this figure emphasises, however, the fact that electric power must be cheap.

Ferro Alloys.—The following ferro alloys are made by electro-thermal processes:—Ferro silicon, ferro chrome, ferro tungsten, ferro molybdenum, and latterly ferro manganese. The consumption of power for such alloys is on a much larger scale than any other electric process in iron metallurgy. The average grade of ferro silicon takes about 10,000 units per ton of alloy produced, and the other alloys are in a similar range.

The operation is generally carried out in furnaces without a roof. Some furnaces are made to tilt, but more often they are fixed. Some have a tap-hole, from which the product can be drawn from time to time.

Amorphous carbon electrodes are simply suspended inside a box lined with refractory material, and the reaction between the carbon and the metallic ore is carried on by means of electric current. Iron is added in the form of steel turnings or iron ore. The layer of ore and carbon suffices to act as a covering for the contents of the furnace.

The electrical arrangements of a Ferro-Alloy Furnace are comparatively simple, but the metallurgical operation demands considerable metallurgical and chemical skill. It will be seen that the product must be good enough to commend a specially high figure, in order to make the proposition attractive in countries like Great Britain, where electric power is so expensive.

Electrodes.—In closing, I should just like to say a few words in regard to electrodes. The amorphous electrode is desirable for all smelting processes, because it necessarily forms part of the fuel used as a reducing agent in the process. For purely melting processes, however, such as steel making, the Graphite Electrode has undoubtedly proved its superiority. It is easier to handle, it makes better joints, and a better contact can be made between the graphite electrode and the electrode holder for the transmission of the electric current.

At present many people are tempted to use the amorphous electrode because of its cheaper price, but even on the price ruling to-day, although the actual cost of electrodes, based upon consumption, may show the graphite electrode to be more expensive, the actual saving with graphite electrodes is gained by lower power consumption, lower labour costs, lower repairs and replacements to furnace roofs and electrode holders, and more continuous working. The graphite electrode has four times the conductivity of the carbon electrode, and is thus used in sizes approximating half the diameter of an equivalent carbon electrode.

It is to be hoped that something will be done towards producing the graphite electrode in this country, as there is little doubt that they can be made and sold over here much more cheaply than they are at present procurable from America.

Land for Public Purposes.

In a recent lecture before the Surveyors' Institution, Mr. J. D. Wallis read a Paper on the proposals outlined in the first report of Mr. Leslie Scott's Committee dealing with the law and practice relating to the acquisition of land for public purposes. He expressed the opinion that, if Parliament, by a general Act, authorised the acquisition of land compulsorily by Government departments, local authorities, private companies and individual promoters, it was unnecessary that each particular application for land should need the procedure of private bill legislation. The cost in many cases would be prohibitive, and the decision as to which particular plot of land should be taken and the allocation of compulsory powers to particular applicants did not need to be a legislative function. The work might be done by a properly constituted tribunal exercising judicial powers, sitting locally where desirable, and carrying out their duties expeditiously and without undue cost to the promoters. In such matters the decision of such a tribunal would be final, and no questions of general policy would arise. They would of necessity consider questions of finance and the general merits of each application, but only in order to satisfy themselves that the application was one which, in the public interest, should be allowed.

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The Economics of Works Costs.

By J. R. DICK, B.Sc.

(*Continued from page* 715.)

Summary.—This article deals with the following points:—(1) Symbolic statement of economic laws in general. (2) Law of rent in the agricultural industry. (3) Rent as a function of productivity of the soil. (4) Kelvin's law compared with law of rent. (5) Royalty for manufacturing processes a species of rent. (6) Law of diminishing productiveness in other industries besides agriculture. (7) Factory costs and their object. (8) Analysis of their components. (9) Labour charges, day-work, piecework and premium systems in relation to workman's productivity. (10) On costs or shop charges in general. Part of the oncost is a function of the productivity of the machines. (11) Hyperbolic laws of the capital cost of machines and the running expenses per unit of product. (12) Effects of increasing output. (13) Relation of machine oncost to direct labour cost. (14) Indirect labour and other shop charges. (15) Limits of accuracy in expressing oncosts generally as a linear function of the direct labour. (16) Relative values of direct labour and shop charges, with examples. (17) Establishment charges—how they are allocated. (18) Selling price inclusive of profit—how ascertained. (19) Relative importance of the cost factors. (20) Instances where materials preponderate in the cost—Cable making—Foundry work. (21) Where invested capital cost preponderates—Electricity supply.

Proof of the Usual Formula for Distributing Oncosts on Direct Labour.

Limits of its Correct Application.

The value of the final coefficient or percentage H is such that, over a given period of working, the aggregate value of the oncost Q is equal to HL. But L is actually the sum of the labour charges of a variety of operations undertaken in quantities of N_1, N_2, N_3, &c., or the sum is $L=L_1+L_2+L_3$, &c., corresponding to N_1, N_2, N_3, &c. The coefficient H is the resultant sum of all the coefficients h_1, h_2, h_3, &c., which fix the relationship of the different elements of oncost Q_1, Q_2, &c., to the value of the labour. It is nearly impossible to build up H synthetically from its components h_1, h_2, h_3, &c., and the only practicable method for finding H is to take the sum of all the items in Q for a given period, say a month, and divide this sum by the total direct wages L for the same period. But bearing their analytical form in mind, the careful cost-keeper is always on the watch to see that allowance is made on individual jobs for any exceptional variation either in the proportion of direct labour or the character of a special shop charge, which may introduce a serious error if the average value of $H=Q/L$ were applied indiscriminately to an operation or job presenting unusual features.

The principles to be followed in distributing the oncosts Q on the direct labour, when estimating for future work can thus be recapitulated.

Q has essentially a fixed ascertainable value per month, at a given stage in the development of a factory. L is the direct labour estimated to be required in the same period, and consists of the sum of the quantities of labour L_1, L_2, L_3, &c., to be expended on the various operations of the normal volume of business in prospect.

Since $H=Q/L$, if any operation requires an amount of direct labour of the value L_n, its corresponding oncost is HL_n. If either of the quantities Q or L diverges much from its original assumed value, it is no longer possible with an invariable percentage H for Q to be equal to HL. In other words, if the shop is slack for a time the direct labour bill L falls, and HL will not then cover the oncosts.

Conversely, trade may be brisker than anticipated, or the character of some of the work may change, so that L may be higher than its assumed value, with the consequence that HL is more than equal to Q. It usually shows unwise management in either of these cases to alter the percentage H every month with the object of satisfying exactly the equation $Q=HL$. It is preferable to adopt a broad outlook. If the output falls for a time it is a doubtful policy to increase the selling price per operation to correspond to the higher value of H. A diminishing output indeed, suggests the necessity for lowering the price rather than increasing it. The remedy for any temporary adverse discrepancy between actual and assumed oncosts per article is greater activity in enlarging the market for the goods. Similarly, it is inadvisable to reduce hastily the percentage H, unless an increased output is likely to be permanent. With premium systems it is usually better when estimating to reckon on the full basis time or labour value allowed, instead of that actually taken; the difference in oncost will appear as profit.

The prosperous stability of a business can only be assured by working to a definite plan, whose object is to reach and maintain an output in keeping with the capital invested. Occasional fluctuations should not tempt the works manager to increase H; if the selling organisation is enterprising in its methods, then the total oncost Q will be covered at the end of the year, when the forecast of the output has been reasonably correct. In establishing a new branch of business the prediction of a suitable output is the governing factor in fixing the percentage for the oncosts. The development is thereby accelerated, as it would be much slower if it were obligatory to cover the oncosts completely from the start, and thus to maintain the oncosts, total costs and the selling prices on too high a level. Briefly, it pays generally to sell at a loss, as regards oncosts, until the proper output has been secured.

The numerical value of H varies within wide limits, depending on the nature of the factory equipment and the work undertaken. In some shops it is 50 per cent., while in others it may reach 150 per cent. with less total costs for similar operations. In the one case $L_1+\frac{50}{100}L_1$ may actually exceed $L_2+\frac{150}{100}L_2$, where L_1 and L_2 are the respective amounts of direct labour. In reality the general relationship between Q, H and L is quite elastic, and nothing can be predicated from the magnitude of one of them alone. But, for a given factory, there is usually a ratio between Q and L which ensures minimum costs.

The tendency in progressive workshops is undeniably towards an increase in the percentage H, accompanied by a diminishing cost per operation due to the productivity of the machinery and the machinists. The payment of less direct wages per operation is not equivalent to lowering the workman's total wages, as already indicated, although this mischievous fallacy shows amazing vitality under many guises.

Example of the Relative Influence of Oncosts and Direct Labour.

Much interesting information on the problems associated with oncosts has been gathered from the experience of general fitting shops, temporarily adapted for the manufacture of shells on repetition lines. The following figures from actual practice illustrate the effect of the different kinds of plant and their capital costs, and the influences of the varying values of the other oncost items relative to their respective "direct labours."

In factory A the plant was chiefly of the modern capstan type, while in B the ordinary shop lathes were powerful and in good order. In C the equipment consisted of cheap light lathes, originally in poor condition but each set up as well as possible for one operation on shell parts. The outputs of shells were in the ratio of 3, 2 and 1 for A, B and C respectively. The net result, after two years' working, was that the labour costs per shell, with oncosts added, did not differ by 15 to 20 per cent. among the three factories.

In case C each of the lathes was kept continuously on one operation, and it is clear from the figures that the dexterity of the attendants on the single-purpose machines nearly

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compensated for the more frequent chuckings that were required, compared with one chucking for a sequence of operations on the capstan, especially when all the heavier shop charges in the latter case were taken into consideration.

This example illustrates the tendency of $L+Q$ to reach an asymptotic value under different conditions of repetitive production. It shows clearly the advantages of making one article in bulk, instead of a variety of articles, or pN instead of $N_1+N_2+N_3$, &c. For precisely similar things, such as shells, the output per week which will give nearly the limiting value of $L+Q$ is not enormously high, as might have been supposed. It is just on this account that the small factory specialising in one or two types can often hold its own against a department of a mammoth concern producing the same types. To restrict small works to one or two specialities in accordance with a pre-arranged co-operative plan is one of the most hopeful suggestions for increased efficiency of production after the war. The chief drawback to this plan is the uninteresting and monotonous character of a "single-purpose" factory.

Establishment Charges and Profits.

The remaining element in the cost of a manufactured article is the establishment charges and selling expenses designated under M. In many cases, especially in large undertakings, it lies quite outside the control of the works management, and its amount is determined largely by financial and commercial considerations. Its importance as part of the actual selling price is as great as that of the other factors, and like them, it has usually a "best value." If it is too low the factory will suffer from want of co-ordination, and the sales will be meagre or at unsatisfactory prices. If it is too high, it may absorb what would otherwise be an adequate profit. Thus again, a mathematical problem in maxima and minima must be practically solved to secure the best results. The value of M used in cost accounts is the sum of its components, all of which are known, for a period long enough to furnish a good average, usually six or 12 months. No good object is achieved by distributing M over the prime cost elements S and L, since M is not a natural function of either. A manufacturer who is a good trader always thinks of and handles selling and management expenses as a percentage of his turnover in money, just as he deals with his net profit as a percentage of the turnover. If F is the value of the turnover, $M=y_1F$ where y_1 is the percentage relation between the two. Similarly, if y_2 is the percentage rate of profit expected, the amount of profit will be y_2F. F is not yet known, but only the cost elements $S+L+Q$, and some percentage x of this sum must therefore be added, so as to cover y_1F and y_2F.

Calling $S+L+Q=A$ for simplicity, then

$$A+xA=F \quad \ldots\ldots\ldots \quad (24)$$

and $$xA=y_1F+y_2F,$$

or $$xA=(y_1+y_2)F \quad \ldots\ldots\ldots \quad (25)$$

and from (24) and (25)

$$x=\frac{y_1+y_2}{1-(y_1+y_2)} \quad \ldots\ldots\ldots \quad (26)$$

Usually it is desirable to know the complete cost of production, dissociated from the profit, and to find M in that case the percentage by which $S+L+Q$ is multiplied, is

$$x_1=\frac{y_1}{1-y_1} \text{ and } M=x_1(S+L+Q),$$

from which $S+L+Q+M$ or the complete cost can be obtained.

The use of the value of x in (26) enables the cost accountant or estimator to arrive at the final goal of his efforts: The actual selling value $F=(S+L+Q)(1+x)$, which will ensure the anticipated profit of y_2 per cent. on the sales. Should the total output fail to reach its predicted amount, it is clear that the percentage x_1 employed in making up the costs of an individual job, will be insufficient to provide for the requisite share of M chargeable to the job. As with oncosts, it then becomes a matter of business judgment whether the greater cost of production should be recognised and the selling price increased, or whether it is better, without ignoring the higher or true costs, to pursue consistently the policy of estimating the individual selling prices on the value of F which is aimed at. It must never be forgotten that the market price is influenced by the competition of other factories, and the knowledge of the cost of production in a particular factory only furnishes a criterion of the safe limits within which selling prices could or should be adjusted.

Another cognate point may be noted in the allocation of establishment charges and profit where there is much diversity in the commodities produced. There is no inherent necessity for using invariable percentages for each article, as market conditions may demand selective treatment. For a time some of the goods may be unable to bear the standard additions for establishment charges and profits, while others may bear considerably more. Capable selling generally implies flexibility in the allocations, subject to the limitation that the total charges are finally covered, and the normal profit on the whole turnover is realised. Even when works costs are ascertained and unquestioned, violent controversies frequently rage over this subject in certain cases—*e.g.*, the sales of electric energy, some engineers maintaining that individual selling prices should always bear a uniform relation to the costs, while others are emphatic that, if the aggregate profits are sufficient, no fixed relation need be preserved in every instance.

Although profits, in the accounting sense, appear suddenly in the final process of determining the selling price, they must be recognised as really growing *pari passu* with the cost items, at all events for standard articles, whose sales are assured to customers of good credit. Profits can then be considered as a continuous function of the time of production. Failure to admit this principle was one of the fallacies which led the earlier cotton manufacturers to justify the employment of child labour for 12 hours a day. They claimed that their small margin of profit was all made in the last hour of the twelve, and any reduction of the hours of labour would have meant ruin. Curiously enough this view was seriously supported by eminent economists!

Examples of the Application of the General Formula, where Cost of Materials is High. Electric Cable Making.

The relative importance of the quantities appearing in the cost equations differs widely in the various undertakings engaged in the production of engineering commodities. This aspect of the question of costs will repay the closest study, for it is fundamental in cost-keeping and estimating to devote most attention to the item which is proportionately the most expensive in the commodity. A saving of 5 per cent. there may be easier to effect, and may be as beneficial in its result on the total cost as a saving of 20 per cent. or 30 per cent. on one of the other items.

One of the typical instances of an industry, where the materials S are the preponderating element, is the manufacture of insulated cables. If the makers' prices for a given class—say low-tension single-core, paper-insulated and lead-covered cables—are represented graphically with respect to the cross-section, the result is a straight line, whose equation is $c=a\,.\,s+b$, in which c is the price in £ sterling per 1,000 yards, s the cross-section in square inches, a and b constants. This relation can also be expressed in the hyperbolic form, on the principle already discussed, and then $\frac{c}{s}=a+\frac{b}{s}$.

The values of a and b, when copper is £100, and lead is £15 per ton, are approximately 765 and 20; hence $c=765\,.\,s+20$, and if, for example, s is 0·3 sq. in., c will be £250 (approx.).

The analysis of the material, S, shows that 1,000 yards of 0·3 cable contain 1·55 tons of copper of £155 value, and 1·8 tons of lead of £27 value; inclusive of paper insulation, &c., the total value of S is £188, or 75 per cent. of the price of the cable.

The charges for labour, L, are £16 (approx.), the oncost Q with H at 100 per cent. is £16, the establishment charges M

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at 7½ per cent. of F, are £19, and $F=S+L+Q+M+$ profit becomes 250=188+16+16+19+11. These figures, although only approximate, are sufficient to show that S is the determining factor in the selling price F. The reason for the straight line law being true for a wide range of cross-sections, say, 0·1 to 0·8 sq in., can also be recognised. The item L depends on the speed of the cable making machinery, as the larger the cross-section the longer the time occupied on the machines, and hence the greater the wages of attendance. L can then be considered as practically a linear function of S (itself directly proportional to the cross-section) with a small constant added, and a similar principle applies to the oncosts and establishment charges. The coefficient H is for convenience based on the weight of the copper, or it is so much per ton. This avoids confusion due to the current variations in the price of copper, which affect the *value* of S. Generally, where the product is uniform in character, and where the expenditure on S is relatively high, it is convenient to distribute not only Q and M, but also L as a function of S, and a little investigation will show as in the above case of electric cables within what limits a straight line law is valid.

The constant b in cable manufacture represents the cost of insulating and lead covering a single infinitely small strand of wire; in other industries the nature of the product will suggest an appropriate definition for the corresponding constant. S in tons is the most desirable independent variable for all the cost factors, in enterprises such as rolling mills for steel sections, brass foundries and foundries for simple heavy iron castings, &c. Reckoning all cost items on tonnage keeps the ratio of L or Q to S independent of the purchase price of S.

Errors in estimating L, Q and M with businesses of this kind would appear to be comparatively harmless on account of the accurate knowledge of the material, which forms the great bulk of the costs. But it must not be forgotten that the very nature of the business, which is to accentuate the trading in contrast with the manufacturing side, tends to restrict the percentage rate of profit to quite a modest figure, and thus there is little permissible margin for gross errors in estimating. The prospects of maintaining a safe level of profits in undertakings, where material costs preponderate, are undoubtedly high. To misjudge the stabilising effect of this factor of materials may bring disaster on a small business, which does outside repairs or erecting work in addition to manufacturing. Where little material is involved on a job done outside the factory, it takes a very high charge for men's labour, to compensate for the profit lost by their withdrawal from productive work inside the factory. As might be seen at a glance, abundant working capital is the necessary concomitant of handling expensive materials on a large scale, and any firm ambitious of entering a field promising moderate but secure profits on these lines must be prepared to invest large sums in stock. From the desire to embark on a business of this kind to its achievement is not an easy step, but the principle of handling as much material as possible with a given plant investment and wages bill, deserves to be kept constantly in view in all businesses.

War work affords some striking examples of the productivity of repetition machinery operating on costly materials such as gun metal, aluminium, &c. In an actual case a capstan lathe, set up for the production of a small bearing bush of phosphor bronze, cost £180 inclusive of its accessories. With the ordinary rate of establishment charges and profit the selling value of the annual output of this one machine on a day shift alone was about £4,000, a result which in the ordinary pre-war shop routine would have seemed unattainable. This is an object lesson in the commercial advantages derived from (1) operating on large quantities of costly material, and (2) securing over long periods a full-load output uniform in character.

(To be concluded.)

Carbon Brushes: Considered in Relation to the Design and Operation of Electrical Machinery.*

By P. HUNTER-BROWN.

(*Concluded from p.* 722)

Selection of Grade.

The available grades of brushes may be divided into four classes: graphite, carbon, electro-graphitic and copper-graphite. The first mentioned consist of practically all natural graphite and have a very high electrical and thermal conductivity and low coefficient of friction. Their sphere of use is primarily on high-speed commutators and on slip-rings if the current density and radiating surface permit. The carbon grades may contain a considerable proportion of graphite. They have in general a higher contact drop than graphite brushes. Electro-graphitic brushes are made from carbon which after kilning is converted into artificial graphite in the electric furnace. The electrical and thermal conductivity are thus increased; the material becomes softer and more refractory, yet can be made very tough. Such brushes are specially useful where circulating currents are excessive or overloads severe, and are largely used for traction work, especially upon single-phase commutator motors.

The copper-graphite brushes contain copper, with or without other metals, and graphite to the extent of from 5 to 60 per cent. This series of brushes is required for slip-ring work and for low-voltage plating and similar dynamos. It is characterised by low contact drop and high carrying capacity.

Current Density.—If two copper conductors of equal length are coupled in parallel the current will divide in proportion to their sectional areas. In the case of carbon brushes in parallel, however, this is not necessarily the case. The two paths each consists of contact, brush material, connection of brush to flexible, flexible, and terminal connection. The contact resistance is normally greater than the sum of the other four components, and the contact drop is by no means proportional to the current. Another fruitful cause of unequal load distribution is unequal pressure applied to the brushes. Fig. 3 shows the relation between contact drop and current density, at 1½ lb. per square inch and then at 5 lb. per square inch (full line curves). The total drop curves are shown closed. It is not uncommon in practice to meet with variations of pressure

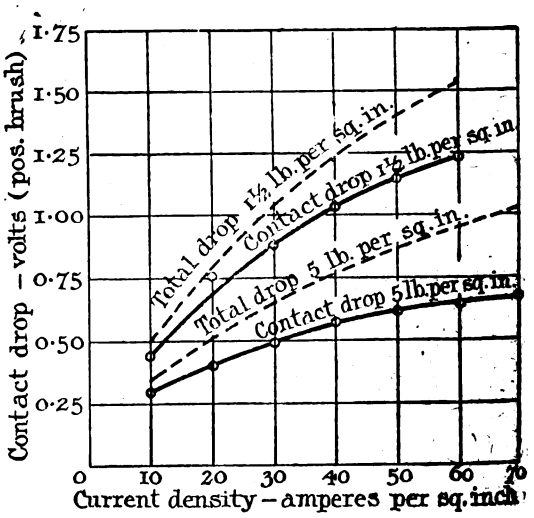

Fig. 3.—Contact Drop of Carbon Brush Containing no Graphite. Speed 3,500 ft. per minute.

as great as 1½ to 5 lb. on the same machine, and many other sources of inequality of distribution of current density could be mentioned.

The carrying capacity of a brush is determined by its permissible temperature rise. The loss in the brush does not depend solely upon the nominal current, and the facilities for dissipating the heat

* Abstract of Paper read before the Institution of Electrical Engineers.

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generated are indeterminate; it follows, therefore, that any figures given in brush manufacturers' schedules can only afford an approximate guide and their chief value is relative.

Peripheral Speed.—With the advent of turbo dynamos peripheral speeds have reached very high values. To meet the altered conditions introduced by turbo machinery it has been necessary to develop new grades possessing a low coefficient of friction, high carrying capacity, and absence of abrasiveness, also preferably low inertia as well. This restricts our selection to brushes in the graphite class.

Mica.—Mica is admittedly very variable in quality. Owing to the impossibility of getting large sheet, built-up mica is used in all but very small commutators. This precludes the possibility of a hard spot extending right through the sheet, and in this respect the built-up article is to be preferred to the pure sheet. On the other hand, excess of the adhesive used may lead to trouble. If the mica is not recessed the brush selected must be sufficiently abrasive to keep the mica flush. On high-speed commutators the mica is invariably recessed. This relieves the brush from the duty of grinding down mica of uncertain quality; it must be clean running, but need not be actually abrasive.

Slip-rings.—In the case of rings the composition of the material used is important. Admiralty gun-metal (88 per cent. copper, 2 per cent. zinc, 10 per cent. tin) has been found excellent. Steel, used sometimes for turbo-alternator rings and malleable iron, occasionally used for induction motors, possess marked disadvantages. Their thermal conductivity is low, and even when clean the contact drop with iron or steel is some 30 per cent. greater than with bronze. The rings tarnish very readily and also unequally if left standing for a short time, and the contact drop is then still further increased, and "flats" are very apt to develop.

OPERATION.

Angle.—The tendency to chatter is reduced by operating the brush either reaction or trailing, *i.e.*, by tilting either against or in the direction of rotation. There appears to be no universally best angle for the brush. In trailing, the angle from the radial may advantageously be from 5 to 15 deg., but in reaction, it should be considerably larger, say from 20 to 35 deg. When the angle approaches the maximum it is advisable to round off the sharp edge of the brush to prevent it from digging into the edge of the approaching segments. Holders should be set as close as possible to the commutator, say $\frac{1}{8}$ in. therefrom. This affords a valuable means of cooling the tip of the brush.

Bedding.—This is an operation that should be thorough. The work should be finished with fine carborundum cloth pulled across the face of the brush in the direction of rotation. After bedding, all dust should be carefully removed. The machine should then be run on "no load" for some time and the current gradually increased so that it is not out of all proportion to the amount of the contact between brush and collector. The pressure should be as uniform as possible. The actual value should be the minimum required to maintain efficient contact between brush and collector. This will vary from $1\frac{1}{2}$ lb. in a well-balanced turbo dynamo to about 2 lb. in an ordinary industrial motor; whilst in a traction motor subject to severe vibration the pressure required may be as much as 6 lb. per square inch, or even more. To prevent the formation of ridges on the commutator the brushes should be staggered.

Mixing Grades.—Here again the guiding principle is to secure a uniform distribution of current. It is therefore inadvisable to mix different grades indiscriminately on the same machine. Occasionally with difficult commutating machines or with very low-voltage dynamos it may prove advisable to mount brushes of one quality in all the positive holders and another quality in all the negative holders. In the case of slip-rings a few graphitic brushes are sometimes mounted on the same ring with metallic brushes, for purpose of lubrication.

Rate of Wear.—The wear of the collector is due to three causes: mechanical abrasion, electrolytic action and burning away of the metal. The rate of wear of the collector is dependent upon its material, the quality of the brush, current density, and the intimacy of contact between the brush and collector. In ordinary practice the last mentioned is the most important factor, and in the case of commutators is largely influenced by the mica, a very variable product, and the cause of much anxiety to the brush manufacturer. Until the advent of modern high speeds, mica was rarely if ever recessed between the segments. The brush was called upon to grind down the mica and keep it level with the copper. If the brush is too abrasive, it will cause excessive mechanical abrasion; if it is insufficiently abrasive to keep the mica flush, copper picking is very likely to result, proud mica being one of the most fruitful causes of this troublesome malady. Copper picking is apparently akin to electrolytic action.

If a commutator is equipped with brushes arranged so that the positives and negatives sweep different tracks, and if the machine is run with no current, the two halves of the commutator will maintain the same appearance and the wear caused by abrasion will be relatively very slight. If then current is passed through the armature the portion of the commutator under the positive brushes (speaking in a motor sense) will assume a dark polished appearance, as though carbon or graphite from the bushes passed in the direction of the current and were deposited on the surface of the copper. The portion of the commutator under the negative brushes will retain a bright coppery colour and become more or less raw in appearance. The rate of wear under the negative brushes will be very much increased compared with that observed when no current is flowing, perhaps by several hundred per cent., showing that, due to the action of the current, particles of copper are passing away from the surface of the commutator in the direction of the current flow. The minute particles of copper passing in the same direction as the current usually do not adhere to the face of the brush, but sometimes they are firmly deposited on the contact surface as though the latter had been copper plated. The action is promoted by lack of perfect contact between brush and commutator, and it increases with the current density. The mechanical scoring action is increased owing to the coating of copper on the face of the brush if the mica is not preventing contact. In practice the positive and negative brushe are arranged so as to sweep the same tracks, and the surface of the commutator assumes an appearance which is a mean between the two surfaces described above.

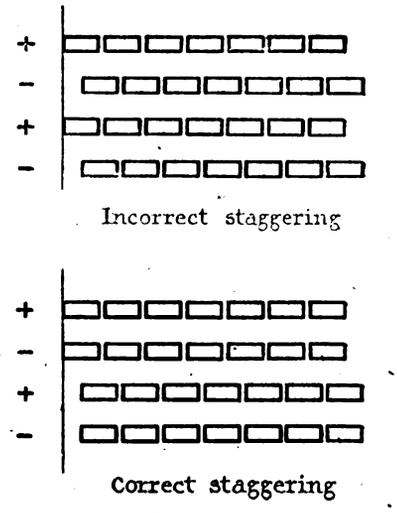

FIG. 4.

When brushes are staggered to prevent the formation of ridges on the commutator this should be done so that each track is still swept by an equal number of positive and negative brushes. Fig. 4 shows the incorrect and also correct methods of staggering brushes.

In individual cases where persistent copper picking occurs an improvement may be effected by a change in the quality of the brush on lines suggested by the above. But the problem is closely connected with the design of the brush holder, the quality of the mica, the shape of the pole tips, and the various other factors determining the extent of the circulating currents, as well as the density in the brushes due to the working current.

In addition to the electrolytic action described, a certain burning action occurs, even when there is no visible sparking. This is dependent upon the intimacy of contact and current density, and of course affects both positive and negative. There is a very close connection between the current density and the life of both brush and collector. Fig. 5 shows the relative amounts of wear produced at various current densities by an ordinary carbon brush. The tests were made on bronze slip-rings. It is clear from these curves that if an absolutely non-abrasive brush were mounted on a commutator with perfectly flush mica, the copper would nevertheless be gradually removed from the face of the segments, leaving the mica standing proud. The process rapidly becomes cumulative.

The wiser course to adopt with large machines, and the absolutely necessary course in the case of very high speeds, is to recess the mica, but the work must be very well carried out or the result will be that the brushes chatter. The depth of the groove should not be greater than the thickness of the mica, which should be cleanly

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removed, and the edges slightly bevelled. If the depth of the slot is excessive, oil and dirt are liable to collect, which may ultimately cause a breakdown. The slots should be regularly cleaned out.

Lubrication.—Most high-grade graphitic brushes are practically if not entirely, self-lubricating, and wherever possible it is advisable to abstain from applying lubricant to the commutator, as a more stable condition of affairs is thereby produced. This is specially important if the mica is recessed, as oil has a very solvent action upon the adhesive used in making the built-up mica.

Operating Conditions.—The commutator, brushes, and brush gear admittedly constitute the most vital parts of a commutating machine, and it therefore behoves the engineer to bestow especial attention upon them.

Commutator surface speeds frequently reach 6,000 ft. or even 9,000 ft. a minute, and are never mathematically circular. A very small mechanical defect is sufficient to cause a momentary separation between the brush and the collector, and the former should be free to follow up slight irregularities. The question of clearance should be carefully watched, but at regular frequent intervals. If this dust is allowed to accumulate in the holders brushes become sluggish.

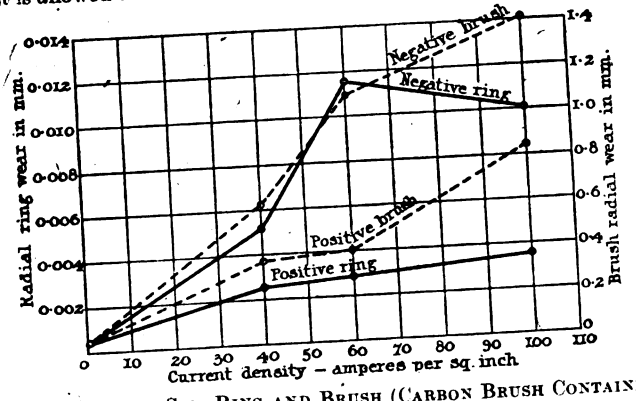

FIG. 5.—WEAR OF SLIP-RING AND BRUSH (CARBON BRUSH CONTAINING NO GRAPHITE). PRESSURE 4 LB. PER SQUARE INCH.

Sparking then occurs under the brush, and what was merely a very slightly "low" place on the collector may rapidly develop into a flat. Thus close attention to the condition of the brushes and brush gear leads not only to a saving in time but also to a marked reduction in maintenance costs.

STANDARDISATION.

At the present time definite recommendations are under consideration with regard to standard sizes of brushes for shipboard machines. In America the Electric Power Club have recommended for general adoption certain standards. They suggest five permissible standard lengths between the limits of 1½ in. and 2⅝ in. inclusive (to be reduced where possible to three); five permissible standard widths between the limits of 1 in. and 1½ in. inclusive (to be reduced where possible to three); 10 permissible standard thicknesses between the limits of $\frac{5}{16}$ in. and 1 in. inclusive (to be reduced where possible to eight). Thus, even within comparatively narrow limits, there are 250 permissible standard sizes (to be reduced where possible to 72). Apparently designers in America are of the opinion that very considerable latitude must be left to them in the selection of brush dimensions. The dimensions of the actual block, however, are only the beginning of the problem. There is also the question of fittings to be considered. As regards quality this would appear to defy all efforts at standardisation, except possibly on exceedingly broad lines. It is therefore wise to proceed by stages, including at first only the mechanical design of the brush and applicable only to machines intended for a certain class of work, such as motors and generators (excluding turbo dynamos) for shipboard use. This is the sphere in which the benefits of standardisation would naturally make themselves most felt.

Lumber Mill Supplies Power to a Central Station.—A curious reversal of customary procedure is reported in Astoria, Oregon, U.S.A., where the local electric supply company is to be assisted by a lumber mill in the vicinity. The electric-steam plant of the Hammond Lumber Company, comprising a 1,800 H.P. boiler, and a 1,500 kw. turbo-generator, is to be used by the Pacific Power Company to distribute electricity to shipyards and other local industries. The refuse from the lumber mills will be used for fuel, which is doubtless a material advantage.

An Electrical Apparatus for Boiling Water.*

By F. BIERMANN.

The heating of water by electrical methods has hitherto been attended with no great measure of commercial success, partly because the apparatus has been too cumbersome and complicated. The present article is intended to describe two simple systems of heating or boiling any required amount of water. In neither case is any special heating element required; the water itself forms the electrolyte; the apparatus consists simply of two or more plates or cylinders, which are suitably arranged beside one another and form the electrodes.

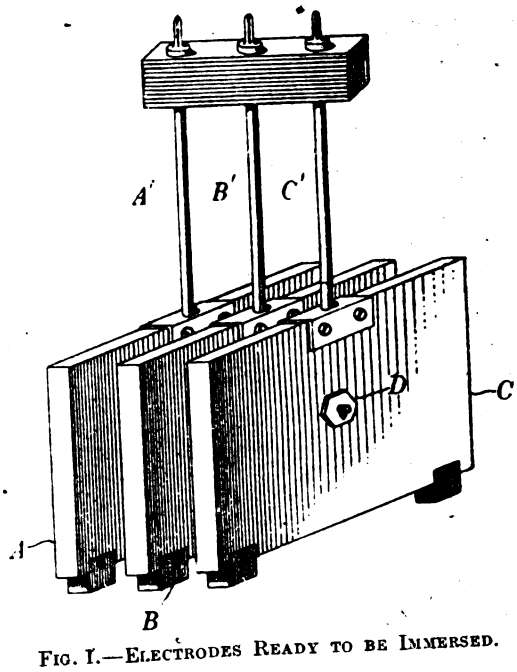

FIG. 1.—ELECTRODES READY TO BE IMMERSED.

In Fig. 1 three carbon plates *A*, *B*, *C* are used, about 8 in. square, arranged parallel to one another at a distance of 0·4 in. or 0·6 in., and connected together by an insulated bolt *D*. The plates are also separated by insulating rollers. The rods *A'*, *B'* and *C'* serve for introducing the current. The apparatus is intended for three-phase current, and can be regulated by cutting off one of the three phases. The apparatus is dipped into the water which is to be boiled, and can

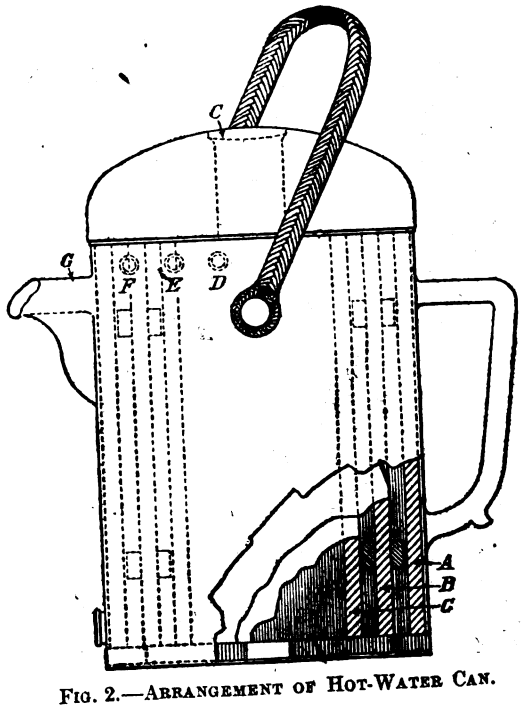

FIG. 2.—ARRANGEMENT OF HOT-WATER CAN.

* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 13, 1918.

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be used on any voltage or with any current. The carbons will last for an indefinite period, and as no heating element is required, consisting of coils and the like, repairs are likely to be negligible; the apparatus is always ready for use and is quite as efficient as anything else on the market for a similar purpose. Carbon is the only substance that can be used for the plates, because metallic plates soon disintegrate and oxidise. Zinc plates become covered with oxide and carbonate; copper, tin, iron and nickel are equally unsuitable. Tests have shown that with this method it requires an hour to heat 70 gallons of water to the temperature suitable for a bath. The current required on 220 volts is 20 amperes, and this gradually rises to 34 amperes. If one of the plates is cut out, it is possible to keep the water for any length of time at any given temperature. The full temperature is reached with the three plates; with two neighbouring plates the current falls by about 50 per cent., and with the two end plates it sinks still further to about 30 per cent. of the initial value. The apparatus is intended to heat fluids which must be conductive, and is specially suitable for heating baths in houses. The tests were conducted in winter when the conditions are unfavourable; in summer there is less loss from radiation. If 20 or 30 amperes are not available smaller plates can be used, or the plates can be separated by greater distances; but in such cases the heating requires longer time.

Another device is shown in Fig. 2, where the water is instantly heated in the can and allowed to flow out. Cylinders, fitted inside one another, are here used instead of plates. In order to make it as compact as possible the cylinders are placed very close together, being separated by ¼ in. The can is something like a coffee pot, being 10 in. high and 6 in. wide. The three plug connections, *D*, *E*, *F*, are for the three phases. The cold water passes first into the inner portion of the can and then flows over into the spaces between the cylinders, and so reaches the mouth *G*. It can be hung on any water tap. The temperature can be regulated by cutting out one of the phases, exactly as in the other type. Tests have shown that 25 amperes at 220 volts will boil 1 gallon of water. According to the speed at which the water passes through the can, its temperature will be warm or hot.

The Manufacture of Vacuum Detectors.*

By O. B. MOORHEAD.

In the early experimental work on vacuum tube detectors operating efficiency and inexpensive manufacture were aimed at. The next point considered was the production of tubes that possessed oscillating characteristics and exceptional detectors The third consideration was the production of a device easily handled and shipped without disturbing the adjustment of the elements and damaging the filaments

Tubes and bulbs of various shapes and sizes were tried using a gaseous medium ranging from 1 mm. to 0·025 mm. of vacuum, many materials being employed as elements. but it was found that accurate reproduction presented difficulties. Gases at pressures ranging from 1 mm. to 0·0013 mm. were next tried

A tube containing a platinum filament in an atmosphere of hydrogen, at about 1 mm. pressure gave fair results. Tungsten filaments were next tried in higher vacua. Conditions could then be duplicated as soon as vacua above that which allowed a "gaseous medium" to exist, were obtained. Moreover, tungsten was ideal as a filament because of its refractory qualities and low volatility, and also because it acts as a purifying agent by attacking any traces of residual gases that may remain in the tube and form compounds which are then volatilised on its walls.

As the parts are small and complicated, the glass is worked before the blowpipe, after it has been brought into the form of tubes by the glass works. This tubing is obtained by first blowing a bulb, then fusing an iron rod to a point diametrically opposite the blow pipe and rapidly separating the two points of attachment from each other. Various grades of glass were used. A mixture containing a high percentage of lead and a small quantity of silicic acid was easiest to work, and produced a detector of maximum sensitiveness when used in conjunction with the aluminium plate and copper grid. The devitrification of the glass had also to be considered, as during exhaustion of the tubes it is necessary to subject them to a temperature near the point of softening. Most glasses, when maintained at this temperature for long, tend to separate out into the crystalline state.

Aluminium plates and copper grids were first selected on account of their electro-chemical relation to the tungsten filament. Later other metals were tried under various conditions of exhaustion, and showed widely different operating characteristics. The selection of metals for the elements is difficult, as a slight difference in either the copper or aluminium changes the whole system of exhaust. Even the copper and aluminium purchased from different factories vary in this respect. I have eliminated this variation to some extent by subjecting the aluminium plates to a temperature of approximately 600°F. (315°C.), immersing them in a saturated solution of cyanide of potassium, and finally rinsing in alcohol. The copper is subjected to heat until it glows, when it combines with the oxygen of the air to form a black, brittle oxide, which breaks off in scales and exposes the underlying metal which is of rose red colour. It is then placed in a current of moist air and becomes covered with a layer of oxygen compounds, which remains very thin, but closes the pores of the metal.

The exhaustion of the tubes is the most important operation because the low vacuum of the round bulb nickel element audion which permits of gas conduction is not used in the tubular "electron relay," wherein all gas phenomena must be eliminated. A Gaede mercury pump capable of producing a vacuum of 0·00001 mm., backed by a piston pump, such as the Geryck type, is the most satisfactory method of evacuation.

The manifold to which the tubes to be exhausted are attached and the vacuum line connecting the manifold to the pumps are preferably made of large diameter tubing. A container filled with pentoxide of phosphorus is connected in the vacuum line between the pump and the manifold. The manifold is contained in an oven heated by gas and arranged to permit the tubes to attain high temperatures during exhaustion.

The lead tubing, used as the container for the elements in the tubular type detector, is obtained from the glass works in lengths of 6 ft. (2 metres) with an inside diameter of 0·875 in. (2·2 cm.) and a wall of 0·032 in. (0·7 mm.) thickness. This tube is cut in lengths of about 6 in. (15 cm.), and one end is drawn down to a point. Two stems are made of glass tubing similar to those used in an incandescent lamp, one stem contains the grid and two filament leads, and the other contains the plate connection and one filament lead. After the wire is sealed into these stems, they must be carefully annealed, the temperature being allowed to drop very slowly, since quickly cooled glass is subject to internal strains.

After the stems are annealed, the grid is wound to the proper diameter and the filament clamped on to the two leads. The plate is mounted on the other stem and the two stems connected together by means of the filament. The plate and grid are then finally adjusted. The spacing between the elements is not very critical in this type of device, but it is best to wind the grid to a diameter large enough to strike the plate rather than the filament when the tube is jarred.

After adjustment of the plate and grid the assembly is inserted into the prepared tubes and the end seals made. A short length of small diameter tubing is attached to the seal at one end of the tube, this being for connection to the pump manifold. The tube is then carefully annealed and is ready for exhaustion.

A number of tubes are sealed on the manifold in the oven and the temperature is gradually increased to 900°F. (489°C.), at which point the pumps are started. The tubes are heated in this manner before the pumps are started, so that the air contained in the tubes may conduct the heat to the central elements and drive off the occluded gases. When the pumps have produced a vacuum of 1 micron the temperature of the tubes is gradually increased to 1,000°F. (540°C.). At this point they must be watched closely, as the melting point of this glass varies greatly, and should the walls of the tubes become soft, the vacuum would cause collapse. From 1 micron the vacuum slowly increases. After five hours of continuous pumping the tubes are sealed off at the manifold, and allowed to cool in the oven.

McLeod gauges are used in the measurement of vacua, but a much more accurate vacuum comparison can be made using a large induction coil. An electrode is sealed to the manifold or at some point in the vacuum line. One terminal of the coil is connected to this electrode and the other coil terminal is connected to the low vacuum pump. A calibrated spark gap is used on the coil, and when the vacuum is high enough and the residual gases are properly pumped from the tube a spark will jump the gap without a glow in the vacuum line or tubes. The vacuum used in the tubular detector will permit a 5 in. (12·5 cm.) spark between needle points in air.

It has been shown that when new metals are heated to incandescence they emit positive ions, probably because of the impurities or gases in the metal. This positive discharge must be eliminated to obtain maximum sensitiveness of the tubular detector by burning the filament on alternating current for about two hours. Tubes that have not been treated in this manner are less sensitive than those in which the positive ionisation has been destroyed.

* Paper read before the Institute of Radio Engineers, New York, slightly abbreviated.

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The Electrician.

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The Tramp Abroad.

The selection of a suitable title for these notes has been a matter of some difficulty, the more so since we have no desire to give offence to anyone. Recently a man was admitted to an office by a card which proclaimed him to be the representative of an old-established firm of electrical engineers. To many of the rank and file of those who practice salesmanship, being on the road and being on the rocks are synonymous terms. Our caller, poor fellow, was down at heel, badly groomed and obviously ill-fed—in every sense a tramp.

In our opinion those who appoint salesmen on an insufficient wage have no right to engage in trade, and if they do not alter their methods they will be driven out of trade by competitors who adopt as their standard a fair day's wage for a fair day's work, irrespective of the business which results.

For four-and-a-half years there has been much babbling of tongues on the subject of after-the-war trade, and now that we are rapidly approaching the formal Peace some are even actively preparing for such trade. To these we wish to sound a warning note on a few of the things most to be avoided when big things are at stake. At first sight these points may seem trivial, but it is sufficient to say that they are not so regarded by some of our most powerful rivals.

It may surprise many of our readers to know that an electrical firm on the Continent paid for the gowns worn by the wife of one of their engineers who was carrying out a large contract in, shall we say, Timbuctu, and that they had a standing arrangement with a firm of jewellers in Timbuctu to lend the jewellery to enable her not only to move in and be comfortable in, but also to take a high place in the best circles. Those familiar with the customs and peoples of many countries need not be reminded that in some countries clothing and jewellery play an important part. To those in the electrical trade who, in the past, have made the balance sheet look well at the expense of the engineering staff, we would say that on the trip in question, which was of several years' duration, the lady accompanied her husband as the guest of the firm for whom he was acting. It is common knowledge that prior to 1914 many of our engineers were sent abroad on salaries insufficient to enable them to move in any society worthy of the name.

Of the many cases that have come to our notice three may be mentioned. The first is that of an engineer sent to South America under agreement on a salary which, had he been in this country, would at least have been adequate to keep a roof over his head. Landed in South America he found that the pay was not enough to keep himself decently, and he had to book a steerage passage to England for his wife, so that she could live at home whilst he "roughed it." Seeking another contract the man on the spot found it necessary to have a motor-car to enable him to cover the ground, and he wrote home to his principals for a "Ford." The financial man endeavouring to pull off big business would probably use nothing less than a Rolls-Royce; but, in the case referred to the luckless applicant for the "Ford" was informed that "if his legs were not young enough to enable him to walk he had better come home." The third case is that of a married engineer working on a job in the Far East a job which brought him into contact with the British-born engineers employed by the firm of Timbuctu fame noted above. The poor unfortunate was so miserably paid that his brother engineers occasionally clubbed together to enable one or other of them to give him and his wife a good time at the races.

If home firms imagine they are going to secure big foreign trade and be parsimonious at the same time the sooner they disillusion themselves the better. The bulk of the trade will go, and, in our opinion, will rightly go, to those who insist on their agents moving in the best circles, and who provide the means to enable them to do so. We could give many more examples, but enough has been said to cause those who count to reflect. Finally, we would say that a large firm in Germany is at the present time training many engineers from neutral countries to enable them to carry on their old successful game in the future when the swords are turned into ploughshares. How many home firms, we ask, are training their own men to fit them for the task?

Review.

Electricity Meters: Their Construction and Management. By H. W. G. GERHARDI, A.M.I.E.E. 2nd edition. (London: Benn Bros., Ltd.) Pp. xx.+504. 15s.

The second edition of this book is timely. Electricity in all its branches is making progress each year, and any book ten years old is tending to become merely of historical interest. To study the early history of meters is necessary for the inventor of a new meter, in order to profit by the mistakes made in the past, but this knowledge is not essential to the average person interested in meters. Mr. Gerhardi endeavours to supply the information that the maker, repairer and tester require every day. He does not refer to those meters that have not become largely used owing to grave defects, but confines himself to those types of meters that are being manufactured in large quantities or have only recently been superseded by improved types.

There is great need at present for the training of meter repairers and testers. This section of electricity supply work has been one of the first to be neglected during the war, and there is much leeway to make up. A good illustration and clear description of a meter is just what these newcomers into this industry require. Those who have been engaged in meter work in central stations for years will also find much necessary information. They need to have the behaviour and defects of any meter discussed impartially. They cannot meet other persons engaged on the same work in other towns, and the only outsider they meet who can give information is the representative of the maker of a particular type, who is naturally biased. They are therefore forced to rely on books for general information.

The author devotes too little space on the choice of a type of meter, but he evidently thought he would be treading on dangerous ground. There are some questions he might have discussed more fully with advantage. For instance, the amalgamation or insulation of the armatures of mercury type meters, the influence of magnetic fields and of temperature, shunt and current transformers, are all subjects which require plenty of light. He avoids any reference to the financial aspect of the meter question. It is certainly difficult to go into the costs of anything under present conditions. This first cost and upkeep question is going to be a very serious one for the meter industry unless there is soon a decrease in prices. Supply engineers will have to cut the meters issued down to one per consumer as far as possible, and drop the separate meter for lighting, heating and power.

The chapter on prepayment meters is very good. One cannot help being struck with the mechanical ingenuity displayed by the manufacturers in order to switch the current

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on and off, and prevent fraud on the part of the consumer, and also on the part of the collector. A short but satisfactory chapter on double tariff meters, followed by a lengthy one on maximum demand indicators, covers the special apparatus used for various methods of charging for electricity. This latter chapter concludes with a description of a printometer demand meter, which will print the meter reading every half hour on a roll of paper. This enables a load curve to be plotted and the maximum demand to be ascertained.

Polyphase meters have become increasingly numerous of late, and are dealt with in an entirely new chapter. The working parts of each meter are illustrated, a diagram of connections given and a full description of the meter. The details are given of a number of American meters and the reviewer was interested to find one described that he had seen on an electric truck. It was a special form of charge and discharge meter. There are chapters dealing with the planning out of a meter test room, standard instruments in general use and testing. Testing in the test room and on consumers' premises are dealt with in separate chapters. In the latter the use of portable rotating sub-standards is described.

The book concludes with the description and specimen pages of meter record books. The author is to be congratulated on the improvements made in this edition, and on the excellent reproduction of illustrations and wiring diagrams.

W. A. TOPPIN.

Note on the Production of Continuous Electrical Oscillations by the Three-Electrode Valve.

By E. V. L. APPLETON, M.A., B.Sc.

Summary.—The three-electrode thermionic valve, when functioning as a generator of continuous electrical oscillation, may be regarded as a tube possessing a negative resistance. Its action is thus analogous to the action of other continuous oscillation generators—*e.g.*, the Poulsen arc and the dynatron.

The action of a three-electrode valve is usually interpreted in terms of the experimentally determined relations between plate potential, plate current, grid potential, grid current and filament temperature. Let the values of these be represented by the letters V, I, v, i and θ respectively.

Keeping the filament temperature θ constant, the plate and grid currents are, in general, functions of plate and grid potentials. Thus, $I=\varphi_1(V, v)$ and $i=\varphi_2(V, v)$.

Let
$$\left(\frac{\partial\varphi_1}{\partial v}\right)_V = k_1$$
$$\left(\frac{\partial\varphi_1}{\partial V}\right)_v = k_2$$
$$\left(\frac{\partial\varphi_2}{\partial v}\right)_V = k_3$$
$$\left(\frac{\partial\varphi_2}{\partial V}\right)_v = k_4$$

where the reciprocals of k_1, k_2, k_3 and k_4 have the dimensions of a resistance. k_1, k_2, k_3 and k_4 are easily obtainable from the static characteristics of the valve.

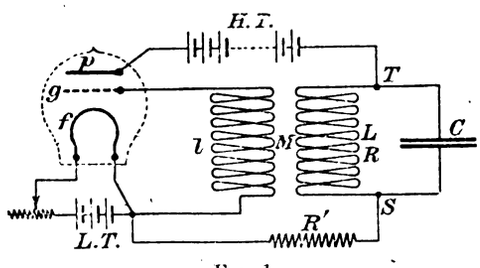

FIG. 1.

The circuit normally used for the production of continuous electrical oscillations of radio-frequency is illustrated in Fig. 1, where the oscillation circuit consists of a condenser, C, in parallel with a coil possessing self-inductance L and resistance R. This coil is coupled electromagnetically with the grid circuit inductance l, the mutual inductance being M.

The conditions for the production of continuous oscillations in such a circuit have been investigated mathematically by Vallauri* and Bethenod.†

Vallauri, neglecting the currents in the grid circuit, shows that the conditions must be such that

$$M=-\frac{k_2L+(1+k_2R')CR}{k_1}.$$

Bethenod, neglecting R' but taking in account grid currents, finds that M must satisfy the equation,

$$-\frac{k_3M^2}{L}=k_2L+(k_1+k_4)M+RC.$$

When we neglect grid currents and the resistance R', both relations then reduce to the equation,

$$RC+k_2L+k_1M=0.$$

Showing that M must be negative and of numerical value,

$$\frac{k_2L+RC}{k_1}.$$

The same result can be arrived at in another manner, which at the same time both makes clear the physical processes involved, and also shows the analogy between the Poulsen arc, the dynatron and the three-electrode valve.

The possibility of the production of continuous electrical oscillations in the Poulsen arc has been shown to be dependent on the existence of a negative resistance in the arc—*i.e.*, if I is the current through the arc and V is the voltage across it, dI/dV is negative. Also Hull, in his work on the dynatron,

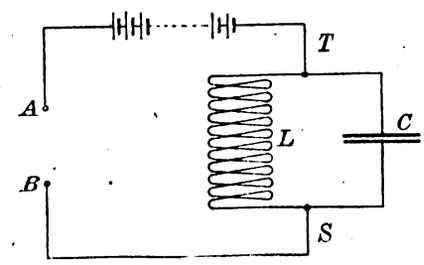

FIG. 2.

has shown that continuous oscillations can be maintained in the circuit LC (*see* Fig. 2) if between points A and B there is a conductor with a negative resistance of numerical value L/CR, where R is the ohmic resistance of coil L.

Let us consider again the circuit shown in Fig. 1, and assume that grid currents and resistance R' are negligible. Ignoring for the moment the existence of the grid coil, we see that an oscillation in the circuit LC would produce a P.D. V between points T and S equal to $V_0\cos(t/\sqrt{LC})$.

(From here onwards we shall consider for simplicity that V and I refer, not to the absolute values of plate potential and plate current, but to the variations from their steady values.)

Such a potential variation in the plate circuit produces a variation in the plate current of value $I=k_2V_0\cos(t/\sqrt{LC})$. Thus, without a reaction coil, we have through the tube dI/dV positive.

* Vallauri, "Elettrotechnica," Nos. 3 and 4, 1917: abstract THE ELECTRICIAN, December 21, 1917.

† Bethenod, "La Lumière Electrique," October 14, 1917.

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Now, if x is the value of the oscillatory current through the coil L, its value is given by $x=-\frac{CV_0}{\sqrt{CL}}\sin\frac{t}{\sqrt{LC}}$. This current will give rise to an induced oscillatory E.M.F. in the grid coil of value $-M\frac{dx}{dt}$, *i.e.*, $\frac{V_0M}{L}\cos\frac{t}{\sqrt{LC}}$. But this variation of grid potential will by itself produce a change of plate current equal to $\frac{k_1V_0M}{L}\cos\frac{t}{\sqrt{LC}}$.

Thus we have to consider the resultant of the two-plate current variations :—

(α) $k_2V_0\cos\frac{t}{\sqrt{LC}}$ due to the change in V. This variation is always in phase with V.

And (β) $\frac{k_1V_0M}{L}\cos\frac{t}{\sqrt{LC}}$, due to the change of v. This variation is only in phase with V when M is positive. It is 180 deg. out of phase if M is negative.

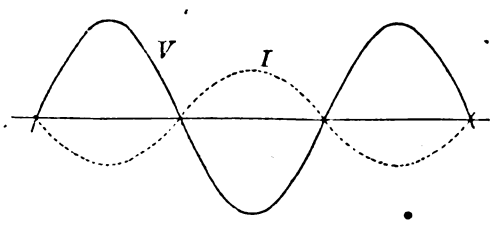

FIG. 3.

Now it is clear that if the effect due to (β) is in the opposite direction to that of (α), and is also numerically greater, we get a relation between voltage and current changes similar to that shown in Fig. 3.

In this case dV/dI would be negative, and, assuming that the path from filament to plate represents the path from B to A (Fig. 2), continuous oscillations will be possible, as in the dynatron, if dV/dI is equal to $-L/CR$.

Now $$V=V_0\cos\frac{t}{\sqrt{LC}},$$

and $$I=k_2V_0\cos\frac{t}{\sqrt{LC}}+\frac{k_1MV_0}{L}\cos\frac{t}{\sqrt{LC}}.$$

Thus, for continuous oscillations in the LC circuit,

$$\frac{dV}{dI}=\frac{1}{k_2+\frac{k_1M}{L}}=-\frac{L}{CR},$$

i.e., $$M=-\frac{k_2L+CR}{k_1}.$$

Progress in Photometry with Special Reference to War Problems.

At the opening meeting of the Illuminating Engineering Society on Dec. 19 several interesting developments in photometry were described. It was explained that the Ministry of Munitions had granted permission for some account to be given of the work done by two committees of the Society in regard to the testing of the illuminating power of flares, parachute lights, &c., and the brightness of self-luminous radio-active materials, which have had many important war uses.

The proceedings were opened by a short account of some events during the vacation by the hon. secretary (Mr. L. Gaster), who alluded to the work done by the Society in preparing recommendations on judicious measures of economy in lighting, and to the Safety First movement, which had now been extended to include both streets and factories, and in which the importance of good lighting in relation to safety received special attention.

Two Papers, dealing with the photometric work referred to above, were then read by Mr. A. P. Trotter and Mr. W. C. Clinton. Mr. Trotter, after making a few introductory remarks on the conditions arising from the termination of hostilities, gave an account of the special problems encountered in the testing of flares, star shells, &c., which burned in a somewhat fluctuating manner but give an extremely brilliant light. The work necessitated special photometers which enabled readings to be taken quickly by inspection without the manipulation of parts, and two instruments for the purpose devised respectively by Mr. J. G. Clark and Mr. J. S. Dow were exhibited and described. These instruments involved a new principle in photometry. In one case the instrument consisted of a long tube with whitened interior having a small glow lamp at one end. A series of letters was cut out of the front surface of this tube, and the strip in which they were located was painted white. One had thus a series of letters of gradually diminishing brightness, but there would be one letter which appeared as bright as the surface illuminated by the light of the flare. This point of balance moved up and down the tube as the light from the flare varied, and the observers called out the balancing letters at intervals of two seconds. Afterwards the average of the readings was taken and the result presented in the form of "c.p.-seconds per gramme" of composition (for a constant length of material). Values up to 6,700 c.p.-secs. per gramme were obtained, and in some instances they had to deal with as much as 120,000 c.p. to 130,000 c.p. The apparatus used by Mr. Dow followed a similar method, but in this case the observer looked through a series of slots in an illuminated surface in a box, and compared the brightness of these with the brightness of an external test surface, on which the light of the flare was received. In most cases the flares to be tested were suspended at a convenient height on poles, but on one occasion the sample was attached to the carrier of a military kite, so that a ground illumination comparable with that obtained in practice from a parachute flare at a great height could be measured. Other experiments included the testing of various compositions, the comparison of results from flares of progressively increasing diameter, and "nests" of parallel flares. It was interesting to observe that the candle-power of a nest of flares was roughly the aggregate of the illuminating values of its components, and that a flare acted like a flame, giving about the same candle-power at different angles below the horizontal (being thus quite distinct from the crater of an electric arc). Experiments were carried out chiefly at experimental grounds in the vicinity of London, on moonless nights, and special measures had to be taken to avoid the uncertainties introduced by smoke, fog, and the effect of varying wind.

The experiments described by Mr. Clinton presented an interesting contrast with the foregoing, in that the brightness was in this case extremely low, being often of the same order as moonlight (or less), while the samples were relatively small. This again involved special photometric methods which were described. Whereas the light from a flare varies considerably during small intervals of time, the brightness of these radio-active luminous materials undergoes very gradual diminution, and experiments were conducted at regular intervals for more than a year. A diagram was presented showing the variation in brightness of samples containing respectively 0·8, 0·5, 0·4, 0·3, 0·2 and 0·1 mg/gm. of radium bromide. The most striking thing about these results was the tendency of all these samples to descend to about the same brightness after a long interval of time (after 300 days about 0·01 ft.-candles). It was therefore concluded that for practical purposes it was unnecessary to work with more than 0·2 or possibly 0·1 mg/gm. composition. Another important point was the thickness of material used. Increasing thickness had the effect, within certain limits, of giving greater brightness but also a more rapid rate of decay. In fact it seemed to have an effect similar to increasing the strength of the composition. In view of the high cost of radium the decision as to the requisite composition and thickness was of very great importance.

In the discussion that followed a number of interesting points in connection with photometry were raised. Mr. J. S. Dow pointed out the value of the special flare photometer for demonstration purposes, as it could be observed by a number of people from a distance. He also showed several new forms of experimental photometers, including one utilising a patch of self-luminous radio-active material instead of the customary lamp and battery. This might prove ultimately to have useful practical applications for approximate work. Mr. C. C. PATERSON discussed the testing of gas-filled glow-lamps in some detail, mentioning the curious fact that the efficiency of these lamps is not necessarily an indication of temperature of incandescence (as in the case of vacuum lamps). Mr. J. W. T. WALSH gave an account of the experience at the National Physical Laboratory in the use of a cubical box integrating photometer, an apparatus of great consequence in regard to measuring the mean spherical candle-power of modern sources in an expeditious manner. Lieut. GRAY, of the Chemical Warfare Department of the Ministry of Munitions, referred in appreciative terms to the work done by the two committees of the Society, and a variety of problems raised by the discussion were dealt with by Mr. F. Harrison Glew, Mr. Arthur Blok, Mrs. H. Ayrton, Mr. Bryson and others.

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Correspondence.

THE TECHNICAL LIBRARY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I attended the other day a meeting of librarians, assembled to discuss the technical library, and was interested to see how radically my ideas differed from those of the grave and reverend seniors, who were so obviously masters of their craft. I, of course, only claim to represent the user of such libraries, *i.e.*, I am a busy man, whose daily work largely consists of putting the latest scientific results into more or less useful practical application, and, therefore, I suppose myself to be, not indeed the cause of the technical library, but, as one might say, the excuse for it.

Now, looked at from the point of view of the professional librarian, what such a one as I presumably should do, is to stroll in for an hour or two a day, ask for all the latest books, periodicals and papers, by name, and then read them through (in a room provided for the purpose), lest, by any chance, something of importance to my work may be in them.

By a marvellous refinement of card indexes and steel shelves, one has only to mention the name of any book or periodical published anywhere on the planet and it is produced for one's inspection, but just there—entirely unsuspected by the professional mind—is the fly in the ointment. How am I to know that in the journal of the philosophical society of Hong Kong there is an article on the particular guinea pig or artificial fertiliser, information on which is so vital to me in my work? The answer is, I don't know and can't be expected to know, and moreover, ought not to be expected to spend the few hours per day required to find out.

It is just here that those responsible for technical libraries, in my humble opinion, utterly fail to realise their responsibilities. Surely it is they who should tell me that such an article has appeared. Now, though not an extremist, I am an honest man and do not expect anything for nothing, although the libraries are financed from the rates, I am willing to pay extra for extra facilities for my work. Let me pay say a guinea per year for each subject I enter myself as interested in: then for 42 shillings a year let me have a postcard whenever my particular guinea pig or fertiliser is mentioned in the annals of science.

You may say that this will take a large staff of readers—well and good. But remember that the total amount read will be no more, and that it will be read once instead of by a dozen readers; also, if I may be pardoned for saying so, it might be read by those whose time is of less intrinsic value to the community.—I am, &c.,

Manchester, Dec. 17. JULIUS FRITH.

STROBOSCOPIC DETERMINATION OF SLIP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of Sept. 20 you quote the description of an apparatus for measuring the slip of induction motors by observing the apparent vibrations of a reed which vibrates synchronously with the current, and which is viewed through one or more slots in a disc, attached to the shaft of the motor.

It may be worth mentioning that this method was described by me at a meeting of the American Institute of Electrical Engineers in 1905, and that it is in regular use by the Westinghouse Electric Company. This company has devised a modification of the method, using a nest of sliding gears, whereby the disc, instead of being carried directly on the motor shaft is on a secondary shaft which turns more rapidly than the motor, thereby extending the usefulness of the method to machines having a slip too great to be directly counted. A table shows the allowance to be made for each of the two or three combinations used.

Allow me to add that I have found a similar device to be of even more extended usefulness. This consists of a similar disc mounted on the alternator shaft, through which is viewed a tuning fork which is adjusted to the frequency in use (with us nearly always 60 cycles). By this simple device a moment's glance shows whether the machine is running at rated speed. Speed adjustments are thereby made quickly and accurately. Variations from standard speed may be easily determined by counting the apparent vibrations of the fork. The introduction of this device has made far more accurate the many experiments where the speed of the alternator must be known at the moment when readings are made.—I am, &c.

Knoxville, U.S.A., Nov. 9. CHAS. A. PERKINS.

[We do not suggest that such methods are new. They have, in fact, been in use for many years, but we think they might be used to a larger extent, and thus we felt it worth while to publish the article to which our correspondent refers. —ED.]

The "Swarren" Conduit Coupling.

Messrs. Swarren, Ltd., 52-54, Theobald's-road, London, W.C.1, have recently put on the market the "Swarren" conduit coupling, which is claimed to be extremely simple, and consequently can be produced at a very small cost. It possesses all the advantages of screwed coupling devices, and its use effects a considerable saving in installation labour, while it is thoroughly water-proof and damp-proof. It allows the maximum capacity of the conduit to be utilised regardless of the length of any run or the number of bends. It is instantly and efficiently sealed by a single movement with as much ease as an ordinary eyeletting or similar operation is performed. It eliminates the necessity of the slightest twisting of the conductors, which is a most important factor in the life of an installation. No screwing operation is required during installation and, therefore, a much lighter gauge of conduit can be employed. Its design enables it to be manufactured without the aid of screw threading or turning tools.

Co-operation in Engineering and Allied Trades.

During the period of transition from the manufacture of war material to ordinary trade, some difficulty may be experienced by firms having more orders on their books than they can readily deal with, whilst there will be other firms having manufacturing facilities without orders to execute. In the national interests, it is essential that firms in these two categories should be brought into intimate touch as rapidly as possible. With this object in view, manufacturers in the engineering and allied trades who need the assistance of sub-contractors, and who meet with difficulty in finding suitable firms to undertake their sub-contracts, are requested to communicate with the superintendent engineer of the Ministry of Munitions in the area concerned. Similarly, manufacturers having capacity available with the necessary labour should notify the superintendent engineer of their area. A list of superintendent engineers, who will give every possible assistance to manufacturers in overcoming difficulties, is appended.

Area No.	Name.	Address.	Telegraphic address.	Telephone number.
1	Mr. G. H. Clay	Pearl-buildings, Northumberland-street, Newcastle-on-Tyne	Munarea Newcastle	3814 Central
2	Mr. H. C. Buckmaster	70, Spring-gardens, Manchester	Munarea Manchester	8740 8 City
3	Mr. H. C. M. Austen	Quebec-chambers, Quebec-street, Leeds	Munarea Leeds	5500 Leeds
4	Mr. A. A. Rowse	111, New-street, Birmingham	Munarea, Birmingham	2700 Midland
4 E.	Mr. G. S. Knocker	91, Queen's-walk, Nottingham	Munarea, Nottinghm.	5578 9 Nottingham
5 & 6	Mr. Selwyn Grant	3, Unity-street, College Green, Bristol	Munarea, Bristol	5090 Bristol
7	Lieut. Moberly	Room 114, Charing Cross-buildings, Embankment, W.C.2	Mundepung 'phone London	Gerrard 540, Ext. 712
8	Mr. G. Davidson	90, Princes-street, Edinburgh	Munarea, Edinburgh	9040 Central
9	Mr. W. D. Kirkwood	39, Elmbank-crescent, Glasgow	Munitions, Glasgow	9880 Central
10	Capt. C. Ablett	32, Nassau-street, Dublin	Munarea, Dublin	4894 6 Dublin
11	Mr. A. W. Brown	Coates-buildings, Castle-street, Belfast	Munarea, Belfast	578 Belfast

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Industrial Council for London Electricity Undertakings.

A joint meeting between the employer and union representatives was held at the London County Hall on Nov. 27, when the following were nominated to give effect to the award of the Committee on Production as to Electric Supply Undertakings in the London district.

The 10 employer representatives are: The 14 London companies, Mr. Charles P. Sparks (chairman) and Mr. F. Bailey; the Incorporated Association of Power Companies, Mr. E. T. Ruthven-Murray; the Tramways Association, Mr. C. J. Spencer; the suburban undertakings, Mr. K. A. Scott-Moncrieff; I.M.E.A., Mr. A. C. Cramb; Conference of local authorities on wages, Mr. Ald. A. G. Beaumont and Mr. A. J. Fuller; L.C.C., Mr. A. L. C. Fell and Mr. P. L. Riviere.

The 14 union representatives are: Electrical Trades Union, Mr. J. Rowan (vice chairman), Messrs. J. Membery, H. H. Morton, —Westfallen, T. Goode and V. Needham; Workers' Union, Messrs. Small, J. G. Greenwood and A. Smith; National Union of General Workers, Messrs. C. L. Skinner and Boyne; National Amalgamated Union of Enginemen, &c., Messrs. J. Meakins, J. Allen and W. G. Chapman.

Pending the setting up of District Boards under the proposed Joint Industrial Council for the Electric Supply Industry, it is proposed that if any questions arise with regard to (1) the intent and application of any award of the Committee of Production; (2) rates for additional grades; (3) re-grading; and (4) general questions, the parties shall confer, after requisite notice has been given, and endeavour to arrive at a mutual settlement. Failing such settlement, any matters of difference are to be referred to the Committee on Production. The Committee are of opinion that the proposal is likely to be of benefit, and they will be prepared to co-operate in its adoption so far as it is in their power to do so.

Effect of Government Control.

At the meeting of the Barrow Hematite Steel Company last week the chairman (Mr. G. Mure Ritchie) referred to the question of Government control. With every desire to avoid controversial topics he could not help saying that in his opinion—and he spoke from an experience of over 25 years of industrial undertaking—if that system of Government control were to continue for a very short number of years longer it would be equivalent to signing the death warrant of British industry. It would mean industrial paralysis, and consequent decadence of our home industries, while also our foreign trade would vanish. As was well known, there was a great shortage of coal in the country, and he expressed the opinion, which he knew to be shared by some of the most eminent expert managers and engineers connected with collieries, that if decent time were kept by the colliers, and during the time they were supposed to be working they put anything like heart and conscience into their work, there need be no appreciable shortage of coal. Consequently, coal would be much cheaper for the community and for the great industrial works and railways. The industrial position of the country depended on cheap fuel. If wages were to go on being increased, apparently without end, while also the hours of working were to be reduced, there could be only one end to that state of things, especially in competition with foreign countries. However, this country had come through such terrible troubles, and they had faced and overcome such enormous difficulties, that personally he did not take a pessimistic view of the future. There would be difficulties and dangers, but in the long run the common sense of the community would assert itself. He was fully convinced that the British working man, taking him all in all, was every bit as patriotic as any other class; but, unfortunately, he allowed in these particular matters a small minority to do all the talking and to manipulate the trade union machine.

Reconstruction and Government Control.

At Manchester, on the 19th inst., Dr. Addison, the Minister of Reconstruction, delivered an important speech on problems of Reconstruction and the Government control of industry. He said we must devise machinery in the industrial world for securing just conditions and opportunities for development, better organisation, with much greater measure of agreement than we had had hitherto. We could not expect to pay for the war except by producing more: we must be able to employ better and improved methods of production. We must, however, guard against tumbly alliances between Capital and Labour at the expense of the consumer. The war had shown what arbitrary and unnecessary restrictions stood in the way of the full utilisation of our mineral resources, and he hoped that, through the information gathered by the Imperial Mineral Resources Bureau, we should soon see great developments.

The plans prepared by the Ministry of Reconstruction had now, with a few minor alterations, been accepted by the Cabinet. On the question of demobilisation, he said it was obviously much easier to demobilise by military units than according to industry. He could assure them that "red tape was being short circuited," but he would emphasise the physical difficulties to be overcome in dealing with millions of men. Probably 70 per cent. of those millions were working on their own account, or who had work waiting for them with a former employer. Those men were being sorted out and ticketed. The first demand on transport when the armistice was signed was for the return of prisoners of war: the second was for leave facilities to 7,000 men a day; the third was for the return of the men most urgently required—100,000 miners—and the men needed to assist in demobilisation. The Government was prepared to spend £6,000,000 for training men who joined up as apprentices or after half-completed courses. There were places for 15,000 men in the various university, technological and other institutions, and the Government would give assistance both in fees and, if necessary, in maintenance. Our requirements of raw materials on the peace basis had been investigated, and sufficient supplies of nearly all were either here or in sight. Now that materials were no longer required for war purposes, the necessity for many of the war controls had disappeared.

Many industries had accumulated stocks when prices were rising. There was now some expectation that prices would fall, and men hesitated on this account to give orders to begin new work. That was the greatest obstacle to resumption of trade, and the Chancellor of the Exchequer had now before him the Ministry's proposals on that point. The Government would have to take some risks in getting the machine of industry re-started. In the case of a good many commodities which people were anxious to have released from control, a rise in prices might as reasonably be expected as a fall.

It was proposed to reconstruct 2,500 miles of road in Great Britain at a cost of £9,400,000, and that would give employment to 142,000 persons.

Legal Intelligence.

A Tramway Benefit Society's Rules.

In the Court of Chancery of Lancashire recently Mr. Jas. Healy (on behalf of himself and other members of the Liverpool Corporation Tramways Benefit Society) sued for a declaration that the committee of management was not duly elected or appointed to that position. The defendants were Ald. Russell-Taylor (chairman of the Tramways Committee), Ald. Fred Smith (deputy-chairman), Mr. C. W. Mallins (manager of the tramways), trustees of the society; Mr. E. W. Pierce (deputy Town-clerk), legal adviser to the society; Mr. T. J. Parry, secretary and treasurer of the society; and others.

Mr. M MASTER (for plaintiff), said the society was composed of employees of the Corporation Tramways Department. It was an unregistered friendly society, formed with the object of giving certain benefits to its members. The committee of management consisted of three different classes of members—ex-officio members, who were officials of the Corporation; members elected by the society; and nominees of the Tramways Committee. What was complained of was that no election of committeemen had taken place for the present year, as required by the rules, which stated that in January of each year each branch should hold a meeting for electing a member of the branch to the Committee of management. That was the direct cause of the action, but the motive for it lay in general dissatisfaction that the rank and file of the society had not enough influence upon it.

Mr. COURTHOPE WILSON, for the defendants, urged that there was no relief claimed against Messrs. Russell-Taylor, Fred Smith, E. W. Pierce and T. J. Parry, and he asked that they should be dismissed from the action with costs. He argued that it was for the committee of the branches and not the committee of the society to convene the annual meeting. The whole difficulty had been caused by the fact that half the members of the society were absent at the war, and the desire of the committee of the society, as far as they had any voice in the matter, was to preserve things in statu quo and carry on the business of the society until all the members were home. The accounts had been audited and he submitted the court ought to preserve things in statu quo until those members returned and were able to look after their own interests.

His Honour (Mr. R. B. Lawrence, K.C.), who reserved judgment, gave his decision last week, and dismissed the action. He thought, however, that somebody ought to convene the meetings, and Mr. Courthope Wilson intimated that they would convene meetings next year.

Baldock v. Westminster City Council.

Last week the Court of Appeal dismissed an appeal by the defendant Council from a judgment of a Divisional Court, reversing a decision of the Deputy County Court Judge at Lambeth on a claim for negligence. The Council constructed a street refuge under powers conferred by sec. 108 of the Metropolis Management Act, 1855, and placed upon it an electric lamp standard, under sec. 130 of the same Act. Owing to the war the lighting was diminished, and defendants were aware that the electric lights became irregular. On a dark night the lamp went out and plaintiff's taxicab ran into the posts of the refuge and he was injured. In the action the jury found that defendants were negligent in omitting to maintain a "danger lamp" on the refuge, but that there was no conclusive evidence what caused the lamp to go out. The Deputy County Court Judge entered judgment for defendants, on the ground that there was no evidence that the particular lamp had gone out before the night of the accident, or that defendants knew that it had gone out or was likely to go out. He held that it would be unreasonable to say that defendants were bound to provide against the contingency that a particular lamp might go out. On appeal the Divisional Court said that it was a question of fact for the jury whether there was negligence on the part of defendants, and it could not be said that there was no evidence to go to the jury that the lighting was insufficient and not reasonable. The appeal was allowed, but defendants now appealed to the Court of Appeal, but it was dismissed with costs.

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Patent Record.

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

December 2, 1918.

19,853 WILKINSON. Electric cookers.
19,873 BLYTON. Electrical apparatus.
19,906 BRANSOM & READ. Control of electric supply plant.
19,913 ROBERTS. Electrical control apparatus.

December 3, 1918.

19,955 COCKING & HEAN. Electrical equipment of motor vehicles. &c.
19,970 ROSE. Metallic conduit couplings.
19,985 ELECTRO-STEAM RADIATOR CO. Electric vaporisers and heaters. (30/11/17, U.S.)
20,004 B. T.-H. CO. & CLINKER. Wireless receiving gear.

December 4, 1918.

20,019 MARR. Sound receiving instruments.
20,027 MALLALIEU. Dynamo-electric machinery.
20,068 FORD & JACKSON. Overhead electric trolleys.
20,109 MCALPINE. Relays.
20,110 ERSKINE-MURRAY. Electro-magnetic wave signalling systems.

December 5, 1918.

20,122 GREEN. Electro-magnetic measuring instruments.
20,135 ANGUS. Means of obviating risks due to failure of insulated joints. (5/12/17, Sweden.)
20,168 CAREY. Electro-magnetic apparatus.
20,170 HULFISH. Automatic switches circuit systems, and operating methods.
20,177 MESSAY. Brakes for electric vehicles.
20,178 MESSAY. Electric trucks, tractors, &c.
20,187 WINTLE. Progressive heating of liquid by electric resistance.
20,209 LATOUR. Lamp telephone relays. (5/12/17, France.)

December 6, 1918.

20,226 ROGERS. Electric motor controllers.
20,235 OLECHNOVITCH. Giving constant number of revolutions to dynamo for vehicle lighting.
20,241 JOUBERT. Metal work for assembling and fixing conduits of non-circular section in electrical installations.
20,254 LYON & WRENCH, TODMAN & COOPER. Manufacture of dynamos and motors.
20,255 LYON & WRENCH & WILMOTT. Electrical apparatus.
20,258 ORURNO. Electro-magnetic apparatus for protecting pneumatic tyres.
20,279 WESTERN ELECTRIC CO. Reduction of static interference in radio-receiving stations.
20,285 WHITTALL & REES. Means of supporting overhead conductors on railways, tramways, &c.
20,289 HULTMAN. Switches. (11/12/17, Sweden.)

December 7, 1918.

20,312 MYERS & ROBSON. Locking out disengaged levels on electric signalling systems.
20,330 HOLT. Ceiling roses, &c.
20,335 FOSTER. Turbine electric driving gear.
20,356 PARSONS. Mounting searchlight reflectors.
20,374 IMBERZ. Apparatus for hardening and tempering wire by electricity.
20,375 IMBERZ. Electric muffle furnaces.
20,378 MOORE. Electro-metallurgical furnaces.
20,379 SIMENS BROS. & CO. & FERREIRA. Armatures and pole-shoes of magnets.

Commercial Topics.

Loss by State Interference.

The original constitution of the Defence of the Realm Losses Commission has been revoked and a new Commission has been appointed. The terms of reference of the latter are extended to include the inquiry into and report upon what sums, in cases not otherwise provided for, ought reasonably to be dispensed from public funds to applicants (other than enemy subjects) for direct and substantial loss or damage sustained through the interference with their property or business in the United Kingdom by the Crown in the exercise of its rights and duties in the defence of the realm.

* * * *

Suspension of More Government Control Orders.

The Minister of Munitions has suspended until further notice the aeroplanes (Experimental Manufacture) Order, 1917, and the Aero-engines (Experimental Construction) Order, 1918.

The Minister has revoked the Lorries and Trailers (Returns) Order, 1917, and he has also suspended until further notice the following Orders:—

Benzol and Naphtha Order, 1917, which controlled crude benzol, crude naphtha and light oils.

Naphtha Order, 1917, which controlled crude solvent naphtha, solvent naphtha and heavy naphtha.

Tar (Coal and Water Gas) Order, 1917, which controlled coal tar and water gas tar.

Chlorine and Chlorine Compounds Order, 1918, which controlled elementary chlorine and chlorine compounds.

The Platinum Order, 1915, and the Platinum Metal Order, 1916, which prohibited purchases, sales or dealings without a permit.

* * * *

An Industrial Fatigue Research Board.

A Research Board has been appointed by the Department of Scientific and Industrial Research and the Medical Research Committee jointly in order to consider and investigate the relations of hours of labour and of other conditions of employment, including methods of work, to the production of fatigue, having regard to industrial efficiency and to the preservation of health among the workers. The duty of the Board will be to initiate, organise and promote by research, grants or otherwise, investigations in different industries with a view to finding the most favourable hours of labour, spells of work, rest pauses and other conditions applicable to the various processes according to the nature of the work and its demands on the worker.

The Board is constituted as follows:—Prof. C. S. Sherrington (chairman), Mr. E. L. Collis, Sir Walter Fletcher (secretary), Mr. W. I. Hichens, Dr. Edward Hopkinson, Mr. Kenneth Lee, Mr. T. M. Legge, Col. C. S., Myers, M.D., Mr. R. R. Bannatyne and Mr. D. R. Wilson.

The Board will be glad to receive suggestions as to any problems of the kind described above. Communications should be addressed to the Secretary, Industrial Fatigue Research Board, 15, Great George-street, Westminster, S.W. 1.

* * * *

Financial Facilities for Reconstruction.

In the report of the Committee on Financial Facilities appointed by the Chancellor of the Exchequer and the Minister of Reconstruction, the opinion is emphatically expressed that the primary factor in repairing the wastage of capital caused by the war lies mainly in increased production and actual saving. The ability of industry to cope with the unusual financial problems during the reconstruction period will be most limited in the case of entirely new firms which have come into existence owing to the demand for war material. It has been urged that every inducement should be given those firms to continue in business, even to the extent, if necessary, of granting State financial assistance, but the Committee thinks the solution in these cases lies in the establishment of new industries, the capital for which should be furnished by the investor or by the individual partners in the business.

The Committee points out that it would be of great assistance to manufacturers in making plans for the future if the future policy of the Government were made known as early as possible in regard to: (*a*) Fiscal policy, (*b*) rationing of raw materials, (*c*) the break clause in connection with the termination of munition contracts, (*d*) the disposal of national factories and surplus stores. As the very great expansion in credits which has taken place will probably persist for a considerable period after the war, the Committee is unanimously of opinion that, if the reconstitution of industry and commerce is to be achieved on permanent and sound economic lines, some restriction must be imposed upon the creation of additional credit by the restoration of an effective gold standard. To attempt to rebuild industry by means of a further indiscriminate expansion of credit would not only endanger our position as the financial centre of the world, but would inevitably lead before long to grave disaster. New commercial capital issues have been largely in abeyance since the commencement of the war, and consequently there will be a great demand from trade and industry for additional capital. State borrowing can only be undertaken in competition with these demands. Any Government guarantee to bankers to enable them to provide, by means of credits, for fixed capital expenditure necessary for the reconstitution of industry, is undesirable as being likely to cause a further expansion of credit, together with an additional rise in prices.

To enable the banks to do more in the direction of granting long trading credits, the Committee is of opinion that it is desirable that bankers should make more widely known their willingness to accept deposits for long periods, at fixed rates of interest.

It is stated that it is most essential for the future prosperity of this country that the available supply of capital should flow, in the first place, to essential industries, and not to the support of enterprises of a speculative or unessential character. While the Committee is in favour of an early removal of all measures of State control of finance and industry alike, it is of opinion that it will be advisable to maintain, after the war, some control over new issues, at any rate until such time as State borrowing in connection with the war is completed. It will, therefore, be necessary for the same period to exercise, as far as possible, supervision over the export of capital and the objects for which such export may be desired. In regard to State aid, the Committee considers that cases of hardship may arise in connection with firms who have undertaken the manufacture of munitions of war, and in order to meet these cases the Committee suggest the establishment of a small Committee of Government officials and business men in leading industries to consider claims of this kind in the first instance, or to act as a tribunal to which applicants can make appeal. The Committee is of opinion that it would be of very great assistance to manufacturers and others who have been prevented from forming adequate reserves by the present high rate of excess profits duty, if arrangements could be made by which a proportion of the tax should be retained for a period as a loan.

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U.S.A. Commercial Intelligence Service.

The chief of the U.S.A. Bureau of Foreign and Domestic Commerce recently made an appeal for an expansion of the United States Department of Commerce. He stated that there were only 11 American commercial attachés, but the new call provided for 18. Instead of being content with 30 travelling agents covering the entire world, as last year, there was now a demand for 30 in Europe alone (when the war is over) and as many more in the Far East and South America. According to the Board of Trade "Journal" he also said: "Our foreign technical service must be reinforced and organised by a force at Washington that can test the work for scientific accuracy, unify it, tabulate it for comparison with previous data, attach correct conclusions and put it into readable form for merchants. The Bureau should have highly competent statisticians, economists, commodity specialists, Customs experts, shipping advisers, &c.; without them the authority and helpfulness of the Department of Commerce fails completely. Men of such grades receiving decent salaries of $3,000 to $6,000 are allowed to the regular Government commissions and to some of the War Boards, whereas we are restricted to salaries around $1,800 to some of our best research men. As a result the bulk of our work falls upon overworked division administrators who tire out and leave us." It is claimed that the Department of Commerce should have added to it a Bureau of Industrial Practice that would aid in eliminating waste in man power, time, material and overhead cost

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also a Division of Material Valuation, for studying the original sources, the handling and the grades of foreign and domestic materials, a Division of Information on Internal Water and Railways, a Division of Distribution Economy and a Division of Cost Finding Methods. "We want to give the commercial public a steady flow of trade and industrial information, comprehensive, straight to the point and usable. Without such helpfulness and advice our business interests may be outstripped by European operators. For we know that the European manufacturer and merchant, under the spur of war needs, has acquired habits of scientific management that have made him more efficient than ever before. During the last 4 years he has been forced to measure with sensitive scales his scanty resources in men, materials and time, and certainly our own producers must observe the same rules of scientific precision if they hope to hold their own in competition. There is not the slightest doubt of our ability to meet all comers on an equal basis if we add to our natural energy and ingenuity a determination to be guided by facts properly ascertained and explained. No agency is better able to discover and collect the facts than the Department of Commerce."

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Electricity Supply.

The Board of Trade has authorised WARRINGTON Corporation to supply electric current to the Orford Tanneries in the rural district.

At last week's meeting of the L.C.C. sanction was given to Fulham Borough Council to borrow £7,230 for its electricity undertaking.

Two firms have applied for a supply of electric power to shipbuilding yards at WEST LYNN, and the electrical engineer (Mr. Jackson) estimates that an expenditure of £3,000 would be necessary for laying a main across the river, and £7,500 for extensions of plant at the central station.

KENSINGTON (LONDON) BOROUGH COUNCIL has decided to oppose the application by the Brompton & Kensington Electricity Supply Company to the Board of Trade for permission to increase their charges, on the ground that it will cause serious hardship to a large number of residents.

An agreement has been entered into between BOLTON CORPORATION and the Lancashire Electric Power Company for a working arrangement for a period of 10 years by inter-connecting the two systems. The Corporation has applied to the L.G. Board for sanction to borrow £7,500 to carry out the scheme.

As the loan of £42,000 sanctioned by the L.G. Board in November, 1914, for mains, sub-stations and services is practically exhausted, BRISTOL CORPORATION has applied to the Board for sanction to borrow a further £38,000 for similar purposes to be spent as and when required. The above figure represents the estimated expenditure for three years and was made up of £50,000 for mains, £9,000 for house services, and £29,000 for sub-stations.

At the meeting of LLANDUDNO URBAN COUNCIL on Friday Mr. Harold Morton, electrical engineer, submitted a return showing the consumption of electric current during the 11 months ended Nov. 27. During the four weeks from Oct. 31 to Nov. 27 there was a reduction of 8,898 units in the current generated, compared with the corresponding period of last year, and for the 11 months there was a decrease of 4,813 in consumption of current for lighting and of 4,085 for electric car traction. The reduced demand for traction was due mainly to the diminution in the number of the stopping places of the tramcars.

The accounts of the SOUTH SHIELDS CORPORATION ELECTRICITY DEPARTMENT for the year ended March 31 show gross capital expenditure £228,752 (increase £1,034) of which £92,635 has been repaid. Revenue was £35,185 (compared with £32,370 in previous year) gross profit was £13,311 (£13,541) and the net result after providing for capital charges quay deficit (£96) and expenditure of a capital nature (£1,108), was a deficit of £3,944 (£3,028). Kelvins sold were 5,413,980 (4,921,944). Maximum load was 2,684 (2,298) kw., and load factor 23 (24·4) per cent.

The closing of the munitions department at BLACKBURN ELECTRICITY WORKS was celebrated by a dinner on Dec. 18, attended by the whole staff. Mr. P. P. Wheelwright, borough electrical engineer, said since the works were established 3½ years ago they had handled 350,000 shells, and there were 95,000 6 in. shells. That was the third largest output of any factory in N.E. Lancashire. Blackburn was one of the few electricity works in the country where munitions had been manufactured, and he was justified in saying it was the largest shell factory controlled by any Corporation.

The LIVERPOOL DOCK BOARD are considering various schemes for the purpose of facilitating the handling of cargoes, &c., in order to be in a position to meet the demands of the expected industrial revival. Though dock extensions does not figure prominently in the immediate programme, the Gladstone Dock scheme is to be completed. Storage accommodation is to be improved by the erection of a cold store which, having a capacity of a quarter of a million cubic feet, will add one-third to the port's cold storage. In order to deal more expeditiously with imports and exports more railway lines and sidings are to be laid down, and a comprehensive scheme of electrification of the dock estate is to be embarked upon, and a sum of £129,000 will be spent at once upon electrical and mechanical appliances for quick loading and unloading, haulage and transport. The Board will devote more attention to the maintenance of the deep 15 miles long waterway through which ships enter the Mersey, and the salvage apparatus will be materially strengthened by the provision of four electrical submersible salvage pumps. In the new bill of the Board power is sought to increase their borrowing powers by £3,000,000

Electric Traction.

Mr. Pilling, tramways manager of Accrington, has had his salary increased from £400 to £500 by ACCRINGTON COUNCIL.

BIRMINGHAM CORPORATION TRAMWAYS COMMITTEE has refused the application of the tramwaymen for an increased war wage of 35s. per week above pre-war rates.

At the meeting of BRIGHTON CORPORATION on Thursday last a proposal was made to make representations to the L. B. & S. C. Railway Company to expedite the electrification of the main line.

On the understanding that the LONDON COUNTY COUNCIL is not committeed as to its policy, Mr. A. L. C. Fell, general manager, and Mr. P. L. Riviere, the electrical engineer of the tramways department, have been appointed to represent the Council on the joint conference of representatives of electrical undertakings in the London district and of trade unions relative to conditions of labour and on any conference of representatives of electrical undertakings in the London district.

MIDDLESEX COUNTY COUNCIL has approved of alterations to the fares and stages of the Metropolitan Electric Tramways, Ltd. All halfpenny fares are withdrawn, the length of several penny stages are reduced, and the issue of transfer tickets is discontinued. Reduced fares for workmen and children are retained, but without halfpenny denominations.

There was no tramcar service at BOLTON, St. Helens or Accrington on Christmas Day, as the employees insisted on having the day off. An offer of double pay for the day was rejected. At Liverpool, Wallasey and other places in the North the service was as on Sunday.

At MANCHESTER and SALFORD the tramway employees refused to work, and there was no tramway service in either place. The Salford Tramways Committee made the ofier of two days' pay, and, failing that, they suggested a service during the afternoon and evening, but all to no purpose. The general manager (Mr. Holford) pointed out that holidays were granted with pay, and that the employees were not only breaking faith with the public, but also with the Committee, who make it one of the conditions of service that work should be performed on Christmas Day.

By the new Lights (Vehicles) Order of the Home Office the restrictions on LIGHTS ON VEHICLES have been considerably relaxed. Electric and acetylene lamps (whether side lamps or head lamps) may now be used unobscured, if the front glass does not exceed 5 in. in diameter and the bulb or burner is within the prescribed limits (12 c.p. for electric bulbs). If lamps are used exceeding the above limits of size or of power, the whole of the front glass must be covered over with at least one thickness of ordinary white tissue paper or with paint, &c., giving a similar obscuring effect. The use of electric bulbs exceeding 24 c.p. is prohibited. The above provisions apply throughout England and Wales, including the Metropolican Police district and the City of London.

Last week SOUTHEND CORPORATION considered a report of the Light Railways Committee on the steps to be taken to provide additional generating plant at the electricity works and to acquire plant for the proposed Leigh and Thorpe Bay sub-stations. The electrical engineer (Mr. R. Birkett) had reported that while it would be necessary to proceed with the work at the central station and the Leigh sub-station as soon as practicable in order to meet the demand for current expected during the autumn of next year, it would be possible by the laying of additional mains to the Thorpe Bay area to avoid the necessity for equipping the suggested sub-station for that district for the time being. Ultimately the Town Clerk and Mr. Birkett were instructed to negotiate for the supply of the necessary plant for the central station and the Leigh sub-station.

At the meeting of the BLACKPOOL TRAMWAYS COMMITTEE on Thursday last a letter was read from the branch secretary of the Amalgamated Society of Tramway and Vehicle Workers enclosing a resolution that "they intended to cease work on Christmas Day, and that on no terms were they prepared to work. In the event of any employees working on Christmas Day they would refuse to work with them on Boxing Day." This attitude of the motormen and conductors was criticised by members of the committee as a gross abuse of trade unionsm and as showing an entire disregard of their obligations and responsibilities as public servants. The Committee considered that the service on Christmas Day should be maintained, as on Sundays, from 2 p.m. to 10 p.m., and they decided they could not recognise the assumed authority of the local employees of the Amalgamated Association of Tramway and Vehicle Workers to dictate when and how such public services should be withdrawn or curtailed.

Miscellaneous.

The report of the second annual general meeting of the FEDERATION OF BRITISH INDUSTRIES, which was held on Oct. 30 and 31 last, together with the resolutions passed, have been issued in pamphlet form. A report of the proceedings appeared in THE ELECTRICIAN of Nov. 8.

The proposed agreement for the RECOGNITION OF SHOP STEWARDS, which the Engineering Employers' Federation has agreed to discuss with the Amalgamated Society of Engineers, provides that the employers and shop stewards shall not enter into any agreement inconsistent with the agreements between the federation of the local associations and trade unions.

The monthly RETURN OF THE COAL CONTROLLER shows that during the first 44 weeks of the year there was a further serious falling off in the estimated output of coal compared with the corresponding period

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of last year. The net shortage is 17,679,600 tons, or about 8·3 per cent., and for the four weeks ended Nov. 9, when the estimated output was 17,762,800 tons (against 18,951,000 tons), the shortage was 1,188,200 tons.

In order to celebrate the Armistice, a soirée, concert and dance, organised by the designs and production drawing office staff of the tanks department of the Ministry of Munitions, took place at Caxton Hall, Westminster, on Wednesday, the 18th inst. The company numbered about 150, and included many well-known members of the civil, mechanical, electrical and automobile engineering professions.

At a conference of British and American journalists on Monday for the purpose of forming a committee to consider the best means of adpating the UNIVERSITY CURRICULUM to the NEEDS OF PROSPECTIVE JOURNALISTS, Mr. Darton, of the Appointments branch of the Ministry of Labour, said the Government were prepared to make grants up to £175 a year towards the training of young men whose careers had been interrupted by the war at universities or technical colleges. The Minister of Labour would be pleased to co-operate in finding the men required.

Educational.

At the TECHNICAL COLLEGE, LOUGHBOROUGH (LEICESTERSHIRE), there are complete courses of training in the theory and practice of electrical and mechanical engineering, and in the workshops there is accommodation for 500 students working at the same time. The complete course covers a period of 5 years, during which works training in all branches will be given. The next term will commence on Jan. 4, 1919. Prospectuses, containing full particulars of the courses, can be obtained from the Director of Education, Mr. W. A. Brockington, O.B.E., M.A.

The report of war work in connection with the Applied-Science Department of the UNIVERSITY OF SHEFFIELD states that the engineering department have a total output of 6,250 gauges to their credit. The possibility of making cupro-nickel in the Sheffield area for the first time, and the subsequent development into an industry involving a capital outlay of £20,000 per week, was due entirely to experimental work conducted by the staff of the non-ferrous and electro-metallurgical departments of the University, and the total output, when the contract was closed, owing to the Ministry having ample supplies in stock, was 1,354 tons. The electrical engineering department, with the local staff of the aeronautical inspection department, has tested and reported upon 27 samples of magnetic steels, 144 standard magnets, 150 tests on non-magnetic (nickel steel) steels and 35,000 magnets. Since December, 1916, the staff of the applied chemistry department has been engaged on investigations on carbonisation of coal. Other work included research work on the cutting of various types of tool steels.

Tenders Invited and Accepted.

TOXTETH PARK Guardians require tenders by noon Dec. 30 for three months' electrical and engineers' supplies. Forms of tender from the Clerk, 15, High Park-street, Liverpool.

SHEFFIELD TRAMWAYS & MOTORS COMMITTEE requires tenders for 50 double deck top-covered tramcar bodies with trucks. Tenders to general manager by Jan. 7, 1919.

LIVERPOOL CORPORATION TRAMWAYS COMMITTEE invite tenders (by noon Dec. 31) for the supply of a number of motor omnibuses. Tender forms, &c., from the general manager, Mr. C. W. Mallins, M.I.A.E., 24, Hatton-garden, Liverpool.

The NEW ZEALAND PUBLIC WORKS DEPARTMENT requires tenders by noon Jan. 6 for the supply and delivery of transformers. Conditions from the Public Works Offices, Wellington, Auckland, Christchurch (Electrical) and Dunedin.

EDINBURGH ELECTRIC LIGHTING COMMITTEE has accepted the tender of the British Thomson-Houston Company for new plant at Dewar-place station, at £28,709.

Appointments Vacant.

The Council of Birmingham University invites applications for the chair of physics. Salary £1,000 a year. Particulars from the Secretary and applications by Feb. 8, 1919.

Stoke-on-Trent Corporation require a superintendent for a power house and electricity works. Applications to the Borough Electrical Engineer, St. Peter's-chambers, Stoke-on-Trent.

An assistant is required at Erith Technical Institute to teach electrical, engineering and mechanics. Initial salary up to £250. Application forms from Mr. A. T. Flux, Education Office, Picardy, Belvedere, Kent.

Applications are invited for the chair of chemistry at King's College, London. Initial salary £600 per annum. Applications to the Vice-Chancellor, University of London, Kensington, London, S.W.7, by Feb. 8.

Mr. Frank Tatlow has been appointed general manager of the Midland Railway Company, in succession to Sir Guy Granet, who retires on 31st inst.

Business Items.

The new London address of Sandycroft, Ltd., is 4, Broad-street-place, London, E.C.2. Tempororay telephone No., London Wall 7144.

The proprietor of patent No. 4900/1903, relating to the manufacture of transformers, desires to sell same or to grant licences. Applications to Messrs. Ecult, Wade & Tennant, 111-112, Patton Carden, London, E.C. 1.

The total output of machinery during 1918 by Messrs. Richardsons, Westgarth & Company, Ltd., amounted to 233,980 H.P., including steam turbines of 48,000 H.P. for electric power installations, with contraflo kinetic high-vacuum condensing plants.

Mr. A. E. McKenzie, M.I.E.E., deputy chief engineer to the Manchester Corporation electricity department, has resigned his position in order to join the staff of Messrs. C. P. Sparks, consulting engineers, of London. Mr. McKenzie has been in the service of Manchester Corporation for 17 years.

The Stanton Ironworks Company, Ltd., which recently amalgamated with the Holwell Iron Company, has now entered into an arrangement with Messrs. James Oakes & Company, under which the Stanton Company will act as sole selling agents for the products of Messrs. James Oakes & Company's blast furnaces and foundries.

As a proof of the great strides BRITISH MANUFACTURERS of MAGNETOS are making, it may be noted with satisfaction that Messrs. C. A. Vandervell & Co.'s output for October alone was no less than 3,500. The C.A.V. magneto figured largely on the motor cycles of our despatch riders on all fronts during the war, and met with their highest commendation.

Companies' Meetings and Reports, &c.

The CANADIAN GENERAL ELECTRIC COMPANY, LTD., has declared a quarterly dividend of 2 per cent. actual for the quarter to Dec. 31 on the common stock.

A dividend of 10s. per cent. has been declared on the EAST LONDON RAILWAY COMPANY'S "B" debenture stock for the past year, against 8s. 9d. per cent. in the previous year.

The MARCONI INTERNATIONAL MARINE COMMUNICATION COMPANY, LTD., has declared an interim dividend of 5 per cent (1s. per share) less tax, on account of the current year.

An extraordinary meeting will be held at 4B, Frederick's-place, Old Jewry, E.C., on the 27th instant to appoint Mr. R. H. Parker liquidator of the MALTA TRAMWAYS (in liquidation), in place of the late Mr. J. R. Tulloch.

The directors of MARCONI'S WIRELESS TELEGRAPH COMPANY, LTD., have declared a dividend of 7 per cent. (less tax) upon the 7 per cent. cumulative participating preference shares for the year 1918, and an interim dividend of 5 per cent. (less tax) upon the ordinary shares. The dividends are payable on Feb. 1 next.

At the adjourned meeting of the holders of the 5 per cent. first mortgage 50-year bonds of the BARCELONA TRACTION LIGHT & POWER COMPANY, LTD., last week, resolutions were unanimously passed sanctioning the scheme of re-organisation. The 1 per cent. interest on the 5 per cent. bonds, which under the scheme was due to be paid on the 1st inst., will be paid on the 6th prox.

The directors of Messrs. MIRRLEES, BICKERTON & DAY, LTD., propose to increase the capital to £350 000 by the creation of 140,000 new ordinary shares of £1 each, and 55,000 of the new shares will be offered to the holders of similar shares at par, while 55,000 more will be offered to them at a later date. The remaining 30,000 shares may be issued, at not less than par, to members of the staff, employees and agents of the company.

Mr. Geo. Fuller, who presided over the annual general meeting of FULLERS CARBON & ELECTRICAL COMPANY, LTD., on the 17th inst., said the usual accounts could not be presented owing to the question of the amount due for excess profits and the various allowances under the Munitions Acts not having been settled. He congratulated the shareholders upon their dividend of 10 per cent. on both classes of shares, against 8 per cent. last year. The turn-over during the period had been increased three-fold. The company's products had largely superseded the foreign product, and for the coming year they had already orders on the books equal to last year's entire sales. That had necessitated the erection of another large building with a fully equipped plant, which had materially increased the output. He looked with considerable confidence to the future, and was glad of the opportunity of capturing a trade hitherto largely controlled by Germany.

The Earl of Kintore, who presided over the meeting of the SULPHILE CORPORATION, LTD., last week, stated that in their accounts was included an amount of £8,500, being the cost of an interest which the company had acquired in Duram Ltd., to an extent approaching one-fourth of the total issued capital of that concern. Duram Ltd. was a highly intensive manufacturing company specialising in the production of tungsten and molybdenum wire and filaments, which were essential to the manufacture of the metallic filament electric lamps. Prior to the war practically the whole of such filament was imported from foreign countries, mainly Germany, but owing to the great development of production by the company the needs of this country could now be entirely supplied at a lower cost than before the war without any importation at all. In addition to wire and filament, the company was specialising in the commercial production of pure metallic tungsten and molybdenum. Duram Ltd. was now operating on a very successful and profitable basis, and under all reasonable conditions gave promise of a prosperous future on an extended scale of operations.

Mr. G. W. Balfour, who presided over the annual meeting of the CASTNER-KELLNER ALKALI COMPANY, LTD., stated that the net profit for the year was £261,339, a reduction of under £2,000 compared with the previous year. Out of the available balance of £208,819 it was proposed to place £50,000 to depreciation reserve, and to pay a final dividend of 11 per cent., making 20 per cent for the year, carrying forward £48,819. The result of the year's working might be regarded as distinctly satisfactory, but it had been a case of working at high pressure throughout. The whole of the company's resources had been placed

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at the disposal of the Munitions Department. In the present chaos of things he would be a bold man who would undertake to see far into the future, but the position of the company was undoubtedly a strong one. The armistice was declared on Nov. 11, at 11 o'clock. On the following day they were requested to cease all preparation of war material and to revert at once to a peace footing. That they were able to do, and by 3 o'clock in the afternoon the change had been made. They were now getting men back from the Front as quickly as possible. The company's output capacity to meet the peace-time requirements of their customers would before long be largely increased.

At the general meeting of the AABADA TRUST, LTD., on Friday, the Earl of Kintore, who presided, said that as the board had decided to have the accounts made up to the end of 1918, the meeting would be adjourned to an early date in the new year. The trust had been in existence since 1912, though for the past few years its operations had been restricted by the war. Its current business was almost entirely confined to the development of electrical undertakings and to allied interests. Their managing director (Mr. C. S. Colton) and their engineers had long been associated with the electrical industry. Mr. J. W. Towle, M.I.E.E., who was formerly superintendent of power for the Metropolitan District Railway and for the London Electric Railways, and chief engineer to the Ebro Irrigation power station, Barcelona, had been appointed chief of the engineering staff. The trust would, therefore, have at its disposal the highest technical knowledge, both for the selection of its undertakings and for the supervision of their execution. The financial resources of the trust were sufficient for all the requirements of the current business, and should further working capital be required for extensions the trust had an unissued capital of £44,000. They had large and important business on hand, and in regard to some of their undertakings several of the best-known engineering and chemical firms in the country were jointly interested with them.

At the annual general meeting of the BRITISH COALITE, LTD., last week the chairman stated that there was immense scope for Government action no less than for individual enterprise. They were within measurable distance of the nationalisation of many public services, including the railways and canals, as well, probably, as the services of gas and electricity. A good and promising beginning may be made with the railways and the supply of electricity. No condemnation could be too severe for the piece-meal fashion in which our electrical undertakings had been allowed to develop. To obtain an adequate supply of cheap power (the great desideratum of industrial economy) under existing conditions was manifestly impossible, and one could not doubt that, given an energetic policy on the part of the Government, all those disparate and oft-times competing concerns would ultimately be swept away or so re-organised that their places would be taken by a tenth of the numbers of vast generating stations working in conjunction with, and contiguous to, the coal mines and such plants as theirs, where the crude coal would be distilled and converted into a smokeless fuel for domestic and other purposes, into fuel gas to replace the present wasteful burning of coal for steam raising, as well as into the many by-products that would enrich the "industrial life-blood" of the country. Under such a scheme, power would cost but a fraction of its present price, while there would be the further double gain of an immense purification of our manufacturing districts and the utilisation—almost, one might say, to the last ton—of our coal measures, so large a proportion of which at present go to waste in the form of soot and smoke.

In the course of his speech at last week's meeting of the DELAGOA BAY DEVELOPMENT CORPORATION, LTD., Mr. H. K. Heyland (the chairman) stated that the gross revenue from all the undertakings in Lourenco Marques amounted for the year to just over £100,000, but expenditure had risen nearly £5,000. The net revenue of the tramways showed a satisfactory increase, as also the electric power supply whereas electric lighting remained the same as in the previous year. In October, 1917, the Corporation was served with a legal notice by the Municipal Council that it would exercise its rights of expropriation of the electric lighting undertaking, which it was entitled to under the terms of the concession after the first 20 years of the concession period of 30 years had expired. The Council stated that it did not wish to exercise this right if the Corporation would agree to certain alterations in the tariff and some modifications in the concession. Lengthy negotiations ensued, but, as finality had not been reached by March, the Board authorised substantial reductions for current to private consumers and for meter rental to take place as from April 1 last. Negotiations were still proceeding, and it was hoped that at an early date the reductions would receive official recognition by the Council, and thus terminate the question. The conditions of expropriation in the electric lighting contract were quite satisfactory and favourable to the corporation. Practically all the electri. energy used in Lourenco Marques was now produced at the tramway power-station, whereas formerly there were three separate stations, one of which belonged to the Corporation. That centralisation meant considerable economy in cost of production and distribution, and that enabled the directors to make the reductions to private lighting consumers.

At the annual general meeting of FRASER & CHALMERS, LTD., on Thursday last the chairman (Mr. A. W. Tait) stated that the net profit was £33,295, compared with £36,174 for the previous year; but the figures only included the trading of the Erith works for nine months. For some time the directors had appreciated that, in order to secure the full development of their manufacturing business, particularly in connection with turbines and turbo-blowers, they should seek an alliance with some company or group in the electrical industry which would be sufficiently strong to quote for and obtain contracts and orders for large electrical installations both at home and abroad. Towards the end of last year preliminary discussions took place with the General Electric Company as to whether it was possible to arrive at some arrangement with them. The directors decided, however, to retain their general merchant business in London, in South Africa and at other branches. Arrangements were practically completed with the General Electric Company upon that basis, but when both parties came to examine the conditions which might arise in future trading, with possible conflict of interest as to rights of manufacture, it was decided that it would be better to sell the manufacturing works and business as a whole, without attempting to retain any part thereof. Accordingly, arrangements were finally completed and agreements signed whereby the whole of the Erith works and plant and the manufacturing business were sold on the basis of the book values at March 31, 1918, together with a substantial sum for the goodwill, patterns and drawings, which amounted to £110,000. There are still some uncompleted adjustments to make, but the figures stated in the balance-sheet as being the sale price payable by the General Electric Company might be taken to be approximately accurate, and the principal sum had been received in cash since the close of the accounts. The South African merchanting business had since been sold, and arrangements had been made with their manager in Canada (Mr. Sancton) to take over the company's assets there. Negotiations were also proceeding with the General Electric Company in regard to their business in Australia and Singapore. In view of the realisation of so large a proportion of their assets and business, it was suggested that the company should go into voluntary liquidation, but that question would be decided at a special meeting.

The report of the EDISON SWAN ELECTRIC COMPANY, LTD., for the year ended June 30 last states that the balance to credit of profit and loss account is £129,209. 13s. 2d., to which has to be added £13,266. 13s. 1d. brought forward, totalling £142,476. 6s. 3d., from which has to be deducted £19,119. 7s. for interest on both classes of debenture stock, and £3,792. 10s. 3d. for interim dividend upon the first preference shares to Jan. 31, 1918, and the following amounts already dealt with: Munitions levy balance (£586. 15s.), expenditure on bomb-proof shelters (£1,403. 5s.), special munitions plant, &c., depreciation) £11,738. 19s. 5d.), expenses of preference share issue written off (£4,221. 15s. 2d.), and cost of debenture stock purchased for sinking fund (£974. 13s. 9d.), leaving £100,638. 11s. 8d. The directors recommend that this should be appropriated as follows: Further provision for debenture stock sinking fund (£8,612. 5s. 3d. 3 per cent. dividend on the first participating preference shares (£3,000), transfer to reserve (£10,000), 7½ per cent. dividend on the "A" shares (£28,760. 17s.), leaving to be carried forward, subject to excess profits duty, £50,265. 9s. 5d. The capital expenditure during the year, before providing for depreciation, amounted to £17,907, of which £2,731 is in respect of additions to buildings and £15,176 to plant and machinery. The plant extensions have been mainly in respect of special plant erected for carrying out Government contracts, and, under arrangement with the Ministry of Munitions, £11,739 has been written off. The new capital provided by the issue of preference shares, and the improved organisation, have had a very distinct bearing upon the increased profits shown. How far the reconstruction and reorganisation of the industrial undertakings of the country will affect the earning capacity of this company in the immediate future it is at present impossible to foresee. Your directors hope that, given an adequate supply of raw materials and an equitable solution of the labour problem, satisfactory profits will be earned; the question of tariffs, however, is a highly important one for all electrical undertakings, and must not be lost sight of. As soon as more normal conditions with regard to the shipment of goods abroad are established, it is hoped that the company's export business will become a valuable source of revenue. In order to carry into effect the general policy of expansion which the directors have in view, it is proposed to take steps to make a further issue of ordinary shares, which in due course will be offered to the existing shareholders for subscription. A freehold property in the north of London has been purchased since the date of the balance-sheet for the purpose of manufacturing dry cells and batteries, the capacity of the existing shops at Ponders End not being sufficient to cope with the orders received, and in addition 10 acres of freeholdland adjoining the Ponders End works have been purchased.

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, December 24, 1881.]

THE TELEPHONE IN LIVERPOOL.—A telephone experiment between the Philharmonic Hall and the office of the chairman of directors—a mile distant—was tried on Tuesday, on the occasion of a concert rehearsal, and found satisfactory, both instruments and voices being heard.

ELECTRIC LIGHTING AT THE ROYAL SOCIETY.—For some time past the Society has been in the habit of occasionally illuminating its rooms on the nights of meetings with Swan lamps. We now hear that it has definitely adopted this system for the meeting room and approaches. The lamps are driven by a Siemens machine.

AN ELECTRICAL CHRISTMAS TREE.—A large Christmas tree, hung with incandescent electric lights, will make a very pretty effect, and we understand that the Edison Agency in London, acting on a suggestion of Mr. J. Munro, intend to have one at the forthcoming Crystal Palace Exhibition. The usual giant tree will not this year be erected, as the space is taken for the Exhibition

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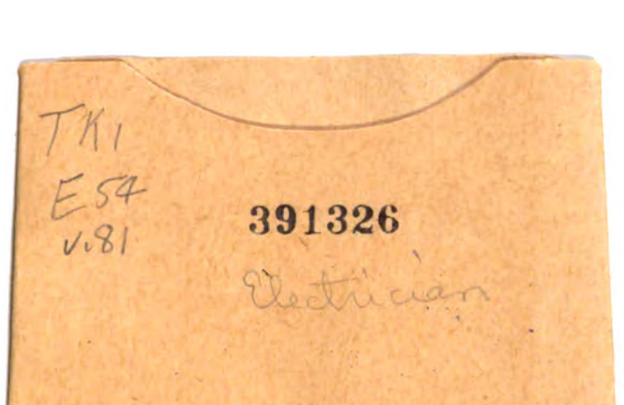
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